Library
of the
University of Toronto

Digitized by the Internet Archive
in 2013

http://archive.org/details/modpowerengin1923toro

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street. E. C. NEW YORK, BOSTON, CHICAGO

Vol. XVI—No 1. Publication Office, Toronto—January 5, 1923
Published Semi-Monthly.
Canada, $2; U.S. $2.50 a year

The *Importance* of
Water Softening and Filtration
In the Modern Power Plant
is a *Proven Fact*
not an experiment

"PERMUTIT"

Water Softening and Filtration Systems
are Giving General Satisfaction

There are in Canada more than one hundred and fifty "Permutit" Systems, with a daily capacity of over thirteen million gallons.

We *Guarantee* Results

Send for our free booklet, "Reducing Fuel and Boiler Plant Operating Costs."

W. J. Westaway Company, Limited
Hamilton - Ontario

Hamilton Office:
"The Westaway Building"
Main & McNab Streets

Demonstrating Department:
"The Westaway Building"
Main & McNab Streets

Montreal Office:
Room 400,
McGill Building

"PALMETTO"

PACKING

for

STEAM (especially high pressure superheat)

and

COMPRESSED AIR

has a world-wide reputation for showing a greater economy over lower priced packings because it is made of materials that give long satisfactory service.

It is cheaper in the long run to use a packing that has the quality if real economy in operation is to be considered.

BRAIDED round and square for rods. Sizes ⅛″ to 2″ by sixteenths. Put up in dust-proof boxes of about 5 lbs. each.

TWIST for small valves—each strand is separately lubricated, and therefore a perfect packing in itself. By unstranding any size valve may be packed from one spool. Comes in sizes ⅛″, 3/16″, ¼″, 5/16″, ⅜″, 7/16″ and ½″ on one-pound tin spools in dust-proof boxes.

Send for free working samples to test under your own conditions. It will pay you to know how long "Palmetto" lasts in service.

Greene, Tweed & Co.

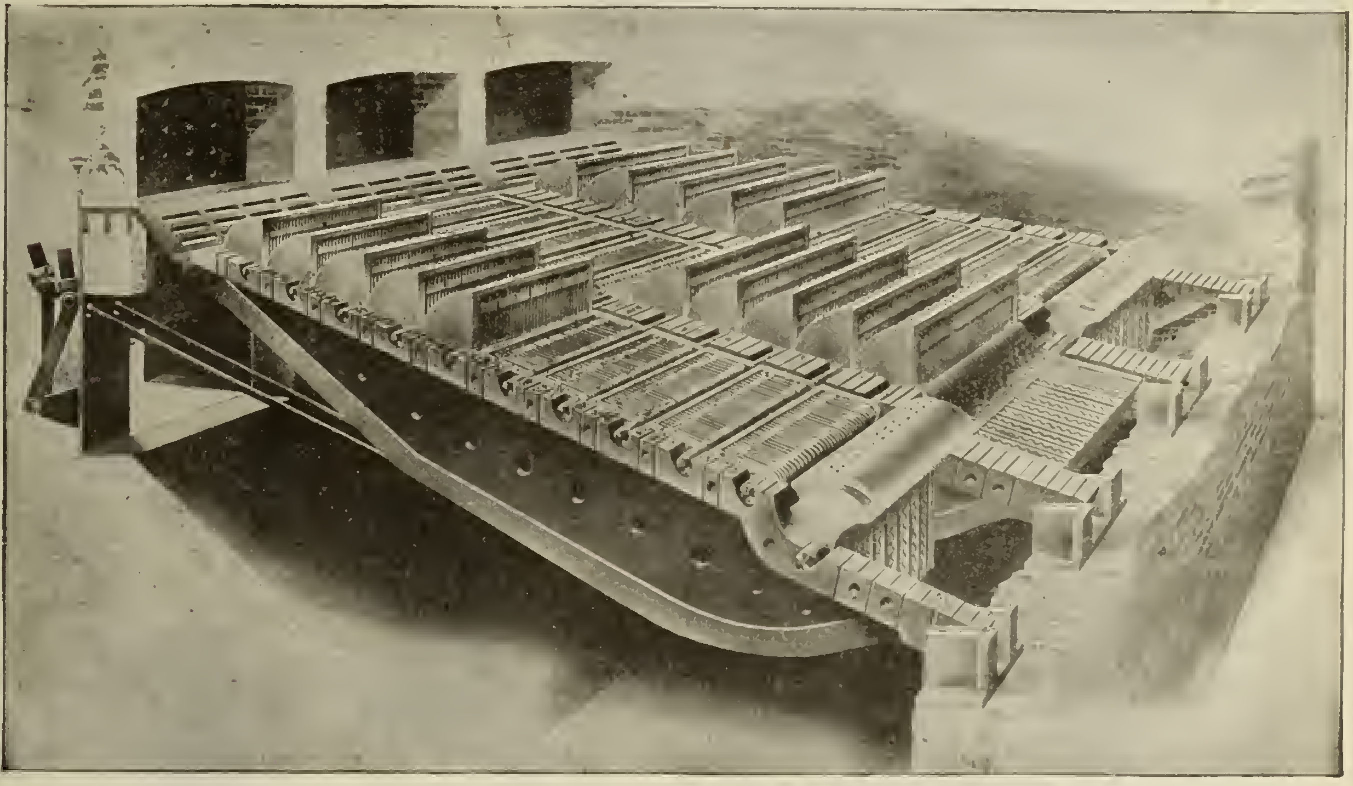
Sole Manufacturers

109 Duane St., New York

CANADIAN AGENTS:
The Canadian Fairbanks-Morse Co., Limited,
Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

Files Stokers

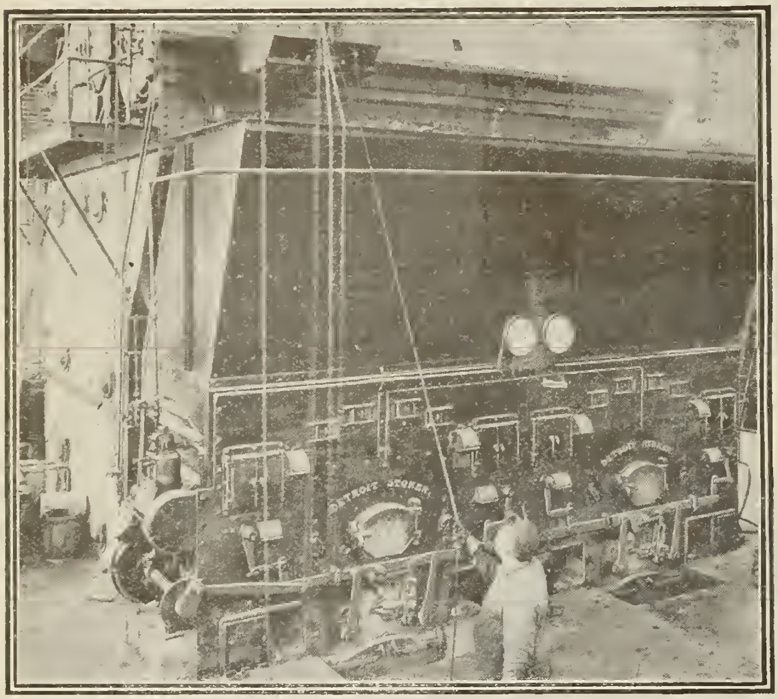
Hand Operated



Waterous

BRANTFORD, ONTARIO, CANADA

\$1000^{00} or More Saving per Year by Use of Cheaper Fuel Alone with one Detroit V-Type Stoker—



Detroit "V" Type Stokers and Stirling boilers.
Coal bunker built by Detroit Stoker Company.

The opportunities for effecting savings through the installation of Detroit V-Type Stokers are larger than are generally appreciated. Coal consumption in the average plant, for instance, is not less than 10 tons per H. P. year— that is 1000 tons of coal will be fired under a 100 H. P. boiler, 2000 tons under a 200 H. P., etc. As Detroit Stokers will burn successfully lower grades of fuel than can be used with hand firing, it is frequently possible to save a dollar or more a ton on the purchase price of coal alone, so that savings of \$1000 to \$2500 per stoker per year from this one source are not uncommon.

Of equal importance is the increase in overall boiler efficiency effected by the use of Detroit Stokers. Fifty-five to sixty per cent efficiency is a really high average for the typical hand-fired plant. After Detroit Stokers are installed efficiencies of seventy to seventy-five per cent are readily maintained. This means that with Detroit Stokers four tons of coal will produce as much steam as will five tons of coal in the hand-fired plant.

Remember that natural draft stokers may be profitably installed under both tubular and water tube boilers.

Send for your copy of the
Detroit V-Type Stoker
Bulletin No. 338

It is yours for the asking

DETROIT STOKER COMPANY
Underfeed Forced Draft and Overfeed Natural Draft Stokers
338 GENERAL MOTORS BUILDING DETROIT, MICH.

SAVE FUEL "DETROIT V TYPE STOKER" AND LABOR

D K McLAREN LEATHER BELTING

There are Two Good Reasons Why

D. K. McLaren's Leather Belting gives such "trouble-free" service on the pulley—a service which means so much when transmission costs are considered.

The first is that only the **back portions** of the choicest hides, selected by experts, are used. All shoulders, necks and bellies go into the discard so far as D. K. McLaren's Belting is concerned.

The second reason is in the

Genuine British Oak Tanning Process

to which every inch of leather is subjected. This process should not be confused with the ordinary "Oak" process more often used in the Tanning of Leather. It is the one-time closely guarded secret of English tanners—a slow, expensive process, but one to which D. K. McLaren's Leather Belting owes its unusual toughness and pliability which gives it that "gripping power" for which it is so famous.

The Oak Leaf stamped upon every length identifies it —it's also your guarantee and is worth looking for.

Made From Back Leathers

The Best Part of the Hide

Only the choicest steers are selected for the making of this belting. It has quality through and through because only Back Leathers are used.

GENUINE OAK

D·K·McLAREN
LIMITED

GENUINE OAK

Head Office and Factory: 351 St. James St., Montreal, P. Q., Canada

Branches:
Toronto, Ont., 194 King St. West.
St. John, N. B., 90 Germain St.

Stock Depot:
Vancouver, B.C., Gormans, Ltd., 1158 Homer St.
Calgary, Gormans, Limited.
Edmonton, Gormans, Limited.

Increases Your Production

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

"P M S"

THE "RED RIBBON" BELT

Increases production by giving greater efficiency in transmitting the power that is so costly to develop, by minimizing "breakdowns" and stops for readjustments.

These are not mere idle claims, but actual achievements by "P M S" in many of Canada's leading plants. Greater adhesion to the pulley, great strength, even pliability, and remarkable resistance to the effects of heat, cold and moisture are the reasons for its success.

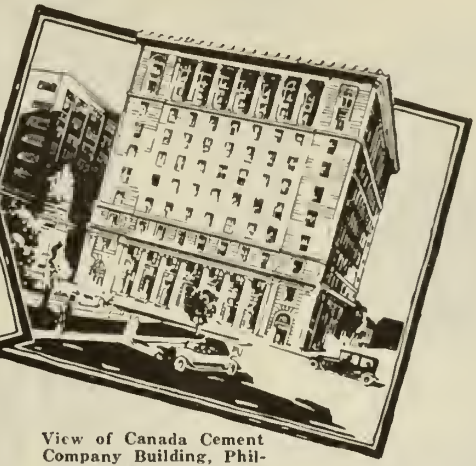
Manufactured Exclusively By

Gutta Percha & Rubber, Limited

Head Offices and Factories, Toronto

Branches in All Leading Cities of Canada

View of new Mount Royal Hotel, Montreal, Completed 1922.



View of Canada Cement Company Building, Phillips Square, Montreal, Completed 1922.

Artistic, Fire-Resisting Buildings of Concrete

The new Mount Royal Hotel and the Canada Cement Company Building add to the architectural achievements of Canada's greatest city.

It is particularly gratifying to have Concrete and Concrete products aid in this accomplishment. The facing and stone trim, manufactured by the Canadian Benedict Stone Co., Ltd., in Montreal, is used on the Mount Royal Hotel. The same stone is used on the Canada Cement Company Building.

This manufactured stone is reasonable in cost as well as pleasing in appearance. It is being used in many of the important structures now under construction in Ontario and Quebec.

The foundation and floors of the new hotel are reinforced concrete and the Canada Cement Company Building is Concrete throughout.

These two beautiful structures are fire resisting—a most important consideration in a hotel and office building. Our confidence in the fire resisting qualities of the Canada Cement Company Building is evinced by our decision to carry no insurance whatsoever on the building.

**We have literature on the possibilities of Concrete in office buildings.
We shall gladly mail copies free to anyone interested.**

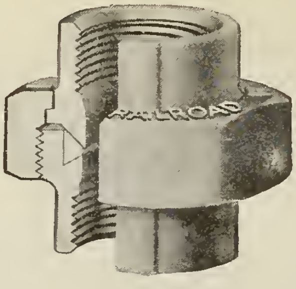
CANADA CEMENT COMPANY, LIMITED

Canada Cement Company Building - Phillips Square, Montreal

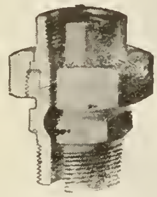
Sales Offices at:

Montreal Toronto Winnipeg Calgary

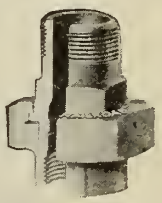
CANADA CEMENT
CONCRETE
FOR PERMANENCE



No. 519



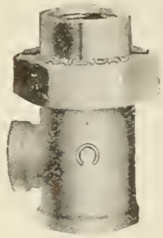
No. 517 Reducing Pump Stud Union.



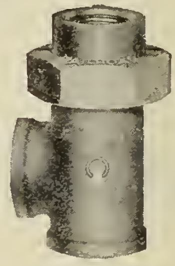
No. 519½. Male and Female Union.

CRANE

RAILROAD UNIONS AND FITTINGS



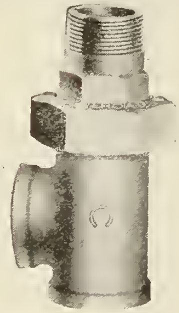
No. 594 Tee with Female Union.



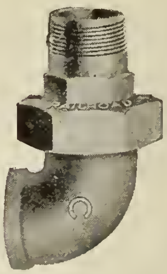
No. 595 Tee Reducing on Outlet

Are Absolutely Leak-Proof, and Eliminate Unnecessary Joints.

THEY REQUIRE NO GASKETS AND MAY BE TAKEN APART EASILY.

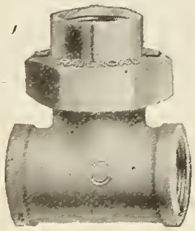


No. 596 Tee with Male Union.

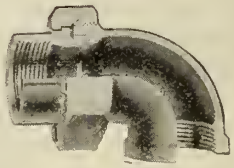


No. 592 Elbow with Male Union

Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe Plumbing and Heating Supplies.



No. 598 Tee Union on Outlet.



No. 590 Elbow with Female Union

Branches and Warehouses:
HALIFAX, OTTAWA, TORONTO,
HAMILTON, LONDON, WINNIPEG,
REGINA, CALGARY, VANCOUVER.

Sales Offices:
ST.JOHN,NB.,QUEBEC,SHERBROOKE
EDMONTON, VICTORIA,
SYDNEY, AUSTRALIA.

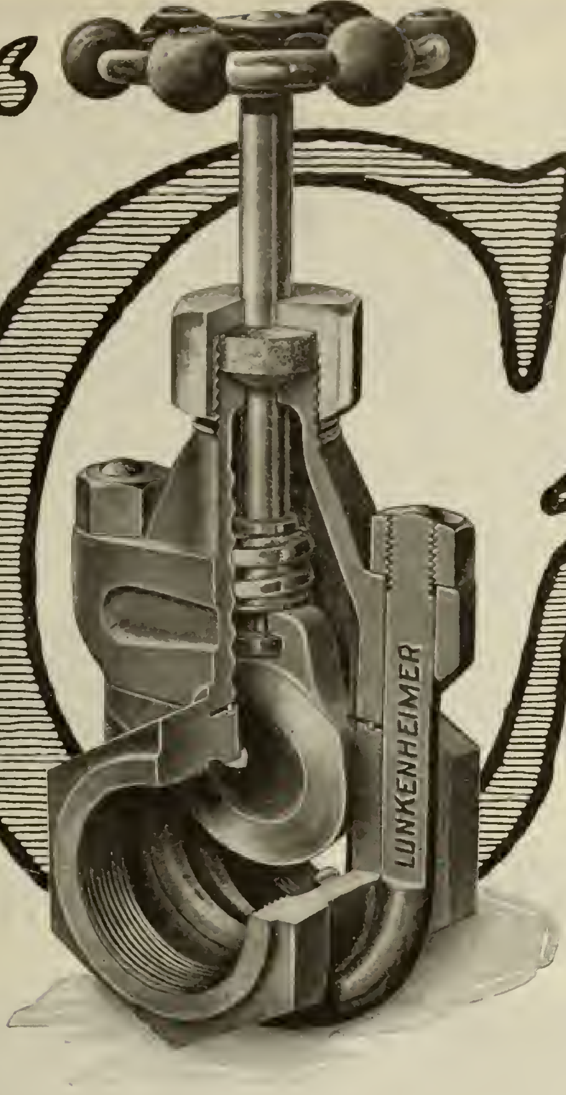
CRANE
LIMITED
HEAD OFFICE & SHOW ROOMS
386 BEAVER HALL SQUARE
MONTREAL
Works
1280 ST. PATRICK ST.
MONTREAL

CRANE-BENNETT
LIMITED
Head Office and Warehouse:
LONDON, ENGLAND.

Sales Offices:
BIRMINGHAM, CARDIFF,
GLASGOW, LEEDS, MANCHESTER.

31

"Clip"



Gate Valves

An original Lunkenheimer development with a record of more than twenty years of success in service.

The simplicity of the design; the durability and the wide range of sizes and material combinations available peculiarly fits them for standardization in the low pressure lines throughout the plant. The Inside Screw type is recommended for pressures up to 100 pounds, while the Quick-operating type is good for 50 pounds.

Iron Body Bronze Mounted for handling Steam, Water, Oil, etc., and "All-Iron" for use with Acids, Alkalis, and other fluids which attack bronze alloys.

Specify LUNKENHEIMER and insist on getting the genuine. Booklet 505-DC covers the full range of types and sizes, together with description and list prices. Let us send you a copy.

Fig. 600—Screw Ends, iron Body Bronze Mounted.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO **CINCINNATI, U.S.A.** BOSTON LONDON
EXPORT DEPT. 129 135 LAFAYETTE ST. NEW YORK

5-18-43.

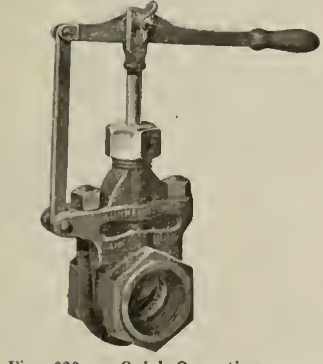


Fig. 639 — Quick-Operating type, screw ends, I.B.B.M.

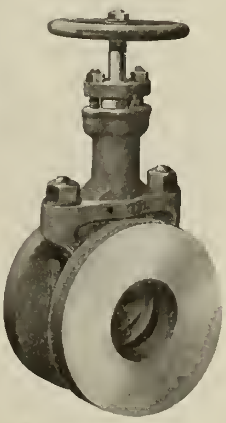
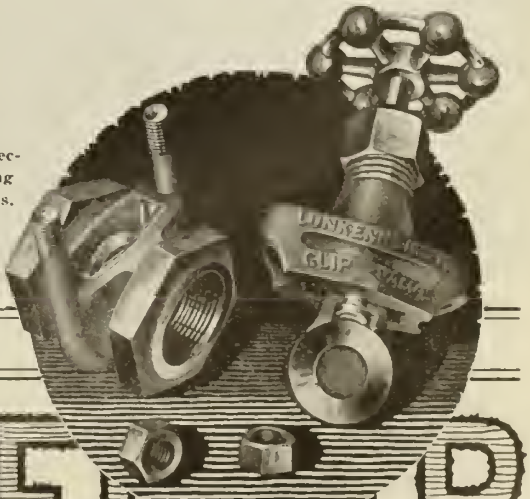


Fig. 638—Flange Ends, Iron Body, Bronze Mounted.

View showing ease of taking apart for inspection or cleaning of internal parts.



"America's Best since 1862"

LUNKENHEIMER

YARWAY BLOW-OFF VALVES

THE YARWAY TANDEM

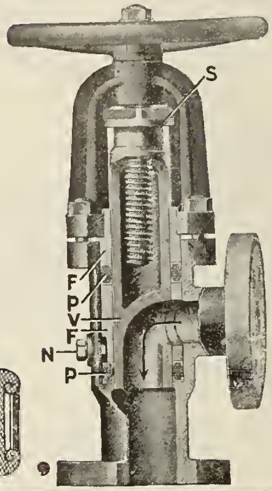
This is the ideal combination for blow-off service. The slow-opening plunger type Seatless valve can be depended upon to keep the line tight and prevent water-hammer, while the quick-opening lever-operated Double-Tightening valve may be used only in case of repairs or emergency.

THESE two valves — the YARWAY SEATLESS BLOW-OFF VALVE and the YARWAY DOUBLE-TIGHTENING VALVE— have given to thousands of power-plant men a new idea of the efficiency and service that may be reasonably expected from blow-off valves.

Both valves are fully described in Booklet B-410. A copy will be promptly mailed at your request.

YARNALL-WARING COMPANY
Mermaid Lane & Ardleigh St.,
PHILADELPHIA

207 St. James St., MONTREAL. 400 Penobscott Bldg, DETROIT.

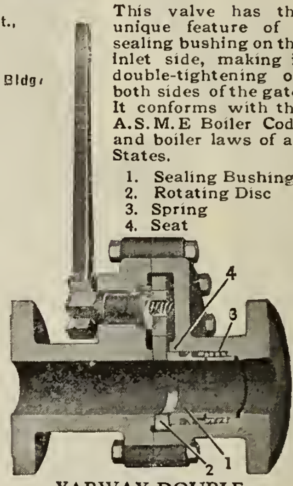


YARWAY SEATLESS BLOW-OFF VALVE

After valve has closed, shoulder S on plunger V engages the loose follower gland F. A hard turn of handwheel then compresses packing P above and below the port, making an absolutely tight valve. This automatic method of tightening the packing is an exclusive advantage of the YARWAY SEATLESS BLOW-OFF VALVE. Set screw N prevents turning of gland F when handwheel is turned.

This valve has the unique feature of a sealing bushing on the inlet side, making it double-tightening on both sides of the gate. It conforms with the A.S.M.E Boiler Code and boiler laws of all States.

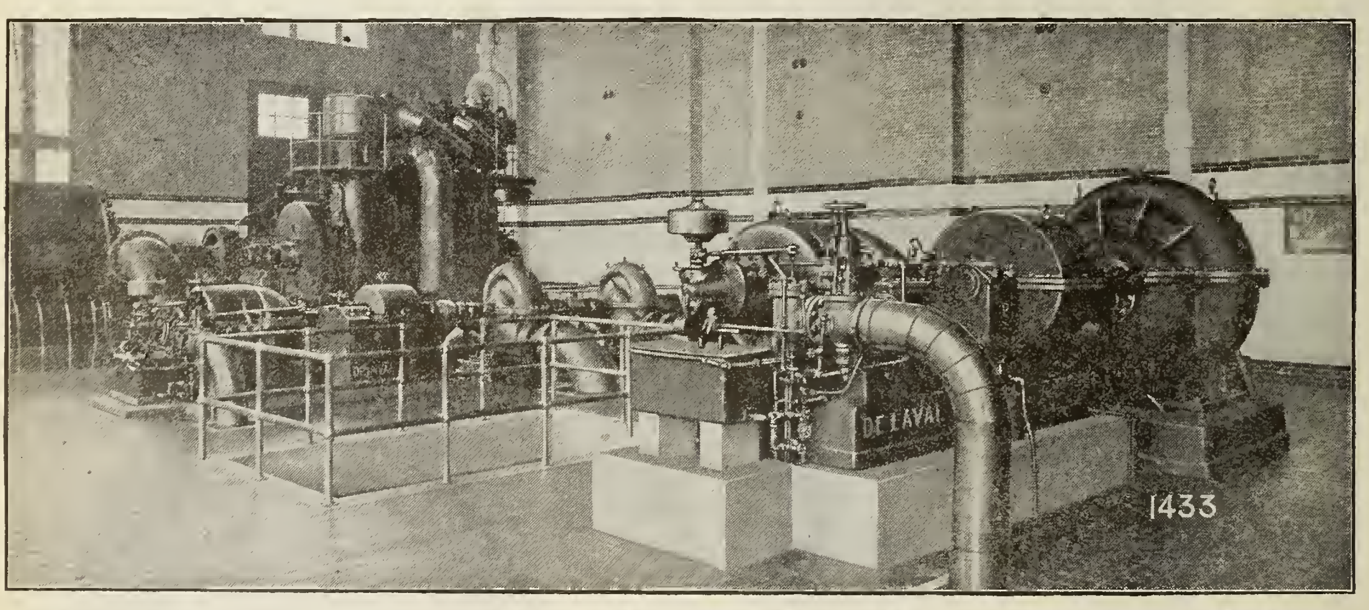
1. Sealing Bushing
2. Rotating Disc
3. Spring
4. Seat



YARWAY DOUBLE-TIGHTENING VALVE

YARWAY

POWER PLANT DEVICES *to save fuel*



DE LAVAL TURBINE DRIVEN PUMPS AT TORONTO

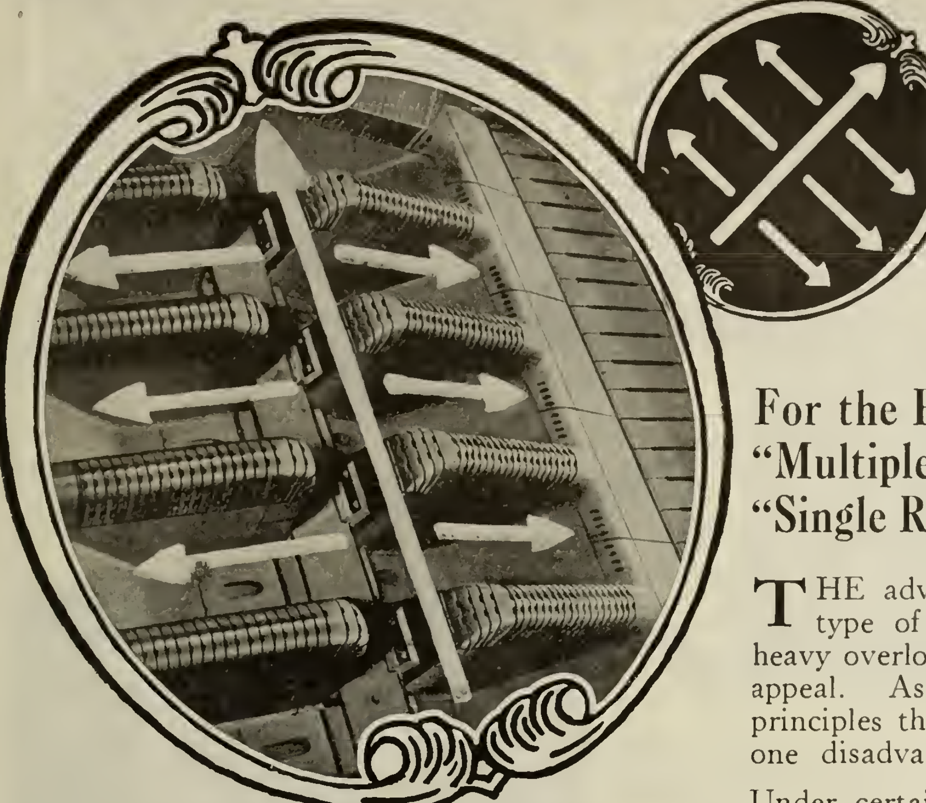
THE De Laval geared steam turbine driven centrifugal pump has amply demonstrated its ability to handle water at the least cost, fixed charges as well as fuel cost being considered. Toronto has three units of this type in the John Street Station and two in the High Level Station, the aggregate capacity being 100,000 Imperial gallons per day, or about 5,000 water horse-power. The High Level Station pumps, shown above, have capacities of 20,000,000 gal. per day against 106 ft. and 7,500,000 gal. against 266 ft. Four 20,000,000 Imperial gal. per day motor driven De Laval pumps designed for 250 ft. head have recently been installed and accepted by the City of Toronto, after highly satisfactory acceptance tests. Over 150 municipalities and some 20,000,000 people on this side of the globe now depend for water supply on De Laval centrifugal pumping units. If you are interested in this subject, we will gladly send you our book W-100 "Ten Years' Progress in Water Works Pumps."

De Laval
Steam Turbine Company

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

TAYLOR ENGINEERING CO., LTD.
Vancouver, B. C.



*"Lateral Retort" is a trademark — illustrated by this figure.

The arrows show the path of coal travel.

For the Plant with "Multiple Retort" Ideas and a "Single Retort" Appropriation—

THE advantages of the multiple retort type of stoker—higher efficiency and heavy overload capacity—make a universal appeal. As compared with other stoker principles the multiple retort type has just one disadvantage — its greater first cost.

Under certain conditions the greater first cost and installation cost of the multiple retort type becomes a serious drawback.

Right there is where the *"Lateral Retort"** Stoker fits in—it has made possible, for the first time, a multiple retort effect in a simple side-cleaning stoker—a stoker that costs far less than a multiple retort stoker; that requires no expensive provisions for installation; that is adaptable to old boilers because no basement space is required for ash pits.

The ingenious *"lateral retort"* principle insures multiple retort stoking in a simple stoker with only a few rugged moving parts.

Coal is first underfed to the large central retort by a steam driven ram. It is then underfed to the several *lateral retorts* by means of simple pusher rods, all of which are operated by a single auxiliary steam cylinder. From its entrance into the main retort until it reaches the dump plate, the coal is always *underfed*—an advantage heretofore possible only in stokers of the multiple retort type.

Learn how the *"Lateral Retort"* Stoker meets a hitherto unfulfilled need. Write for the new bulletin.

Underfeed Stoker Co., of Canada, Ltd.
146 King Street West, Toronto

Sales Agents for Jones Under-Feed Stokers, Riley Under-Feed Stokers, and Murphy Automatic Furnaces

Alta. and West Sask.:
Mr. J. Twomey,
Camrose, Alberta.

Man. and East Sask.:
W. W. Hicks & Co.,
Winnipeg.

British Columbia:
E. A. Earle, Limited,
Vancouver, B. C.

Quebec:
The Cleaton Co., (Canada), Ltd., Montreal,
Que.

RILEY
JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

The "Lateral Retort" Stoker

TRADE MARK

LINDE

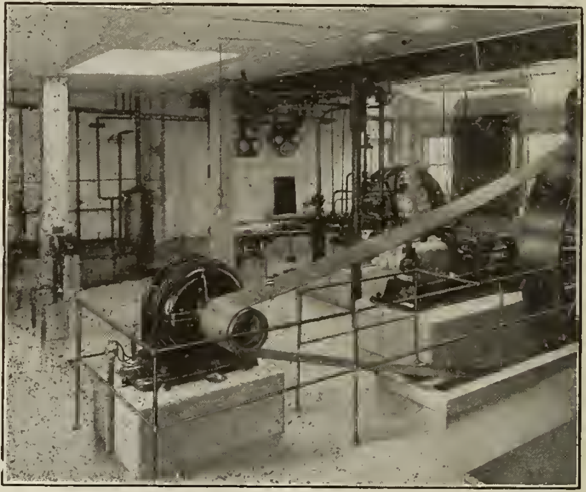
Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants,
Large and Small.

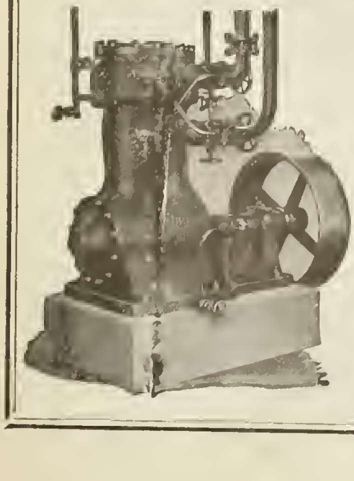
Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.
37 St. Peter Street, MONTREAL, Que.
TORONTO WINNIPEG VANCOUVER



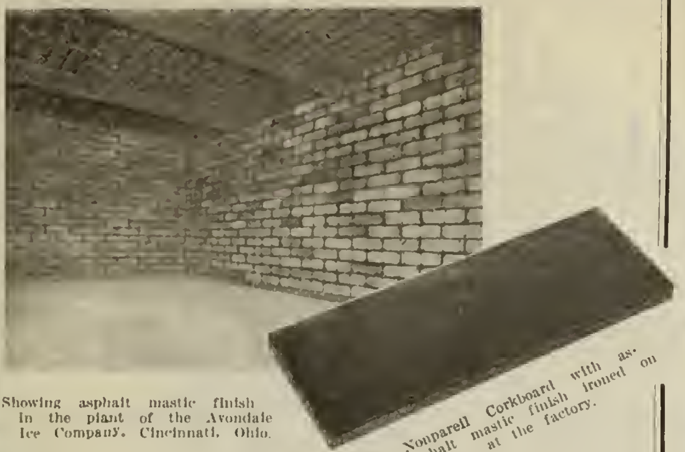
Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada
CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company
242 Beecher St. - - - Milwaukee, Wisconsin



Showing asphalt mastic finish in the plant of the Avondale Ice Company, Cincinnati, Ohio.

Nonpareil Corkboard with asphalt mastic finish ironed on at the factory.

Asphalt Majestic Finish for Ice Storages

HERE is a finish that does stand up in ice storages and one that will protect your insulation permanently—asphalt mastic Nonpareil Corkboard. Asphalt mastic is not a mopped coating, but is ironed on at the factory, smoothly and evenly—approximately 1/8 inch thick. It is keyed into the board under pressure and contains no voids or air holes.

Asphalt mastic is impervious to air and moisture and so tends to prevent the formation of frost in and under the finish. Asphalt mastic is odorless. It will not run or peel at ordinary temperatures or crack when cold.

Asphalt mastic Nonpareil Corkboards are used for the finish course only. The edges of the coating are slightly beveled, leaving shallow V-shaped joints in the surface when the boards are erected. These are filled with mastic composition which is smoothed out and amalgamated with the mastic on the board by going over the joints with a heated iron. The result is an unbroken, airproof and waterproof surface. No other finish is required.

Asphalt mastic Nonpareil Corkboard is recommended for all ice storage rooms, for coil lofts and bunkers and for all cold storage rooms where excessive moisture is present.

Full Information will be furnished on request. Ask for a copy of the 152-page book, "Nonpareil Corkboard Insulation" and a sample which are sent free of charge.

Armstrong Cork & Insulation Co., Ltd.

902 McGill Building
Montreal, Que.

11 Brant Street
Toronto, Ont.

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers, tanks and cold surfaces generally; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Corkboard Insulation

For Ice Storage Rooms

"For Reliable Service give me YORK Equipment"

When the Operating Engineer of an Ice Making or Refrigerating Plant insists upon the Plant Manager buying York Ammonia Fittings and Supplies, he knows he is saving himself a lot of time and trouble and also reducing the operating costs of the plant.

He knows, because he has learned through past experiences of his own, or perhaps from another Engineer, that York Equipment is designed and made to meet the severest Service.

Surely, the man who is responsible for the operation of the plant, who sees and handles the equipment every day, should be best able to judge the merits of each piece of apparatus.

And the engineer out of justice to his employers and to himself, will recommend York Apparatus, which he realizes will give satisfactory results in actual service. That's why more York Ammonia Fittings and Supplies are sold each year than any other make.

There is perhaps no other concern of its kind in the world able to handle such a large number of orders or such a heavy volume of business.

A trial order will convince you of the Superior Quality of York Ammonia Fittings and Supplies.

CANADIAN ICE MACHINE CO., LTD.

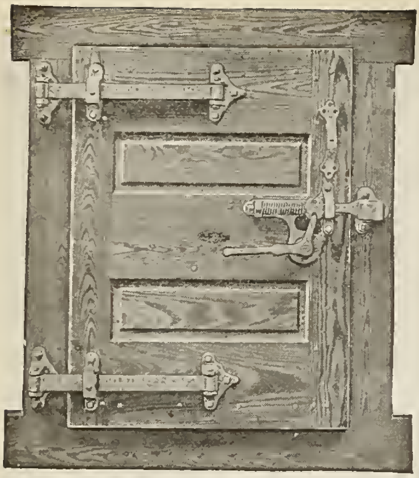
Toronto: Villiers and Munition Sts., Eastern Harbor Terminals; **Montreal:** 324 Craig St West, **Winnipeg:** 1415 Whyte Ave., **Vancouver:** 1158 Homer St.

Representing

YORK MANUFACTURING CO.

Ice Making and Refrigerating Machinery Exclusively

YORK PENNA., U.S.A.



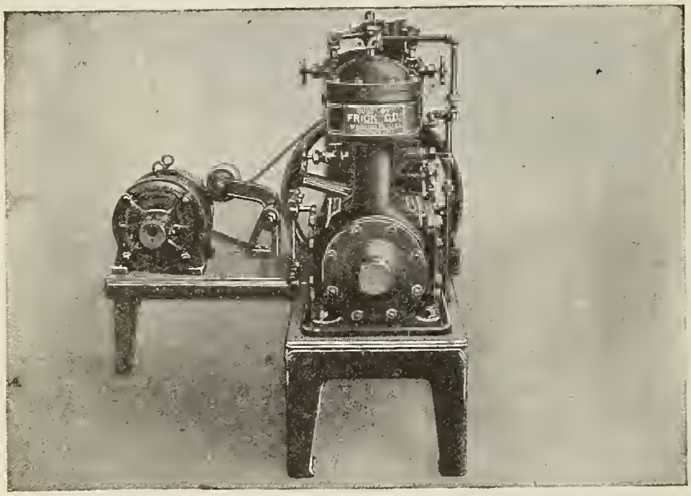
Jamison HEAVY DUTY Cold Storage Doors

Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)
HAGERSTOWN MARYLAND, U.S.A.



FRICK Combined Refrigerating Machine

This machine fills the needs of dairies, groceries, meat markets, restaurants, hospitals, confectionery and floral shops, etc., for a simple and efficient small refrigerating plant.

The machine is manufactured in one-ton and two-ton sizes. It is a complete self-contained unit, including compressor, condenser, separator, receiver and connections mounted on one solid portable iron base as shown. It is completely assembled in one crate with motor and motor base in separate box, and can be taken through a 26-inch door without uncrating.

No foundation is required. The machine is as easily put in place as the ordinary counter or refrigerator, and as easily removed—an important feature to the user who rents his place of business.

Machine is completely protected with safety devices. Either part automatic or full automatic control is supplied as desired. It is unusually quiet in operation and can be placed in any desirable location.

Ask our nearest distributor for further details and prices.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

---

NORTHERN

CRANES

NORTHERN CRANE WORKS, LTD.
Walkerville, Ont.

INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE

OF POWER HOUSE

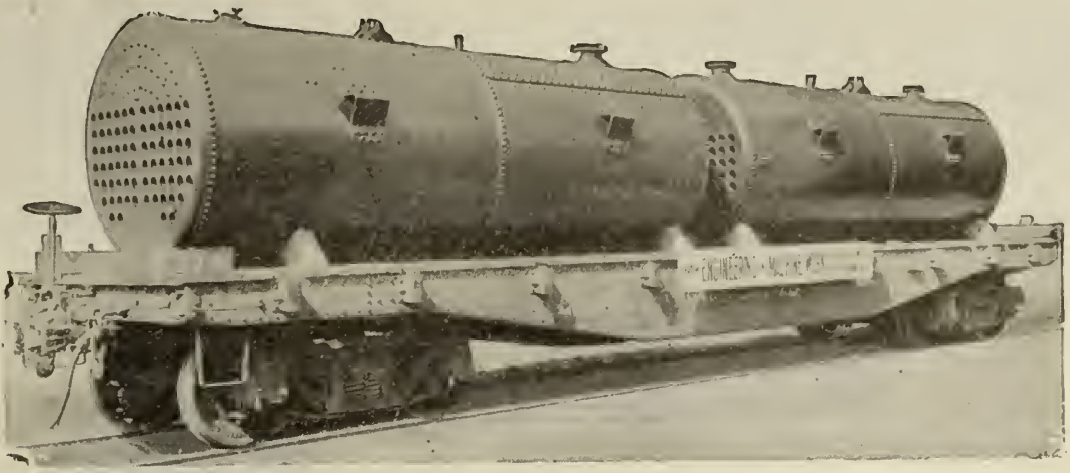
MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

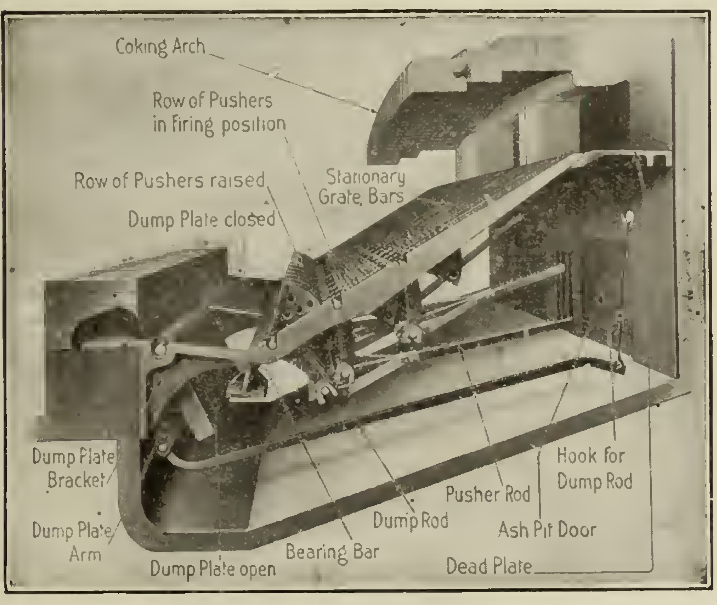
The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: **W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA**



$1,946 Buys Your New Boiler

That is, if you want a 66″ x 16′ horizontal return tubular boiler, of 110 h.p., built for 125 lb. Interprovincial Code, complete with suspension harness, including columns — or $2,423 gets you a 72″ x 18′, 125 lb., 150 h.p. size, with other sizes (smaller and larger) in proportion. This is just to give you an idea of the moderate prices we make for first class Boilers, built of the highest grade materials, in the light of 35 years of practical experience. The increased power you get and the big savings in fuel effected by our boilers show you very handsome returns on your investment.



Big Savings are possible with the National Stoker

The special coking arch construction, possible only with the downward slope of our fire grates, is the most successful smoke consuming device you can use. Yet this arch is only one of several features that makes the National Hand Fired Stoker a wonderful fuel and labor saver. The downward sloping banks of grates operated by convenient Pusher Rods from the front of the furnace enable even "green" help to get perfect stoking results with almost any grade of fuel.

The National can be installed with your present Boilers. Send for illustrated booklet.

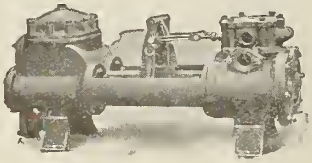
Engineering & Machine Works of Canada, Limited

St Catharines, Ontario

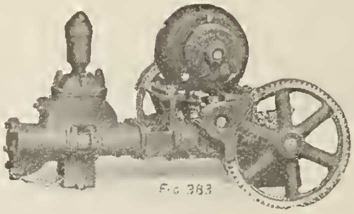
Eastern Sales Offices: **Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal**

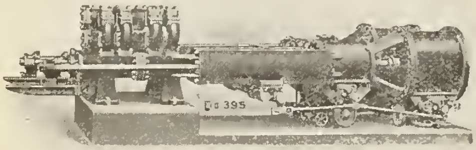
STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN

Simple
Duplex
Steam
Power



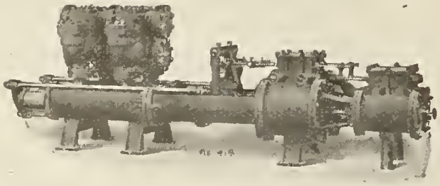
Condensing
Non-Condensing
Compound
Triple Expansion

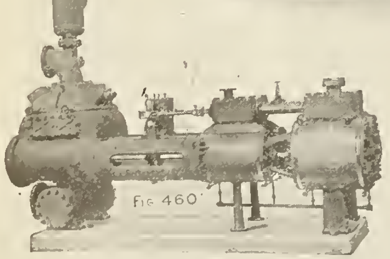




For All
Conditions
of Service

Mills, Mines,
Railways,
Power Plants





For All
Industrial
Plants

The consulting and operating engineers who are planning for the future are specifying McGowan--because they know that they are designed right and built "Honest".

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

KERR

"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville Ontario

General Engineering Equipment

Mechanical and Electrical

◆

Steam Power Plant and Fuel Economy Specialists

CUT DOWN YOUR
POWER COSTS

by

Reducing Your Ash-Handling Charges

Install a

UNITED STEAM JET ASH CONVEYOR

For the Economical Handling of Ash, Soot,
Coal and other material.

Hollow Tile,
Steel Reinforced
Storage Tanks,
Coal and Ash Gates,
Airtight Doors

Modernized Ash-Disposal

A United Conveyor will dispose of your Boiler Room Ashes for one-tenth the expense and time required to do so by manual labor. Costs but little to install and usually pays for itself in six months. The United Conveyor must not be confused or compared with the original and antiquated design of Steam Jet Conveyor. It is different. Our new Bulletin 105 gives you facts and figures that illustrate the evolution of this type conveyor and patented features which are only embodied in a "United." It shows you why Exterior Impact Wear Sections has reduced repairs to practically nothing. We will give you guaranteed insurance on repairs. It also explains how and why the "United" Triple Valve Control and associated features has reduced the operating Steam Consumption and labor of the operator more than one-half.

UNITED CONVEYOR CORPORATION
Engineers, Manufacturers and Contractors
1500 Old Colony Bldg., Chicago, Ill.

Represented in Canada by

GELINAS & PENNOCK REG'D
207 St. James Street Montreal, Canada

"MONO" TRADE MARK REG. U.S. PAT. OFF. BOILER BAFFLES

ARE MONOLITHIC

AND "HUG THE TUBES" AT ANY ANGLE

AND ARE NOT DAMAGED WHEN TUBES ARE WITHDRAWN, REPLACED OR BY THE USE OF A TURBINE CLEANER.

OUR ENGINEERS ARE AT YOUR SERVICE TO HELP YOU SOLVE YOUR COMBUSTION PROBLEMS. THE CUT ON THE RIGHT IS AN EXAMPLE OF WHAT WE CAN DO FOR YOU.

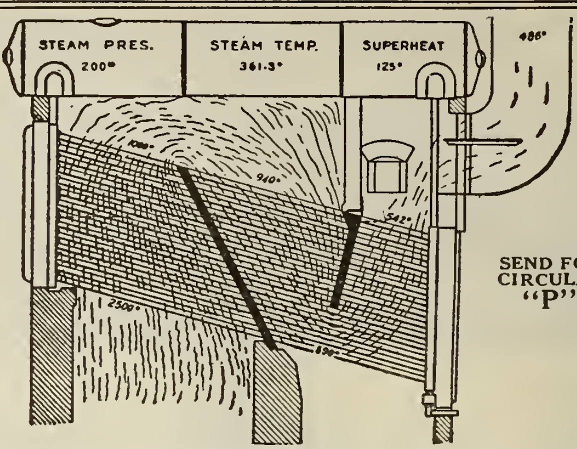
KING REFRACTORIES CO.

Sole Canadian Representatives:

GRANT E. COLE CO.

21-23 River St., Toronto, Canada

Represented in Vancouver, Winnipeg, Montreal, Halifax.



SEND FOR CIRCULAR "P"

Automatic Valved Soot Blowers

Diamond "VALV-IN-HEAD"

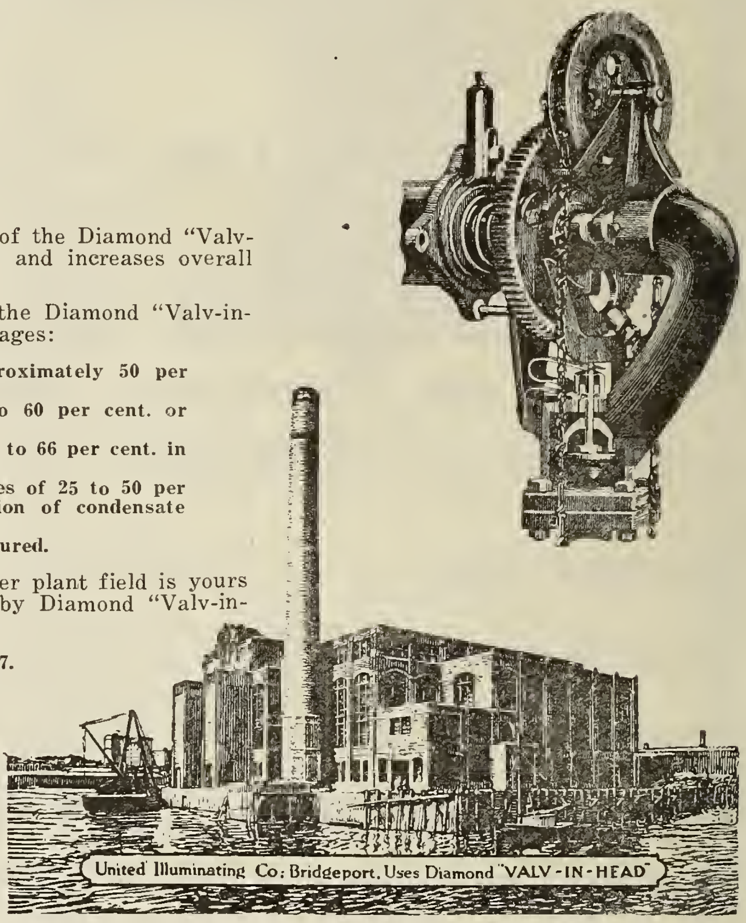
As with previous mechanical soot blowers, the use of the Diamond "Valv-in-Head" effects a saving of 4 to 8 per cent. fuel and increases overall boiler efficiency.

As compared to previous mechanical soot blowers the Diamond "Valv-in-Head" also possesses the following distinct advantages:

1. LABOR FOR OPERATION—A saving of approximately 50 per cent.
2. STEAM FOR OPERATION—A saving of 50 to 60 per cent. or more.
3. PIPE, VALVES and FITTINGS—A saving of 50 to 66 per cent. in cost of pipe, valves and fittings.
4. MAINTENANCE—A reduction in annual charges of 25 to 50 per cent. or more. Practically complete elimination of condensate obtained.
5. EFFICIENCY—Greater cleanliness of boiler assured.

One of the most interesting publications in the power plant field is yours for the asking. It describes the savings effected by Diamond "Valv-in-Head" soot blowers in detail.

Ask for your copy of Bulletin 287.



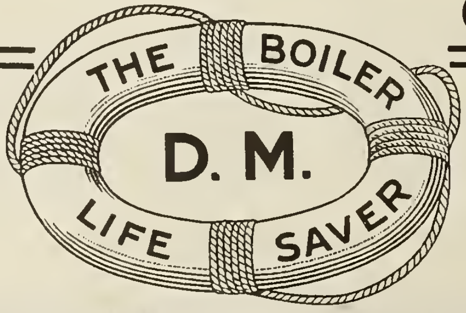
United Illuminating Co; Bridgeport. Uses Diamond "VALV-IN-HEAD"

DIAMOND SPECIALTY, LTD.
WINDSOR, ONTARIO

Diamond

Soot Blowers - Save 4 to 8% Fuel

Get the Most Out of Your Fuel



Keeps your boiler clean and thus eliminates repair bills, besides reducing maintenance cost.

Will not injure boilers or fittings.

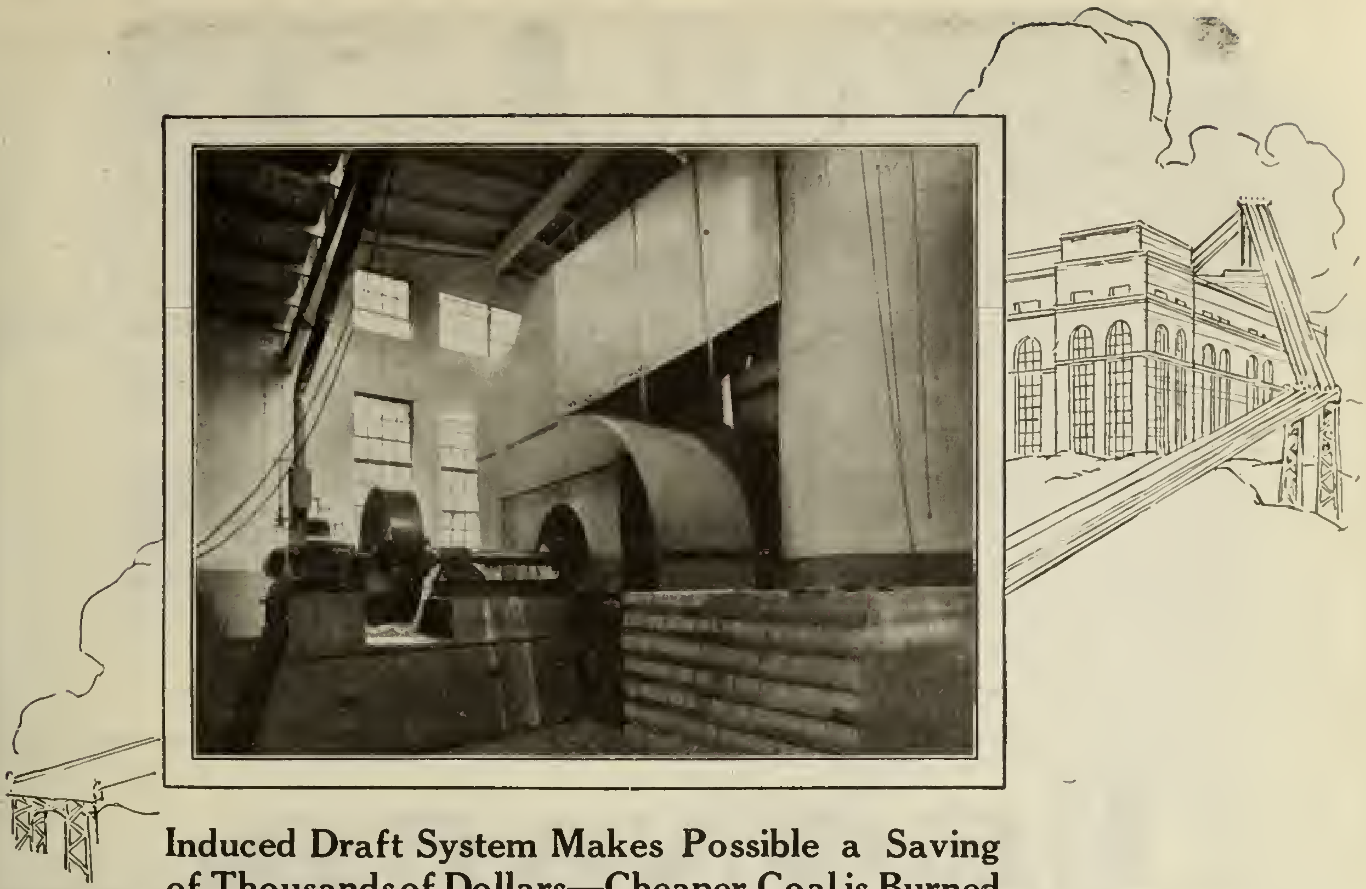
No acid — No chemicals — Just "D. M."

"D.M." Boiler Compound is a Vegetable composition, absolutely harmless, and will keep your boilers clean right down to the bare metal. Prevents all scale formation, corrosion and pitting. "D.M." Boiler Compound is used by many of the largest users of steam throughout the world including the British Government.

Manufactured by: HOUSEMAN & THOMPSON, Ltd., Newcastle-on-Tyne, England.

Sole Distributor for Canada :

J. A. CARRUTHERS - 23 Scott Street, Toronto



Induced Draft System Makes Possible a Saving of Thousands of Dollars—Cheaper Coal is Burned

Ample power, though cheaper, poorer grades of coal are burned, and a most noticeable reduction in the cost of arch and boiler tube repairs are a certainty in power plants where Canadian Sirocco Induced Draft Systems are in operation.

Frequently the saving effected totals thousands of dollars each year.

Evidence of huge savings come to us from power plants in all sections of the country where Canadian Sirocco Induced Draft has replaced ordinary methods.

The following statement by the president of a large carton manufacturing company is typical:

> "When we could burn only the better grades of coal, fuel shortages frequently forced us to stop half our cardboard machines and lose 40 or 50 tons of production per day.
>
> "Eighteen months ago we installed your induced draft system and saved many thousands of dollars lost through such production tie-ups because it enabled us to get ample power with poorer, cheaper coal without any difficulty.
>
> "Formerly, even when we had the coal, our seven boilers (of 25,000 total horse-power) had to be forced very hard and 'bottled heat' resulted in arch repairs costing some $2,400 a year and tube repairs of $800 more.
>
> "Your System cut our arch repairs 75% and tube repairs 90%—thus saving us enough in repairs alone to pay its total operating cost, including interest, depreciation and power.
>
> "In 24 hour service, 6 days a week, for a year and a half it has given us great satisfaction and required no attention but lubrication.
>
> "With this equipment we get higher efficiency out of our coal, develop more power, save thousands in costly shutdowns and avoid $2,500 of troublesome arch and tube repairs."

Write to-day for our latest bulletin describing Canadian Sirocco mechanical draft equipment, both forced and induced.

CANADIAN SIROCCO COMPANY, LIMITED, WINDSOR, ONTARIO

BRANCH OFFICES IN ALL PRINCIPAL CITIES

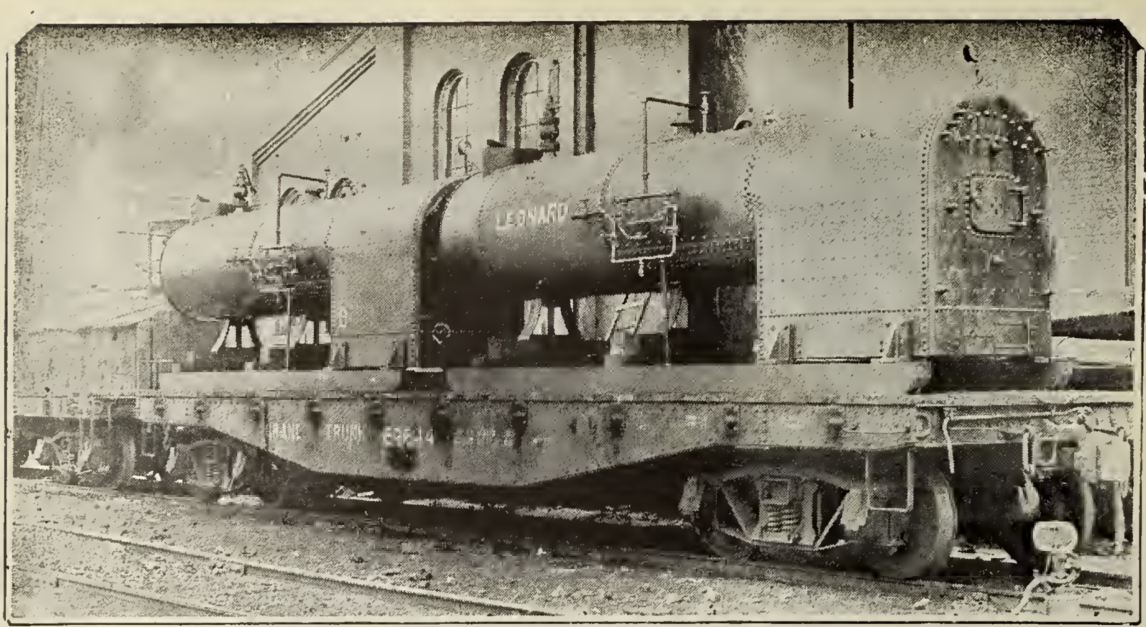
(198)

"Sirocco" Products

TRADE MARK

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT



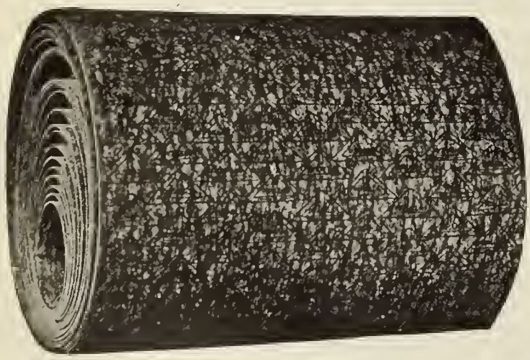
Two 60 H.P. Locomotive Boilers for 125 lbs. Under Ontario Regulations.

E. LEONARD & SONS, LIMITED
Head Office and Works, London, Canada.
Branches and Agents from Coast to Coast.
Established 1834

LEONARD

Durabla Gaskets Make Tight Joints

Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.



Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

DURABLA
TRADE MARK REGISTERED

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in. long.

In thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Let us send you a trial order.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

On Great Engineering Projects

Following the hose and pipe lines from clanking rock drills, back perhaps to a shanty open to dust and dirt, we come to the throbbing air compressor.

The compressor rod packing forms an important item contributing toward successful and continuous operation. The intense dry heat of compression together with the abrasive action of grit and dust soon destroy a packing not designed for this trying service.

Garlock Style No. 222 combination packing, designed with a thorough understanding of compressor requirements, has given efficient and continuous service on compressor rods under all conditions.

GARLOCK
PACKINGS

TRADE GARLOCK MARK

THE GARLOCK PACKING COMPANY.
HAMILTON, ONTARIO.

BRANCHES:
Montreal, Que. Toronto, Ont. Winnipeg, Man.
Calgary, Alta. St. John, N.B. Vancouver, B.C.

GOLDIE & McCULLOCH

DEPENDABLE POWER PLANT EQUIPMENT

Sectional Water Tube Boilers

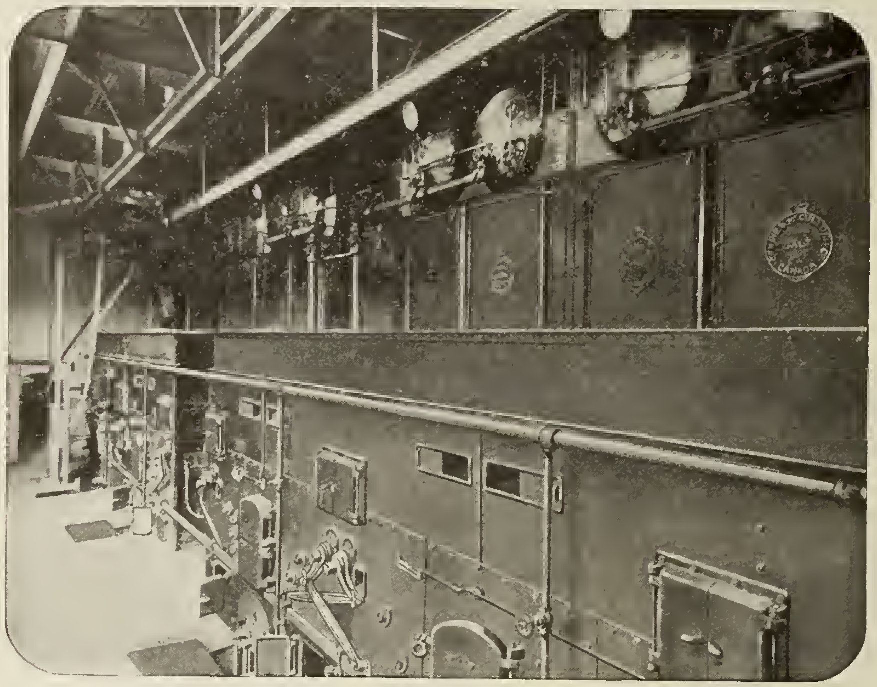


Illustration shows Boiler Room of The Toronto Carpet Company, equipped with 4 G. & McC. Double Drum Sectional Water Tube Boilers.

Superior in Design, Workmanship and Material

G. & McC. Sectional Water Tube Boilers provide more rapid circulation and increased steaming capacity. They can be forced without danger. Equipped with steam and water drum connecting nipples of increased size—lower tubes always supplied with water, and free passage is permitted for escaping steam.

Mr. Melvern F. Thomas, Consulting Engineer, in a letter dated May 23, 1922, has the following to say regarding the above plant:

"Three of the boilers are kept in service and during a part of the day are under heavy overload and we find them entirely satisfactory."

THE GOLDIE & McCULLOCH CO.
LIMITED

Head Office and Works: GALT, ONTARIO, CANADA

Toronto Office
Suite 1101-2
Bank of Hamilton Bldg.

Quebec Agents
Ross & Greig, 400
St. James St., Montreal.

Western Branch
248 McDermott Ave.,
Winnipeg, Man.

British Columbia
Robt. Hamilton & Co.
Bank of Ottawa Bldg.
Vancouver, B. C.

POWER HOUSE

Members of the
Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Principle of the Una-Flow Steam Engine

The Theoretical Advantage of a Una-Flow Compared With a Counter Flow Engine, Also the Features in the Design Upon Which Economy Depends, and its Increasing Popularity in Pumping and Rolling Mill Engines

L. T. RUTLEDGE[*]

AS A GENERAL rule, all new inventions are merely the applications of old principles, which may be very old indeed, so that the innovation, whatever it may be, carries with it nothing fundamentally new. The application of the principle, however, must be acknowledged to be original and new. In the case of the una-flow engine, which engine might be called a una-directional engine, the above remarks apply very fittingly.

As the name indicates, the energy is taken from the steam in the una-directional engine without causing the steam to return on its path. In the ordinary engine, with which all of us are quite familiar, the exhaust steam within the cylinder flows in a counter direction to the direction in which the expanding steam travels.

Becoming More Popular

The una-flow engine is at present coming into use in America. New engines are being installed and old counter-flow engines are being outfitted with new una-flow cylinders and steam valves. This new type of reciprocating engine has for some time occupied a conspicuous place in European manufacture, where it has been built in stationary, marine and locomotive types. It has become popular as a portable engine, a rolling mill engine and is much used for driving compressors, blowers, pumps, stamping machines and presses.

The first successful stationary una-flow engine was built at Brunn, Austria, by the Brunner Machinery and Manufacturing Company in accordance with the design of Professor Johann Stumpf, professor in the technical high school, Charlottenberg, Germany. The first una-flow locomotive was built and assembled in a Moscow railway shop for the Moscow Kazan Railway. Prof. Stumpf's pioneer una-flow engine proved highly satisfactory and showed a steam consumption equal to a first-class compound engine of the usual type.

The Idea Not New

Although the German engineers were the pioneers in putting the principle of the una-flow engine to a practical use, nevertheless it was an English engineer, J. L. Todd, who actually did the first research work on the application of the principle involved. Todd was granted the British patent No. 7301 in the year 1885. In this patent a very clear statement is set forth concerning the thermal conditions existing in an engine in which the inlet valves are located at the ends of the cylinder and the exhaust ports in the centre and controlled by the piston. Todd, however, in applying the principle made certain initial mistakes and failed to put the pure una-flow principle to practical use. Prof. Stumpf asserts in his writings on una-flow engines that his investigations have been carried on independently and without any knowledge of the nature of the work done by other investigators. It would appear that the present high degree of perfection in una-flow engines is due to the perseverance of Johann Stumpf.

Fig. 1 is a vertical longitudinal sectional sketch of the cylinder and adjacent parts of a double-acting una-flow steam engine. The sketch illustrates one of the first designs of Prof. Stumpf. The live steam is admitted through each cylinder head or cover of special design, the flow being controlled by valves. It will be noted that mechanically-operated exhaust valves are absent but instead of these there is a row of ports or slots at the middle section. This ring of exhaust ports makes it possible to have the area of the exhaust passage very much greater than is provided in the ordinary engine. The release and compression of the steam is controlled by the piston which is shown to be in length almost half that of the inner length of the cylinder. The piston is fitted with a set of three rings close to each end.

Exhaust Valves Not Essential

In the una-flow engine it is common practice to have the release take place after 90 per cent. of the stroke has been passed and compression begin after 10 per cent. of the return stroke has been completed. Thus compression extends over 90 per cent. of the stroke and thus it is possible for it to have a high value. Though the exhaust valves are shown to be absent yet there are una-flow engines equipped with exhaust valves where the specifications call for a variable release or compression.

Una-flow engines have their cylinder heads jacketed and for maximum efficiency the jacketing is extended along the cylinder to the point where cut-off takes place. The idea is to have the inlet as hot as possible and the exhaust as cold as possible. This is in accordance with a sound thermodynamic principle, first outlined by Carnot and illustrated in the famous Carnot's Cycle.

The una-flow cylinder consists essentially of two single-acting cylinders set end to end with a common exhaust opening and chamber. The heads remain hot on account of the jackets and yet the high temperature has no deleterious action on the cylinder and the piston. The exhaust belt is cold relatively speaking and remains cold, there being well-defined separation between the hot intake and the cold exhaust. Besides there is an extra advantage gained insomuch that the lowest cylinder temperature is secured where the piston velocity is the highest. As suggested by the sketch of Fig. 1, this cooling is facilitated by the dispensing with the steam jacket in the neighborhood of the exhaust ports.

---

[*] Assistant Professor of Kingston University.

The piston in this type of engine must, of necessity, be made quite long. It has, therefore, a large bearing surface and consequently a low intensity of bearing pressure. The cylinder itself is very simple in construction, being free from such subsidiary parts as are necessitated in, for example, a D-slide valve engine. This feature is of utmost importance, not only from a thermal point of view but also from a mechanical standpoint. When the steam chest is cast in one piece with the cylinder, the construction and moulder's core work is complicated, and very often considerable initial internal stresses are introduced. The cylinder heads in una-flow engines are much more complicated than in the counter-flow machines but since the pieces are never very large, the core work and moulding does not present any great difficulty. For perfect operation of a una-flow engine all that seems necessary is good workmanship and efficient lubrication. These, undoubtedly, are requisites in any engine of any design.

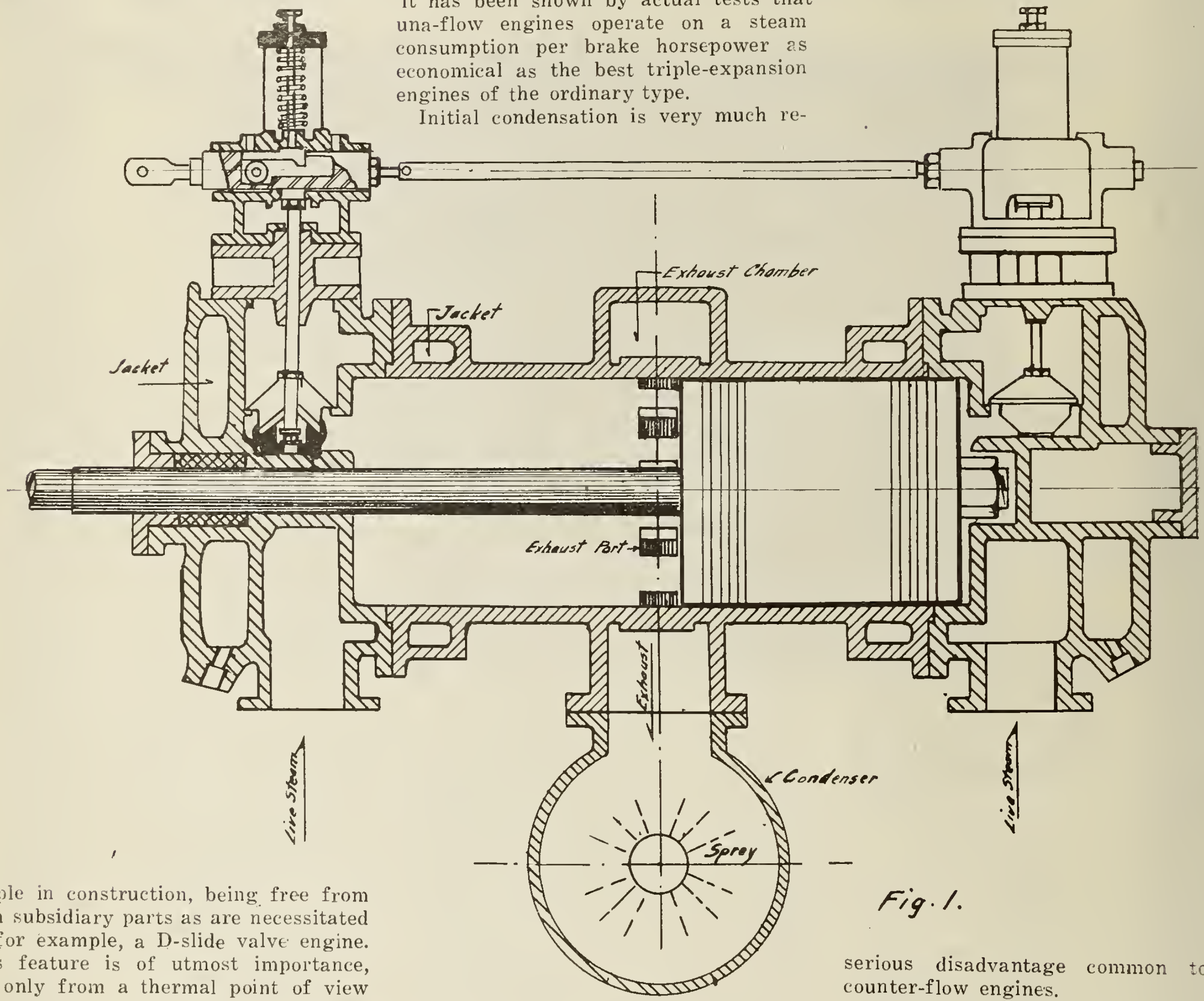


Fig. 1.

In the counter-flow engine the reversal of the steam during the exhausting period causes very considerable cooling of the clearance surfaces, steam ports and steam passages because of contact with the wet steam. This cooling results in initial condensation when the live steam comes into contact with the moisture deposited on the surfaces and entrained in the trapped steam. To offset this, the steam is superheated and several stages of expansion are used, as is the case where triple and quadruple engines are used. In una-flow engines the initial condensation is practically eliminated for reasons given below and it has been shown by actual tests that una-flow engines operate on a steam consumption per brake horsepower as economical as the best triple-expansion engines of the ordinary type.

Initial condensation is very much reduced in the una-flow engine by the unique position of the exhaust ports and by the system of steam jacketing employed. The wet steam after expansion, as suggested above, is exhausted out of the cylinder without coming into contact with the clearance spaces and passages through which the live steam has to pass, as illustrated in Fig. 2, which illustration is due to Prof. Stumpf. The wettest steam is in the layer nearest the piston and the wetness decreases back to the cylinder head. During the exhausting period almost all the entrained moisture passes out of the cylinder and any steam entrapped is the steam which was in contact with the surfaces heated by the steam jacket. The heat absorbed from the jacket is not lost in the exhaust but is retained during compression and is available for mechanical work on the next expansion stroke. Whereas in the ordinary counter-flow engine the exhaust steam must be in contact with the steam-jacketed surfaces since the steam jacket extends the whole length of the cylinder. The exhaust steam cannot do otherwise than absorb heat from the jacket and this heat is rejected to the condenser. Thus it is apparent that the una-flow engine tends to overcome this serious disadvantage common to all counter-flow engines.

Due to the absence of initial condensation, the expansion line for the una-flow engine is adiabatic or very nearly adiabatic and if superheated steam is used the compression line as well as the expansion line will be adiabatic. The adiabatic expansion gives an indicator card of greater area than a non-adiabatic expansion and it is the expansion line most desired. Only in high-speed engines of the counterflow type does the expansion approach the adiabatic, since the high speed does not allow sufficient time for any appreciable transfer of heat by conduction or radiation.

In the ordinary engine, due to the reversal of steam velocity, there is a considerable amount of eddying motion in the steam which results in the cooling action, whereas in the una-flow engine there is a comparative stillness among the steam molecules of one layer of steam relatively to the adjacent layer. This stillness is due, firstly, to the method of exhausting and, secondly, to the absence of a great amount of re-evaporation and, thirdly, to the combined heating action of the cover jackets and the high compression possible in the una-flow engines.

Correct Position of Condenser

Lastly, owing to the fact that a large exhaust area is possible, the exhaust pressure in the cylinder is practically equal to the condenser pressure, especially so if the design of the plant admits of the absence of a long exhaust main with sharp bends. A low condenser pressure is most effective when it is effective at the exhaust ports of the cylinder. In Fig. 1 the condenser is shown immediately beneath the cylinder which is the ideal position for it. This design may be effected by locating the condenser in the room below the engine room and directly below or nearly so.

It is claimed that una-flow engines have a minimum of leakage and this is a factor that contributes to economy. During the admission period the long piston with its double set of rings is between the boiler pressure and the exhaust. With good construction, leakage past the piston can be reduced to a minimum even with high pressures. The admission valves sustain the maximum pressure difference for a shorter period of exhaust. Much of the admission valve leakage in our ordinary counter-flow engines is caused by the violent fluctuations of temperature resulting in distortion of valves and seats. With the una-flow engines the inlet valves are kept at practically constant temperature. The valves used are generally poppet valves of special design and are supposed to remain tight under all conditions.

As a brief summary, the makers and advocates of una-flow engines state that by careful design and construction the seven principal losses common to other designs of reciprocating engines may be reduced to a minimum. These losses, some of which have not been discussed in the above explanation, may be listed as follows:

1. Losses due to surface condensation in the cylinder.
2. Losses due to leakage at valves and pistons.
3. Losses due to necessity of large clearance volumes.
4. Losses due to friction of auxiliary moving parts.
5. Losses due to heat radiation and conduction.
6. Losses due to inefficient expansion.
7. Losses due to wire-drawing of steam.

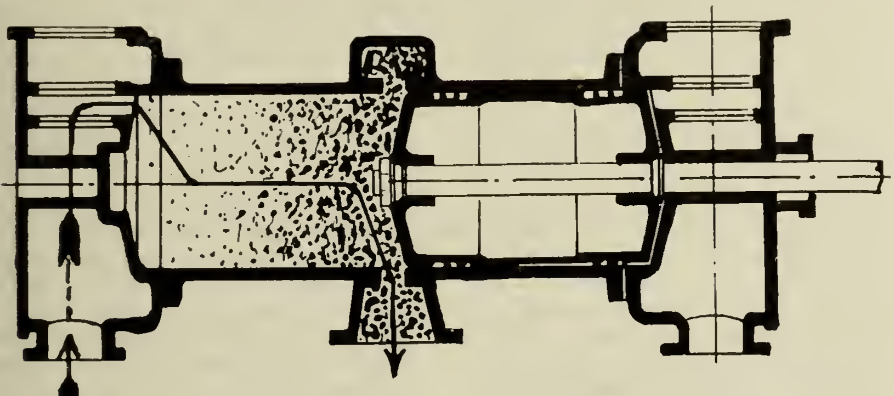


Fig. 2.

---

*Assistant Professor of the University of Kingston.

Better Results from Wire Rope. Too many accidental breaks occur from too little thorough knowledge of wire ropes, their strengths, and proper methods of fastening. There are six kinds of commercial wire rope, from iron having tensile strength of 60,000 lb. per sq. in. to improved plow steel with 220,000 to 280,000 lbs. per sq. in. Gives directions for telling various grades, and illustrated descriptions of various wedges and fastenings and methods of applying and using. E. O. Keator, Rock Products.

Gum Forming Constituents in Gasoline. Study of the various methods of evaporation and oxidation of cracked gasolines lead to the conclusion that gummy and resinous deposits are caused by oxidation and have no direct relation to unsaturation as determined by solubility in suphuric acid. A new and convenient method has been developed for determining these gums. They are probably polmerized aldehydes, which are formed from the oxidation of olefins, etc. Storage tests included in the paper confirm these conclusions. M. B. Cooke, Bureau of Mines, Reports of Investigations, No. 2394.

A BELT POORLY REPAIRED

Not long ago I was called to take a look at an oil-driven engine which the owner wished to dispose of because it "gave him too much belt trouble." The owner admitted that the engine itself was all right. He could find no fault with it as far as it running ability was concerned but, he said, "It breaks the belt as fast as I can fix it. I spend most of my time fixing the belt."

Of all the belts I have ever laid eyes on I never saw the equal to this one. I maintain that the said belt is the "most patched belt in the world." And I also maintain that it is the "most poorly patched belt in the world." The word "repaired" can hardly be used because it is too dignified a word in this case, and, besides, the belt wasn't repaired. It was just simply "patched." Originally, it was a double leather belt.

Whenever the belt would break the owner would simply take a piece of belting of the same width, lay it over the break, drive some rivets through, clinch the rivets, and let it go at that. No attempt was made to produce a smooth-fitting joint. No tapering down to a feather edge. No gluing. No squaring up with a square. The patch was simply laid on top, and, you might say, "nailed on."

Of course, the joint wouldn't hold long. Another splice would then be riveted on top of the first, the owner doubtless thinking that two splices should be twice as strong as one splice. And when that, again, would break, the owner "simply couldn't understand it." He decided that he would have to sell the engine and install a motor.

The entire belt was made up of splices in this manner, overlapping and underlapping one another until the average thickness was about equal to the thickness of three belts, one on top of the other. Never before has it been brought to my attention so forcibly that whenever a belt needs repairing it pays to do the job right in the first place. In this instance, if the first repair job had been properly done it is quite possible that up to the present time there would have been no need for a second repair job. The joint of a leather belt that is properly scarfed and cemented is just as strong as the solid leather belt itself. Leather-laced joints are of course never as strong as the solid leather, but if the owner had even laced his belt instead of riveting in this unworkmanlike manner, he probably would have had much less trouble. Wire-laced joints are stronger than leather-laced joints. They often have a joint efficiency of 85 to 90 per cent. A wire-laced joint could have been used as well as not, and the writer believes it would have held.

Owen Sound may install an asphalt plant in carrying out a proposed paving program. A movement is on foot looking to expenditure of $125,000 on harbor improvement.

Utilization of Waste Heat in Factories

The Author Has Succeeded in Condensing Information Lately Published Upon Heat-Saving Appliances, Used in England, America, France and Germany, and Adapted to Develop Greater Efficiency in Works and Factories

By JOHN B. C. KERSHAW

THE increased cost of most forms of solid and liquid fuel which has resulted from the war, in all countries, has rendered the subject of Waste-heat Utilization of exceptional interest and importance; for there are few manufactures in which some economies are not possible in this direction. In certain industries this waste of heat, and therefore of fuel, attains very large proportions. It is of course admitted that not all waste heat is economically recoverable, although scientifically this recovery may be possible. In the majority of cases, however, a very considerable percentage of the heat at present lost, with chimney-gases, exhaust-steam, and with other waste-products, especially in small works and factories, can be recovered at reasonable cost. Such recovery would promote not only the efficiency of the particular process, but also reduce the fuel cost of the product concerned.

Well-managed and up-to-date works and factories are no doubt already equipped with many of the devices and heat-saving appliances which will be described in the course of this article. The majority of smaller works and factories in this country (England), however, are still unprovided with them; and even when already installed, as in the larger works, they are not always operated so as to yield their highest efficiencies.

In order to show the magnitude of the heat losses that are occurring in many branches of industry, a few general figures may be given. The majority of power-plants in this country make use of steam for generation of the mechanical or electrical energy required to drive their machinery. The very best steam-power plant, however, can only yield the equivalent of one-sixth of the heat-value of the fuel at the shaft of the engine. The remaining five-sixths pass away with the exhaust-steam and chimney gases and in frictional or radiation losses. The losses that occur with the internal combustion engine are no less striking since 40 per cent. of the heat-value of the fuel is lost with the exhaust-gases and 28 per cent. with the cooling-water.

In the steel industry, nearly one-half of the heat actually delivered to the open-hearth furnaces is lost with the exit-gases; and in the coking industry, from one-quarter to one-third of the heat-value of the fuel is lost during the coking operation.

These figures and examples show the great importance and magnitude of the losses arising from the inherent defects of our methods for the conversion of the latent energy of coal or petrol into more useful forms of energy. These losses are proportionately as large when employing other forms of solid and liquid fuel.

The author in this article will attempt to condense into reasonable compass all the more valuable information which has been published lately on the subject of waste-heat utilization, and will describe the most efficient forms of heat-saving appliances that have been used in England, America, France and Germany. It is hoped that this summary of all the more recently published facts and figures will prove of considerable interest and value to those, who either as managers or engineers are responsible for the progressive development and efficiency of their works and factories.

Heat-Losses From Steam Boilers

As has already been stated, the best boiler and steam engine converts only 16 per cent. of the heat value of the fuel burned under the boiler into useful forms of energy, and 84 per cent. is wasted, chiefly in the chimney gases and in the exhaust steam.

Examining the losses in further detail, we find that the chief item in the boiler, is the heat carried away by the exit-gases, i. e., by the air used for combustion of the fuel. If oxygen gas should ever be produced sufficiently cheap and in adequate amounts to be employed for combustion purposes, this source of heat loss in furnaces and boilers might be greatly reduced; but so long as air is employed, a considerable loss of heat with the exit gases is unavoidable.

With regard to the calculation and checking of this loss, the measurement of large volumes of heated gas, or of the air flowing into the furnaces is, of course, a difficult matter. The CO_2 test of these gases has now been recognized as yielding the simplest and most reliable guide to the amount of excess air that is being employed for the combustion of the fuel. The following explanation of the reason may be quoted here, since many boiler-engineers do not understand clearly why this is the case:

Air contains in round numbers, 21 per cent. by volume of oxygen and 79 per cent. of nitrogen. When this oxygen is employed for burning solid carbon, it yields the same volume of carbon dioxide gas. If, therefore, the whole of the oxygen of the air could be used up in burning fuel on the grates of steam-boiler furnaces, and if this fuel contained nothing beyond carbon and ash, a maximum percentage of 21 per cent. CO_2 by volume in the waste gases would be attainable.

The hydrogen present varies considerably in different classes of solid fuel. In bituminous fuels it ranges, as a rule, from 3 to 6 per cent. By calculating the weight of oxygen required to burn the hydrogen present in the fuel, and by deducting from this, the oxygen contained in the fuel, one obtains the oxygen required from the air. Deducting the equivalent volume of this from 20.8,, we have the percentage by volume of oxygen available for combustion of the carbon. This figure for most bituminous coals is about 19.2 per cent., and this therefore represents the maximum percentage of CO_2 which could be obtained by perfect combustion, with the theoretical amount of air.

Now 12 lbs. of air are necessary theoretically to provide the oxygen required for the complete combustion of 1 lb. of ordinary fuel, and as this would yield, according to the above, a CO_2 test of 19.2 per cent., the calculation of the air excess for any other percentage of CO_2 is obtained, roughly, by dividing this into 19.2 and the lbs. of air by multiplying the result by 12. The formula $x = \frac{19.2}{y} \times 12$ is the algebraical expression of this method of arriving at the air excess, x representing the lbs. of air actually used per lb. of fuel burned, and y the average CO_2 test over a long period of time, for the exit-gases of the boiler.

As already pointed out, an air excess of from 150 to 200 per cent. is required to obtain perfect combustion of the carbon in solid lump fuel (dust fuel can be burned with a lower excess) in steam boilers. This signifies that for every lb. of coal burned in the furnace of the boiler, 18 to 24 lbs. of air must be passed through the boiler fires and flues. Adding the lb. of gaseous products obtained from the burning of the fuel, from 19 to 25 lbs. of gaseous matter are therefore passing up the chimney of the plant, per lb. of fuel burned.

The temperature of these exit-gases at the down-take of an ordinary tubular boiler is generally about 600 deg. F., and taking the Sp. heat of the exit gases as .24, the heat-losses in these two cases work out as follows:

(1) 19 × .24 × 600 = 2736 B. t. u.
(2) 24 × .24 × 600 = 3456 B. t. u.

Supposing, therefore, that a coal, testing 12,000 B. t. u. net, as fired, is being employed for the boilers, the percentage of loss in the first case is 22.6 per cent., and in the second 28.8 per cent., of the total heat-units contained in the fuel. The loss increases rapidly with every increase in the volume and temperature of the air passing through the furnaces. With 3.8 times the theoretical amount of air (corresponding to a 5 per cent. CO_2 test) and exit-gases at 600 deg. F., the percentage fuel loss rises to 40.88, and with exit-gases at 700 deg. F. to 48.46 or to nearly one half the heat value of the fuel, as charged into the furnace of the boiler.

These, of course, are extreme cases of bad management; but there are still too many small steam-power plants the engineers and firemen of which are running their boilers with a great excess of air in order to minimize the trouble from smoke. Five per cent. CO_2 tests would be found in many cases of these plants to-day, if such tests were being made. The average for the whole country would probably be 7 per cent., which is equivalent to 2.75 times the theoretical amount of air, and to fuel loss of about 33 per cent., when the exit-gases from the boiler escape at 650 deg. F. The heat-losses therefore which occur in the operation of steam-boilers entail the absolute waste of from twenty-five to fifty per cent. of the fuel used, unless heat-saving appliances are employed to reduce these losses to a minimum.

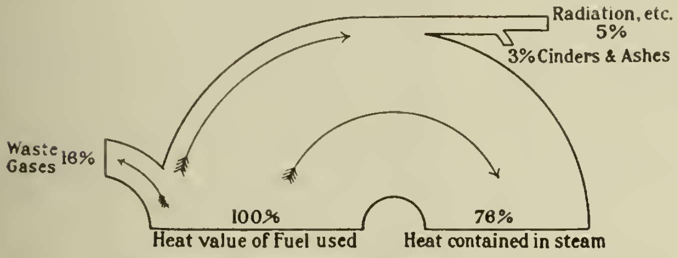


Fig. 1. Diagram of heat-losses in a well-managed boiler-plant.

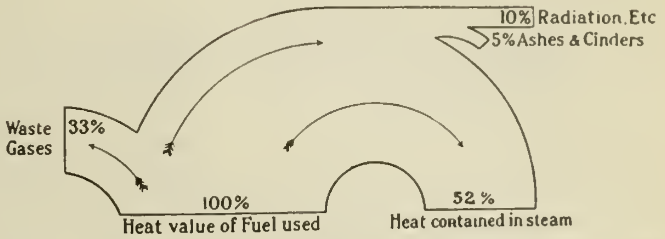


Fig. 2. Diagram of heat-losses in a badly-managed boiler-plant.

Where natural, i. e., chimney draft, is employed for working the boiler-plant, it is impossible to recover more than one-third or one-half of this waste-heat; for effective draft of a chimney depends upon the difference of temperature and consequently of weight between the column of heated gases inside the chimney and that of an equal column of the outside air. It is therefore not wise under these circumstances to reduce the temperature of the exit gases below 450 deg. F., for the lower the temperature of the exit gases, the poorer the draft. Where fan-draft has been installed, as in many of the more modern plants, it is possible to reduce the temperature of the exit gases to 265 deg. F., by the use of well-designed heat recovery apparatus. At this temperature, assuming that only the theoretical quantity of air is employed to burn the fuel, namely, 12 lbs. of air to 1 lb. of fuel, 13 lbs. of waste-gases are obtained, per lb. of fuel consumed, and the net B. t. u. lost would be 13 × .24 × 200 = 624, or only 4½ per cent. of the heat value of the fuel. This figure is, however, only of theoretical interest, for it is impossible to burn solid fuel completely under boilers with merely the theoretical amount of air admitted to the furnaces. It is rarely that the heat recovery plant is adequate to reduce the temperature of the escaping gases to 265 deg. F. Assuming, therefore, as air excess corresponding to 10 per cent CO_2 in the exit gases is employed, (equivalent to 192 per cent. of air excess), 23 lbs. of air will be required for each 1 lb. of fuel burned, and 24 lbs. of waste-gases will be obtained. Taking as before, the Sp. heat of these gases as .24, the heat units lost will be 24 × .24 × 400 = 2304 B. t. u., or 16 per cent. of the total heat value of the fuel.

This is the loss shown in Fig. 1, which has been drawn to illustrate in a diagrammatic form the heat-losses that occur in a well-managed boiler plant; whereas Fig. 2 illustrates, in a similar manner, the losses that are possible in a badly designed and badly managed installation.

It will be seen that the heat carried away by the waste-gases under ordinary working conditions may vary from 16 up to 33 per cent., and that the losses by radiation and with the ashes and cinders, will lie between 8 and 15 per cent. The total losses therefore range from 24 per cent. up to 48 per cent. of the heat-value of the fuel; and the steam ultimately obtained will represent only from 52 per cent. to 76 per cent. of the original heat-value of the fuel. These diagrams are well worth the careful study of chemical engineers in control of large works, for they show how important, and from the fuel-economy point of view, how urgent is the recovery of some proportion of this wasted heat.

Recovery of the Waste-Heat from Boiler Exit-Gases

The calculations and data given above show that even well-designed and well-managed boilers are unable to utilize more than 76 per cent. of the heat-value of the fuel, and that in a large number of cases the thermal efficiency of the boilers is not much above 52 per cent. The scope for waste-heat utilization in steam-power plants is therefore very considerable. Even when, by scientific management, the average thermal efficiency of all steam-boiler installations in the United States has been raised to 70 per cent., there will still be ample margin for the application of heat-recovering methods and apparatus.

Acording to Breckenridge about .255 million tons of the fuel raised annually in the U. S. A. are being consumed for steam-raising purposes, without including that consumed by the railroad companies. Since it is known from recent investigations of the efficiencies of land boiler-plants, that the larger number of these are being worked with efficiencies much below their maximum of 70 per cent., the fuel equivalent of this wasted-heat is calculated to be about 90,000,000 tons of coal per annum.

The question whether, in any particular case, it will pay to install heat-recovery apparatus depends more upon the temperature of the exit-gases than upon the size of the plant. In the majority of cases there is no doubt that the value of the fuel saved annually would more than cover the interest and amortization charges upon the economizers, or other forms of waste-heat apparatus installed. As a general rule, the gases which carry away this heat to the atmosphere leave the boilers at a temperature of from 600 to 700 deg. F. Now, taking the case of boilers burning 10 tons of fuel per day, or 50 tons per week, with the high average efficiency of 70 per cent., it is shown by Fig. 1 that 20 per cent. of the original heat-units of the

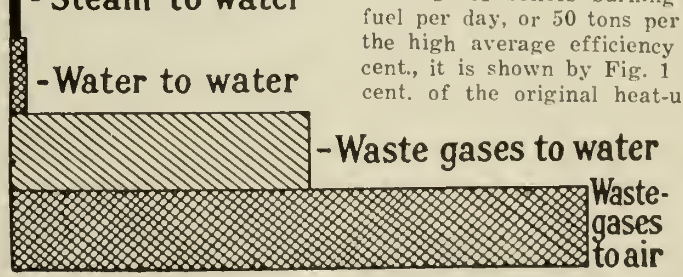


Fig. 3. Diagram of superficial area required for heat transfer from steam and hot air to water and air.

fuel will be present in the exit gases. Assuming that only one-half of these heat-units can be recovered, the weekly saving of fuel would be 5 tons, or 250 tons per annum; and at $6.00 per ton delivered at the bunkers, the annual cost of fuel saved would be $1,500. This sum would cover the amortization, interest, and upkeep charges upon a simple yet adequate heat-recovery apparatus.

Apart from this question of whether a heat-recovery plant pays, however, there is the question of the conservation of American fuel supplies; and manufacturers and engineers should be prepared to install heat recovery apparatus of this kind, simply because it enables them to obtain an equal heat effect, from a smaller consumption of fuel.

One may take it as proved, therefore, that in nearly all cases of steam-generation by the burning of solid fuel under boilers, some form of heat-recovery apparatus is called for, both on economic and national grounds.

Turning now to the consideration of the principles of heat recovery, as applied to the exit-gases of steam-boilers, it is at once evident that since air and water are the two chief requirements (apart from fuel), the preheating of these, before they enter the boiler, is the purpose for which the heat of the exit-gases can most usefully be applied. Engineers have in most cases in the past, chosen to apply this waste-heat of the exit-gases to the pre-heating of the feed-water by means of the apparatus known as "economizers," although there is no special reason why the term should be applied only to this particular water heating apparatus. The pre-heating of the water, rather than the air supply of the boilers has been adopted for three reasons.

In the first place, it is now generally recognized that a steam-boiler will only yield its highest thermal efficiency when fed with water at or near the boiling point for the particular steam-pressure under which the boiler is being operated. Feed-water heating has thus become accepted as a, sine qua non of efficient boiler management, and in all well-managed and well-equipped works it is customary to find not only the waste-heat of the exit-gases but also the heat of the exhaust-steam of the engines, applied to this purpose.

In the second place, it is also becoming more generally recognized that the gases dissolved in feed-water are the chief causes of the internal pitting and corrosion of boiler plates. Since pre-heating is one of the simplest and most effective methods of expelling these gases, it is very generally adopted on that account.

The third consideration is, that it is a more simple matter to transfer heat from a gas to water, than from a gas to air. The transference of heat from the exit-gases of the boiler to the feed-water, demands, therefore, a simpler form of apparatus than would be required for the transfer of this same amount of heat to the air. In connection with this subject of heat-transfer, the following figures and diagram have been published lately by Frenckel, a German engineer; and without in any way guaranteeing their accuracy, the author reproduces them here as interesting to all engineers engaged in the practical solution of problems of heat-recovery from water-gases.

The table appeared in the Zeits. Vereines Deutsch Ing., and is part of a lecture delivered before the Bochum Branch of the Verein. It shows the square meters of heating surface required to convey the same amount of heat, from and to, different heating agents.

	Heating Agent.		
	Steam	Hot Water	Air or hot gases
Product	sq. metres	sq metres	sq. metres
Boiling Water	1.0	2.3	93
Hot water	2.0	3.3	95
Air or hot gases	93.0	95.0	186

The figures of this table and diagram show that when heating water by aid of steam, for a stipulated transfer of heat, 2 sq. metres of heating surface are required; whereas when hot air or hot gases are employed for the same purpose, 95 sq. metres of surface are necessary. To transfer a similar amount of heat from hot gases to air, a heating surface of 186 sq. metres is required. It is for this reason that in the past waste-heat plants have been usually planned to recover the heat by steam, or hot-water, rather than in the form of hot-air, and that water economizers are found much more generally in connection with the utilization of the heat of chimney gases, than air-pre-heaters.

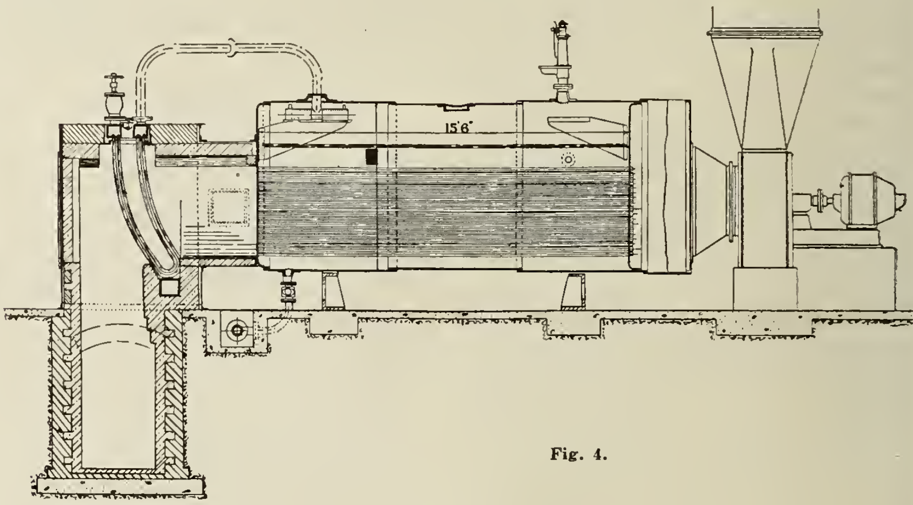


Fig. 4.

An economizer, in its simplest form, is simply an arrangement of cast iron pipes or tubes, 4 in. in diameter, and 8 to 10 feet in length, through which the feed-water is pumped on its path to the boiler. These tubes are placed in a special brick-work chamber behind the boilers, through which the exit-gases pass on their way to the chimney. Mechanical scrapers are used to keep the outsides of the tubes free from scale and soot. The flow of water through the economizer is on the counter-current principle, and theoretically the best results would be obtained with all the tubes connected in series. It is found impossible in practice, however, (owing to back-pressure) to operate more than two or three economizer tubes in series. Therefore the tubes in one economizer are all connected to the one water-supply box, and are worked in parallel, while the economizers themselves are sometimes operated in series.

As a general rule, only two sets of economizers are installed, and therefore the water has a passage of at most 20 feet through the heated tubes. This is sufficient, in the majority of cases, to increase its temperature up to 180 deg. F. The temperature drop of the exit-gases is about 300 deg. F. on an average, namely, from 650 deg. F. on the boiler-side of the economizer to 350 deg. F. on the chimney side. It is not, for the reasons already given, desirable to reduce the gases below this temperature, if natural or chimney draft is depended on.

The water supplied to the economizers should be raised to 90 or 100 deg. F. before entering the box that supplied the first series of tubes, otherwise sweating occurs, and external corrosion of the lower portion of the tubes results.

Considering first the theoretical aspect of the heat transfer in economizers, it is necessary to remember that the amount of heat transfered from hot gases, through an iron pipe to water, depends upon the temperature and velocity of the waste-gases; and that to obtain a high rate of heat-transmission, there must be either a high temperature-drop or a high velocity. In the former case the heat transmission is by conduction, in the latter case by convection. The researches of Kresenger and Barkley (see U. S. A. Bureau of Mines Bulletin No. 145) have proved that the rate of heat-transfer by conduction is practically constant per degree difference of temperature; whereas by convection it is nearly proportional to the velocity of the gases. Now in the economizer, both the temperature drop and the velocity of the gases are comparatively low, so the rate of heat-transfer is much lower than in the boiler.

In order to calculate roughly the amount of heating-surface required in an economizer, under stated conditions, in order to obtain specific results, the following formula may be used:

$$E = K\left(\frac{t_1 + t_2}{2}\right) - \left(\frac{t_3 + t_4}{2}\right)$$

in which E = the total heat units transmitted and recovered in British t. u. per sq. foot per hr. K = the heat-units transmitted per degree difference of temperature per sq. foot per hour. This value may fall from 4 to 1 if the tubes of the economizer are allowed to become covered with internal or external deposits.

t_1 = the temperature of the waste gases at the inlet to the economizer chamber.
t_2 = the temperature of the waste gases at the exit from the economizer chamber.
t_3 = the temperature of the feed-water at the inlet to the economizer tubes.
t_4 = the temperature of the feed-water at the exit from the economizer tubes.

Taking the case of a boiler which is evaporating a metric ton or 224 lbs. of water per hour, from water at an initial temperature of 50 deg. F. with exit-gases leaving the boiler at 750 deg. F. the above formula may be used to calculate the economizer heating-surface which would be required, in order to raise the whole of the feed-water to 194 deg. F. The economizer to give this result must recover per hour from the waste-gases, 2204 × (194 — 50) = 317,376 B. t. u. Now according to the equation, the amount of heat which can be recovered per sq. foot of economizer surface per hour, with fairly clean tubes, under the conditions given above is:

$$E = 2\left(\frac{608 + 311}{2}\right) - \left(\frac{50 + 194}{2}\right)$$

or 676 B. t. u.

$$\text{and } \frac{317.376}{676} = 468 \text{ sq. feet.}$$

An economizer tube, as a general rule, possesses 12½ sq. ft. of heating surface, and holds from 50 to 62 lbs. of water. In the above case, an economizer with 36 tubes would just suffice to provide the boiler with feed-water at the temperature required. In order to give satisfactory efficiency, economizers ought to possess sufficient capacity to hold fully one hour's feed to the boiler; and since the boiler in this case is required to evaporate 2204 lbs. of water per hour, an economizer of 36 tubes is requisite.

As already stated, when natural chimney draft is employed, the temperature to which the waste-gases can be reduced, is regulated by the needs of the chimney. For a boiler installation dependent for its draft upon a chimney only 80 ft. high, it is not wise to go below 550 deg. F., whereas with a chimney 135 ft. high the waste-gases can be reduced to 300 deg. F. without spoiling the draft.

In deciding upon the proper size of economizer for any plant it is sometimes customary to use the coal consumption as a basis of the calculation and to allow four tubes for each ton of coal consumed per week. Thus for a plant with a fuel consumption of 50 tons of coal per week, 22 tubes would be required. Another empirical rule, for calculating the size of water economizers, is, that their superficial heating surface should lie between one-third and one-fifth that of the boiler-plant to which they are accessory.

As regards the saving of fuel possible by heating the feed-water, assuming the initial temperature of 50 deg. F. and a final temperature of 180 deg. F., the saving will represent 11.23 per cent., and with a final temperature of 200 deg. F., over 13 per cent. The more wasteful in fact the boiler, the more useful becomes the economizer. It is a mistake, however, to purposely allow gases to leave the boiler with a high exit-temperature in order to obtain a greater effect from the economizers; for the more rapidly the heat generated from the fuel can be converted into the energy of steam, the higher the efficiency of the plant, since there is less opportunity for radiation and other losses. Further, the thermal efficiency of economizers owing to the small heat-drop and low velocity of the gases and to other causes, is low, and seldom rises above 25 per cent. It is, therefore, more conducive to economy to convert all the heat possible into steam in the boiler, and to use the economizer merely for trapping the heat units that cannot be utilized in steam-raising. Another disadvantage of economizers is, that if worked with natural draft they cannot be made adequate in size to extract all the heat-calories possible from the waste-gases; and that if worked with a fan and induced draft, the large amount of brickwork involved in their construction, increases greatly the risk of air-leakage, and reduces the efficiency of the whole installation. The following test of an economizer, under working conditions, shows the gain that may be expected to follow their use:

Heating surface of economizer	4300 sq. ft.
Coal consumed per hour	3035 lbs.
CO2 test of exit gases	12.26 %
Weight of gases passing to economizer per hour	108,827 lbs.
Weight of water passing through economizer per hour	33,877 lbs.
Temp. of water at inlet of economizer	91° F.
Temp. of water at exit of economizer	191° F.
B.t.u. absorbed per hour by water	3,387,700
Temp. of gases entering the economizer chamber	511° F.
Temp. of gases leaving the economizer chamber	232 F.
Mean temperature difference	230 F.
B.t.u. transmitted per sq. foot of economizer area per hour	787.8
B.t.u. transmitted per sq. foot per deg. F. per hour	3.42

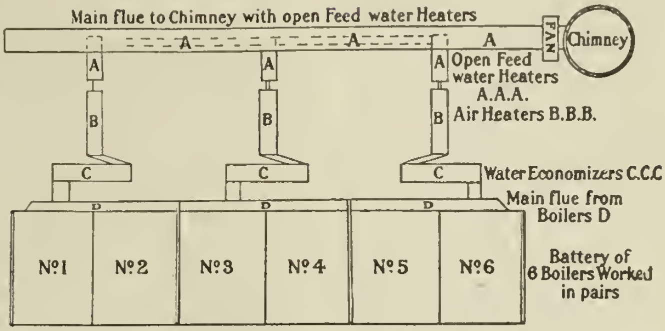

Main flue to Chimney with open Feed water Heaters
A
A
A
FAN
Chimney
A
A
A
Open Feed water Heaters A.A.A.
B
B
B
Air Heaters B.B.B.
C
C
C
Water Economizers C.C.C
D
D
D
Main flue from Boilers D
Nº1
Nº2
Nº3
Nº4
Nº5
Nº6
Battery of 6 Boilers Worked in pairs

Fig. 5. Diagram of Booth and Kershaw's system of waste heat recovery.

HEAT-BALANCE OF ECONOMIZER

For every lb. of fuel consumed in the boiler 6.72 lbs. of feed-water was raised through 100 deg. F. in temperature in the economizer	672 B.t.u.
Heat units contained in the exit-gases passing through the economizer chamber per hour	13,289,380
Heat units represented by gain in temperature of feed-water per hour	3,387,700
Economizer efficiency	24.5 %

Further calculations show that of the remaining heat-units, 38.79 per cent. was carried away by the waste-gases to the chimney, and 35.43 per cent. was lost by radiation, etc., from the economizer walls. The fuel economy resulting, in this particular case, from the use of the economizer was therefore 8.20 per cent.

Another test of an economizer carried out under strict conditions, yielded figures showing an efficiency of 26.16 per cent., and a value for R (the coefficient of the rate of heat-transfer) of 1.58, which is only half that obtained by the test given in detail above. In this case no doubt, the economizer-tubes were badly in need of a cleaning.

These figures prove that the rate of heat-transfer through economizer tubes, under actual conditions of work, is considerably lower than is usually assumed; and that more effective methods of cleaning them both on the exterior are necessary, if good results are to be obtained.

For these reasons the older method of cleaning by mechanically operated scrapers, is being discarded, since scrapers, unless very close-fitting, do not remove the whole of the soot, and more than half of the new installations of economizers in U. S. A. are reported to be having their tubes cleaned with a hand-lance. As regards the internal deposits of scale and sludge some important plants blow down once or twice a week, and also bore out the tubes once each year in order to keep the tube as free as possible from internal deposits; but the frequency of these operations must depend altogether upon the character of the water supply.

In many cases of economizers installed during the last few years, the induced-draft fans have been found of too small capacity to enable any overload to be carried by the plant. This brings one to consider the most serious drawback to economizers, namely, the large amount of brickwork which is involved in their construction, and the serious amount of air-leakage which occurs when, as is often the case, the installation is neglected and the brickwork is allowed to fall into disrepair. Whenever air leakage is suspected simultaneous tests of CO_2 contents of the waste-gases should be made, taking the gas-samples at the inlet and exit ends of the economizer chamber. The difference in CO_2 percentages will give some idea of the amount of air leakage and of the loss that is taking place in consequence of it. If serious leakage is occurring, the place can be detected by going round the brickwork with a lighted candle or burning taper, and noting where the draft draws the light into the cracks. The most likely places for cracks to occur, are in the side-walls, between the flue covers and tops of the economizer, around the bottom branch-pipes, and in the spaces between the top-boxes. The soot and sight-door joints are also places where air leakage may occur. Frequent pointing of the cracks may minimize the trouble; but the only real remedy is to enclose the economizer brickwork witht sheet iron, or with some other sheet material which will stand heat, and is impervious to air.

The large amount of heat (36 per cent. lost by radiation from the side-walls and tops of the economizers) is also a feature of economizer working which requiries attention; for there is no reason whatever why this loss should be permitted, or why economizers should not be encased in, or coated with, heat-insulating materials. A thousand heat-units when lost by radiation from the economizer walls, are just as much lost to the credit side of the heat-balance account, as if lost by radiation from the boilers. Could radiation losses from economizers be reduced by 10 per cent., that is to 25 per cent. of the heat passing through them, their efficiency could be raised to a much more satisfactory figure, than that given in the two tests quoted above.

There is no reason also, when fan-draft has been installed, why the exit gases from an economizer should be allowed to escape to the chimney, still carrying 40 per cent. of the original heat units contained in them when issuing from the boiler. It may not be practicable, for the reasons already given, to cool these gases to atmospheric temperature in the economizers themselves, but some other method of saving these heat-units ought to be adopted.

Many years ago, the writer of this article, in collaboration with the late Mr. W. H. Booth,* suggested that the heat contained in the exit-gases from economizers might be utilized for pre-heating the air-supply to the boilers, and the following extract from the I. E. E. paper in which this plan was advocated, may be given here:

"The ideal system would be to reduce the exit flue-gases to atmospheric temperature, by means of economizers, air-heaters and preliminary feed-water heaters—chimney-draft being dispensed with, and the draft produced by fans. The preliminary feed-water heaters would be placed last in such a system, and the whole of the remaining heat would be removed from the exit-gases by spraying the water through them, or by use of a tower filled with tiles or flints.

"Little or no unconsumed carbon would be produced under the conditions obtaining with a very high temperature in the combustion chamber of the boiler furnaces, and the sulphur dioxide and CO_2 absorbed by the feed-water would be neutralized in the water-softening operation. It must be remembered here that the sulphur would finally appear in the boiler as sodium sulphate; but the authors suggest that it (the sulphur) might be recovered in some way, and made a source of revenue to the feed-water purification plant. The air-heater would be of the type used in the regenerative gas-furnace—lengthened contact with a considerable surface of heated brickwork being necessary to heat air, which is a poor conductor of heat, and demands time for its temperature to be raised."

Although this plan of recovering all the heat-units from the waste-gases of boilers has not yet been operated upon an industrial scale, the writer is convinced that it (or some modification of it will be adopted) when the need for practising fuel-economy becomes more and more pressing, in this and other manufacturing countries. The only alteration the author has to make in the original suggestion is, that the air-heaters should be planned on the lines described in the next section of this article; since what is known as the regenerative system of air-heating (as applied in the Siemens gas-heated glass and open-hearth furnaces) demands very extensive chequered brickwork chambers, with complicated flue systems and change-over dampers; whereas. what is known as the "recuperative" type of air heater, is of fairly simple design.

If economizer-working does not develop in this direction, it is probable that it will give place entirely to a system and type of water-heating apparatus, planned on the lines of the Kirke waste-heat boiler.

Owing to the much higher pressures now being used for steam-engines and for steam-turbines, the use of cast-iron tubes for economizers is no longer quite safe. Owing to their design and large number of tubes, economizers provided with steel tubes are very costly, although they have been adapted in a few cases in U. S. A. The Kirke waste-heat boiler, of course, demandse a powerful fan-draft, in order to overcome the resistance offered by the length and narrowness of the tubes, through which the gases are drawn. On the other hand there is no brickwork involved in its construction, and therefore no air-leakage can occur. The heat transfer to the water in the boiler in fact can be made so efficient, that the temperature of the escaping gases can be reduced to within 80 deg. F. of that of the water contained in the boiler. It may be admitted that a Kirke waste-heat boiler is more costly to install than an economizer, but its heat-efficiency is far higher; and now that higher temperatures and pressures are being employed for boiler working, the demand for heat recovery apparatus that is both safe aand efficient is certain to increase.

Up to the present time, the Kirke waste-heat boiler has been employed chiefly for recovery of the heat from the waste-gases of metallurgical and other furnaces; but the writer expects to see its sphere of application and usefullness widened, as the need for higher and yet higher thermal efficiencies in steam boiler practice grows more urgent and insistent.

A scheme of hydro-electrical development on the east branch of Bear River, Nova Scotia, at a probable cost of 11,150,000 dollars, which would supply the north shore of Nova Scotia from Yarmouth to Middleton, was recently outlined by Mr. K. H. Smith, chief engineer of the Nova Scotia Water Power Commission. The work had, he said, so far advanced that, within a very short time the Commission would be prepared to suggest a definite contract for the approval of the town. Distributing stations under the plan would be at Middleton, Bridgetown, Annapolis, Bear River, Digby, Weymouth, Port Maitland and Yarmouth.

Experiments carried out in America on the treatment of carbon monoxide asphyxia have shown, according to the Gas Journal, that when breathing oxygen the rate of elimination of carbon monoxide is somewhat more rapid than when the subject breathes merely air, but that the elimination is enormously accelerated when the inhalation consists of oxygen, plus carbon dioxide. A blood concentration of carbon monoxide of 40 to 50 per cent. saturation (a dangerous amount) was reduced to 10 or 12 per cent. (a quite harmless amount) in half an hour.

Canada has sufficient coal to last 30,000 years, according to Dr. Charles Camsell, Deputy Minister of Mines.

Radium has been discovered on the Petawawa River near Pembroke, Ontario, according to a report from Toronto.

With 55 thousand million tons of lignite in the southern part of Saskatchewan, the Provincial Government is not going to give up the experiments now being conducted by the Lignite Utilisation Board at Beinfait until it is proved

(Continued on page 30)

Safe Practice in Handling Acetylene Generators

Best Housing Methods Under Different Conditions—Fire Hazard Requires Special Attention—Natural and Artificial Lighting of Buildings—Pressure in Pipe Line Important

IT IS ALWAYS desirable to have two workmen trained to properly operate the acetylene generator. If you only have one man in your employ who knows how to operate the generator and he should be sick or absent from other cause, you are liable to permit a man who knows absolutely nothing about the operation of the generator to attend to it, and possibly with serious results, and the chances are that your foreman or ever you, yourself, have not enough knowledge about the generator to tell an unskilled man how to operate it or to judge whether he is operating it properly.

Recharging Generators

In the recharging of acetylene generators it is most important to follow the orders and instructions for consecutive operations as laid down by the manufacturer. Manufacturers of acetylene generators have endeavored, as far as seems humanly possible, to make their generators fool-proof, but the idea has never been quite accomplished. It is most important to remember when an acetylene generator is recharging that the generating chamber which contains the water and spent carbide is first of all drained or flushed out and again filled with water before any attempt is made to open or fill the hopper or container with carbide.

Supposing you have drained all the water from the generating or water chamber and that you then before refilling it with water, fill your carbide hopper, there is just the possibility that a piece of carbide may drop down through the feeding mechanism into the empty generating chamber. You must remember that the bottom of this generating chamber will probably have a coating of moist lime sludge. The moisture will attack the carbide and start to decompose. There is, however, not sufficient water to cause the decomposition to take place rapidly and, as a result, the decomposing carbide may heat up and reach a temperature where it is possible for it to ignite a mixture of acetylene and air. Remember if the carbide hopper were opened up before the generating chamber was filled with water, it would be possible for some air to have got into it.

Special attention should always be given to making sure that the hydraulic seals and backflash devices at the discharge of the generator are properly filled with water and are in proper working order. The pressure relief valves, which are commonly employed on what is known as the medium pressure type of generator, should be tested periodically in order to see that they are working freely and release at the proper pressure.

If any repairs have to be made to an acetylene generator, the whole machine should be thoroughly flooded with water to make sure that all gas has been expelled. This may seem very elementary advice, but history seems to warrant it being given as often as possible, and notwithstanding the fact that this advice is given on every possible occasion, workmen will sometimes occasionally open up an acetylene generator to make some minor repair or adjustment and then, without making sure that all gas has been expelled, start to use some metal tool and create the spark necessary to cause trouble.

In these cases where the shops are piped for oxygen supply and the oxygen is supplied from a number of cylinders manifolded together, it will probably be arranged for the same man who looks after your acetylene generator to look after the oxygen manifold and replace the exhausted cylinders with full ones when necessary. It is essential that the workman looking after this work be very carefully instructed in the matter of handling the cylinders with his hands free of grease or oil. When the empty cylinders are disconnected from the manifold and put on one side, the full ones that are to be attached should all have their valves cracked, that is to say, they should be opened very slightly for a moment to blow out any dirt or foreign matter that may have accumulated in the valve orifices during transport or storage. The cylinders should then be connected up in turn through flexible connections to the manifold and the valve on one cylinder opened up, care being taken to open the valve slowly so as not to throw a pressure of 2,000 pounds suddenly on the system. With the valve of one cylinder opened up, the manifold and all connections will contain oxygen at 2,000 pounds per sq. in.

Search for Leaks

A careful search should then be made for leaks, which will be detected by a hissing sound. Connections where leaks occur should be tightened up immediately. After the operator has made sure there are no leaks in the manifolding system, the rest of the cylinders connected to the manifold can be opened up. It should be appreciated that it is necessary to open the valves on oxygen cylinders fully. If any cylinders are found that leak around the valve stem they should be disconnected and returned to the manufacturer.

Under no circumstances whatever should workmen be permitted to attempt to make any repair to the valves and valve fittings on an oxygen cylinder. All oxygen cylinders are fitted with valves having right-handed connections. Unfortunately, certain combustible gases are stored in cylinders of similar size and appearance to oxygen cylinders. Such cylinders should, in the cause of safety, be equipped with left-handed valves, but

The cutting operator working on the outside of the casting cannot see the line of cut. The man in the picture is his helper and is guiding the cut with signals.

As recommended by the National Safety Council.

there are no laws which make it possible to enforce such a safety measure, and I regret to say that there have been one or two isolated instances where a cylinder of combustible gas has been connected up to an oxygen manifold along with oxygen cylinders and with, of course, disastrous results.

These occasions, however, have been so very rare that there is really nothing much to worry about, and even if every combustible gas cylinder were equipped with left-handed valves we would still have the man who might occasionally, by some means or other, connect a right-hand connection to a left-hand connector. As a matter of fact, cases are known where an operator endeavored to connect up a connection from an oxygen manifold to a cylinder of combustible gas, and he found he was unable to make a proper connection because the thread on the valve of the combustible gas cylinder was left-handed. This, however, did not thwart the determined worker and he went into the machine shop and got them to make up an adaptor for him so that he could make the connection. Now when instances of this sort do occur it is very clear that the workman delegated to look after cylinders, generators, etc., has not been properly instructed and cautioned.

Operation of Welding Units

It is quite needless to talk about the operation of the actual welding units, that is, the blowpipe, gas regulators, hose, and the installations using individual oxygen and acetylene cylinders where they are employed. Every manufacturer of apparatus puts out detailed instructions on how the various items of equipment are to be connected up and operated, and if users would follow these instructions, few, if any, accidents would occur. If, for some reason or other, oxygen or acetylene regulators which are employed for adjusting the pressure of the gas for delivery to the blowpipe become disarranged, do not permit your workmen to attempt to repair these themselves. Large establishments can, of course, have a department where welding equipment can be periodically overhauled, repaired and tested, and can employ in that department a man who is properly and thoroughly skilled in his work; but in the case of smaller establishments, it is advisable for defective apparatus to be returned to its manufacturer when overhaul or repair is necessary.

Testing Working Pressure

It is very important to periodically test the working pressure gauges on the regulators. These are the pressure gauges that indicate the delivery pressure of the gas from the regulator. As previously mentioned, acetylene should never be used in a blowpipe, or in a hose or piping system at pressure over 15 pounds per sq. in., and it is on this account that we emphasize the importance of making sure that the working pressure gauges, particularly those on the acetylene supply, are periodically tested to see that they register correctly. You hear occasionally of accidents where the hose supplying the gas to the blowpipes has burst. In nearly every case this can be traced down to the fact that acetylene was being supplied to the hose at a pressure in excess of 15 pounds per sq. in., either intentionally or because the working pressure gauge on the regulator did not record properly, with the result that a backfire in the blowpipe propagated through the blowpipe to the hose. Now appreciate that the backfire would not matter at all if the pressure in the hose was not above 15 pounds per sq. in. The acetylene would not even burn. But when the pressure is over 15 pounds to the sq. in. the acetylene may readily decompose and cause the hose to be ruptured, and probably disarrange the functioning of the regulator attached to the gas cylinder.

Proportions of Hose

Guard against using long lengths of hose of too small a diameter. Quite a number of blowpipes only function properly when the acetylene is delivered to the inlet to the blowpipe at pressure somewhere between 10 and 12 pounds to the sq. in. Therefore care must be taken to see that the diameter of the hose is large enough in proportion to the length to be employed to insure that the drop in pressure between the outlet of the regulator and the inlet of the blowpipe is not more than a pound or so.

It is probably advisable to say a few words about the acetylene cylinders. Some of you may not appreciate the fact that an acetylene cylinder is not merely an empty shell containing compressed gas the same as an oxygen cylinder. The interior of an acetylene cylinder is completely filled with a porous material such as asbestos, or a concrete made up of charcoal instead of crushed stone. This porous mass has a porosity of about 75 to 80%, and is being employed for the following reason:

It is found that if acetylene is compressed into a porous substance, and where the porosity does not exceed 80%, and acetylene cannot be exploded or ignition propagated when the pressure is over 15 pounds per square inch, as it could be if the cylinder contained no porous mass. Therefore, a cylinder properly constructed and containing the proper porous mass can be safely used for the storage of acetylene at over 15 pounds pressure per square inch. Cylinders commercially used today, in addition to containing the porous mass, also have in them a solvent, which will dissolve many times its own volume in acetylene, thus making it possible to store in the cylinders large quantities of gas at comparatively low pressure. A charged cylinder of compressed acetylene contains practically no free gas. All the gas that is in the cylinder is in solution in the liquid solvent, which liquid solvent is in turn absorbed in the porous mass in the same manner that a sponge absorbs water. When the valve of the cylinder is opened and pressure released, the acetylene gas comes off from the solvent in the same manner that CO_2 bubbles up through the water in a seltzer water syphon when the valve is opened. Acetylene cylinders should always be stored and used standing upright.

Safety Fusible Plugs

As mentioned previously, the safety devices in acetylene cylinders consist of fusible plugs which melt at a temperature of 212° F. It will therefore be seen that care must be taken not to let any flame come in contact with the fusible plugs. Otherwise they will melt instantly and release the full charge of gas in the cylinder.

Make a point of insisting that all welding operators wear suitable goggles. When securing suitable goggles it is advisable to have them comply with the specifications for goggles of the National Head, Eye and Ear Code for acetylene workers. Welders employed on heavy work should be supplied with fireproof gauntlets and aprons as a protection against radiated heat, and it is considered advisable where welding is being performed in the interior of some structures to insist that all outer clothing be fireproof.

Get The Safety Habit

It is sincerely hoped that some of the recommendations may help to steer you clear of accidents which need not occur, but don't forget that safety practice does not end with proper operation of your welding equipment. Welding must only be used for work where welding can be considered good and safe practice for construction or repair. Some users become over-enthusiastic and attempt to employ welding on certain work where it should never be attempted and consequently fall down badly, with the result that it tends to give welding a bad name and creates a feeling of insecurity about the process in the minds of those who are considering its use.

UTILIZATION IN WASTE

(Continued from page 28)

beyond all doubt that briquettes cannot be made from the fuel. The Saskatchewan Government has contributed almost a quarter of a million dollars as the Province's share in this experimental work.

A factory is being put up by the Canadian Salt Company, Limited, at Windsor, for the manufacture of liquid chlorine. It will have a capacity of 10 tons per day, and will be producing shortly. This is the first plant of its kind to be erected in Canada.

Engineers Discuss Boiler Problems

Annual Meeting of Mechanical Engineers in New York Has Many Features of Interest—Animated Discussion on Power Equipment, Management, Test Procedure and Make-up of Codes

THE FORTY-THIRD annual meeting of the American Society of Mechanical Engineers was held in New York on Dec. 4 to 7. With an attendance of more than 1,600, it was one of the most successful conventions in the history of the society. The outstanding feature was the animated discussion and interest in problems associated with the use of higher steam pressures and temperatures in power-plant work and in connection with the use of stokers and coal and ash-handling equipment for central-station plants. Another prominent feature of the convention was the notable address of the retiring president, Dexter S. Kimball, dean of the Engineering College of Cornell University, on the place of the engineer in modern industrial civilization. President Kimball has been preaching the gospel of social service and the possibilities of the engineer in the political field during the past year and has aroused a great deal of interest throughout the country on this subject.

Ash-Handling Methods

Ash handling was the subject of discussion at one entire session, the feature of which was a paper presented by John Hunter, chief engineer of the Union Electric Light & Power Company, St. Louis, and Alfred Cotton, chief of the research department of the Heine Boiler Company. The paper embraced a very extensive and complete discussion of the methods of removing ashes from basement boiler rooms, the design, construction and capacity of hopper ash pits, systems of mechanical conveyance and elevation, fluid and gas conveyance, and the final disposal of ash. Sufficient description and illustration of all successful methods of handling ash were given to enable those interested in the subject to lay out or criticize intelligently almost any installation with which they may be confronted.

Several engineers discussed the general problem of ash handling, attention being centred on (a) the logical fields for different types of ash-handling equipment, (b) the place and limitations of gas and fluid conveyors, (c) the size of ash pits and storage base, and (d) quenching of ashes.

Unless carefully designed and laid out, the steam-jet ash conveyor is very uneconomical in steam consumption, Eugene Hahn declared. The design of the nozzles is extremely important, and fittings, especially elbows, should be provided which will strongly resist abrasion and can be readily replaced.

The serious effect of small-size ash pits on stoker maintenance was emphasized by T. A. Marsh, who illustrated both good and faulty designs. He strongly advocated much larger ash pits than are ordinarily employed. Commenting on gas-type ash conveyors he contended that they are not suitable where considerable clinker has to be transported. Worn nozzles were pointed to as the chief cause of excessive maintenance in gas-type conveyors.

F. D. Allen maintained that most methods of quenching ashes are inadequate and advocated a system in which water headers run along the outside of the ash hoppers and connect with easily accessible spray nozzles that discharge water over the surface of the ashes. The principal advantages claimed for this system were the more uniform cooling of the ashes and the greater reliability and flexibility of operation. With tight-fitting hopper gates and drains for water discharged into the hoppers the basement floor can be kept dry, and a water seal can be maintained which will increase the economy of operation of the furnace. The speaker also referred to an installation at Durham, N. C., where carbon is being recovered from ash at a cost of 40 cents to 60 cents per ton.

More attention must be given to the working conditions under which boiler refuse has to be handled in designing ash-disposal systems, R. H. Beaumont said. Furthermore, the systems must be laid out in such a way that various means of removal from the plant can be utilized in emergencies.

Bottom-Dump Hoppers

Of all the systems considered by Mr. Hunter in his paper, N. E. Funk favored the bottom-dump ash hopper with railway or industrial cars for removing ashes. He maintained that this system is most easily operated and maintained, is flexible in operation and can be replaced by some emergency expedient when necessary. No more headroom is required than for other systems, he contended. Ample ash storage is imperative because emergencies will arise when the largest storage will be insufficient. Referring to water-sealed ash pits, he declared that they are somewhat untidy and are amenable to operation only with overhead cranes or grab buckets operated by a locomotive crane. The carrier-ring system of coal and ash handling is objectionable because it may discharge ashes into coal bunkers; the cross-bar conveyor, even when duplicate conveyors are employed, may shut down all the boilers in a row, and the vacuum ash tank is liable to blow up because of the generation of gas. In one 60,000-kw. plant using coal containing 15 per cent. ash and operating at 70 per cent. load factor it has been possible to handle all the ashes with two storage-battery locomotives, industrial cars and two men, Mr. Funk declared.

N. W. Elmer pointed out that disposal of ash will be a serious problem for all to consider if powdered fuel becomes more extensively used.

In congested sections it is becoming a very big problem how to dispose of ashes, I. E. Moultrop declared. In such places big ash pits are imperative. Furthermore, the ash-handling equipment must be simple and should not break down easily. The ash hoppers should be high enough to permit railway cars trucks or industrial cars to be run under them to remove the ashes. In emergencies the ashes can be dumped on this floor and removed later.

At Cleveland industrial cars and a skip hoist are employed to handle ashes, asserted T. Mainz. In emergencies the ashes are dumped on the floor. The speaker warned against cutting down the size of ash pits and storage space.

Explaining his reason for adopting submerged ash pits, G. G. Bell said that they prevent the emission of carbon monoxide, corrosive gases and flames and simplify the problem of ventilating the ash room. Furthermore, they cost only two-thirds what other ash pits would have cost. At the Windsor plant ten days' storage is provided in the submerged ash pits, the contents being removed by a crane, conveyor and aerial tramway. The aerial tramway which has recently been installed will take care of conditions for some years to come by filling in ravines around the station. Ashes can be handled with this tramway at a cost of 25 cents per ton, and this cost may be reduced to 12 to 15 cents.

In a written communication from E. H. Tenney it was pointed out that freezing of gates on overhead ash hoppers during cold weather can be prevented by steam lines.

In closing the discussion, Mr. Hunter pointed out that operating engineers are anxious to secure the largest ash pits possible, but monetary conditions sometimes stand in the way. He questioned the economy of recovering carbon from ash in most plants. Despite the comments on gas and fluid ash conveyors, he contended that they had a definite field and must have consideration for the reasons previously outlined; besides, they provide considerable storage. In emergencies they can be unloaded by locomotive cranes if sufficient headroom is available. Referring to the disposal of ashes in powdered-fuel plants, he pointed out that John Anderson of Milwaukee has claimed that he has been able to remove 50 to 100 per cent. of the ashes by washing the flue gases. He insisted that more consideration must be given to the problem of handling ashes in small plants.

Material-Handling Equipment

A report was submitted by the committe delegates to develop formulas for calculating the investment justified in material-handling equipment, the yearly cost of maintenance and the yearly profits. Mr. Hunt pointed out that the formulas are very simple to use but cannot be presented without considerable explanation.

Stoker Symposium Arouses Interest

A profitable session was held under the direction of the fuels division, with Prof. L. T. Breckenridge in the chair. A symposium on stokers was presented in the shape of four phases, which outlined in detail the field, the operating possibilities, the installation methods and the development of the modern stokers. T. A. Marsh discussed the development and use of the modern chain-grate stoker and showed how greater boiler capacity can be obtained by increasing grate size or by increasing the draft. He gave in detail the operating possibilities of the modern chain-grate stoker for power purposes, including a table of results obtained by a number of stations equipped with these chain grates.

In discussing the overfeed-type stoker, G. I. Bouton stated that apparently this type has reached a limit in a stoker having a projected grate area of 100 sq. ft. to 110 sq. ft. in a single unit capable of burning sufficient coal under forced draft to develop about 2,000 boiler-horsepower at the maximum. Mr. Bouton discussed the development and present success in method of operation of the front and side-feed types of the inclined overfeed stoker, and gave illustrations of the settings. The effect of the content of ash in determining the fusion temperature was also discussed.

H. F. Lawrence labeled his paper "The Design and Operation of Underfeed Stokers" and described briefly the distinctive features of the single and multiple retort types of underfeed stokers, giving illustrations of a number of each type as well as particulars regarding their operation and results that have been obtained. The author accented the advisability of giving attention to the secondary feed system and pointed out the types of coal to which this type of stoker is best adapted. He also gave some very good curves and data showing the best types of fans to be used in stokers and a table of settings for the boilers.

The chronological history of stoker development to the present day was the subject of a paper by A. H. Blackburn.

These papers were discussed as a whole by many members, and much valuable information was obtained from those who have had experience with the several types. The consensus of opinion was to the effect that the chain-grate stoker was best adapted for burning high-ash Western coal. In connection with the operation of the chain-grate stokers, however, T. L. Mainz pointed out that among points to be watched is the amount of carbon in the ash and trouble with the seal at the end of the stoker. He said that the best results could be obtained by having a uniform size of coal sent to the grate and that this was a part of the function of the coal-handling system. Another point he mentioned was that the boiler-room dirt must be eliminated when using forced draft under the chain-grate stoker. Further discussion brought out the fact that several types of the modern stoker had solved these problems successfully.

H. C. Heaton of Sargent & Mundy pointed to results obtained by operating chain-grate stokers and said that one of the great features was to insure the proper spreading of the coal and that his experience indicated the movable spout as the most successful means of securing proper spreading.

In a general discussion W. N. Polakov brought out the fact that in many cases the installation of good types of stokers was in itself no guarantee of efficient operation. The human element must be considered and the personnel trained if good results are to be obtained. Mr. Roney also accented the necessity for a skilled personnel, and D. M. Meyers pointed out that, in engineering terms, a stoker's effiicency was the product of the mechanical efficiency by the human efficiency. He asked questions about the formation of clinkers on the underfeed type of stokers and the value of automatic control equipment and the ratio of combustion space to the capacity of a boiler, and also asked what possibilities there were of introducing stokers into marine practice.

Other speakers brought up the point that with modern conditions for obtaining coal it is a necessity to have a stoker that will operate under a wide variation of fuel conditions and, if at present there are seventy-five fuels and five stokers, the ideal thing would be to have one stoker that could burn any of the seventy-five fuels. Discussion brought out the fact that this ideal could not be reached at present, but that several types of stokers could burn a wide variety of fuels with success and efficiency. Another point brought up in this discussion was that the coal-handling equipment is a part of the stoker problem and that the furnace setting in particular is very important to insure proper upkeep of furnace refractory material and the arrangement of the material in the furnace. Devices for obtaining the best operation for a given type of stoker and for getting rid of ash and clinker were discussed. O. P. Hood mentioned, incidentally, that a committee was at work to try to standardize engineering details in an anti-smoke ordinance.

Question the Use of Automatic Equipment

One of the most interesting points in the discussion was regarding the necessity and advantage of using automatic stoker control equipment. The points brought out were to the effect that it was almost a necessity to afford the boiler-room employees proper training facilities, meters and instruments. Automatic equipment, it was pointed out, is a safeguard in regard to pressure maintenance. In many ways it is far from ideal, but much may be expected as it is developed. The parallel operation of boilers and fans with control based only on steam pressure was mentioned as decidedly a makeshift proposition at the present time, but several members maintained that by using a certain number of the boilers to maintain pressure with manual control of firing maintenance on the remainder of the boilers a good combination for obtaining reliable and efficient operation would be gained.

Industrial Education and Training

One session of the meeting was devoted to the education and training of men for the industries. This was taken up from the standpoint of the correspondence school, extension course and apprentice course in industries, and very valuable material along these lines was compiled and presented by a committee. The statistical information afforded an indication of the great increase in training men for the industries.

Baffling the Boilers

Results of extensive tests on large type W Stirling boilers at Deroit to determine the effects of different baffle arrangements, grades of coal, banking methods, intervals between blowing of flues and methods of operating during low-load periods were presented by P. W. Thompson. As a result of these tests the boilers have been rebaffled with considerable improvement in efficiency and degree of superheat, and the Babcock & Wilcox Company has developed a new design of this type of boiler. The baffling arrangement selected exposed two layers of tubes to the radiant heat of the furnace and allowed the gases to cross the inner bank of tubes at the top, pass the superheaters and then return along the outer bank of tubes to the stack. With this arrangement an average increase of 50 deg. F. in superheat was obtained, the flue-gas temperature was reduced 70 deg. and the draft was reduced 38 per cent.

Changes of the extension grates did not have the desired effect, although it is believed that further study will develop better arrangements of air openings and possibly reduce ash-pit losses. Air leakage from the chamber below the stokers was found to be as much as 25 per cent. at high ratings. As much as 2.6 per cent. increase in efficiency was obtained with the best coal tested, but clinker trouble was experienced, so that one of the grades giving only 0.6 per cent. increase in efficiency was preferable. Energy for boiler auxiliaries averaged between 0.7 and 1.6 per cent. for light load and 170 to 200 per cent. rating. Considering all economic factors, twelve and a half hours was determined as the most desirable interval between blowing of flues. The coal required for banking in excess of four hours was found to be 8,600+105× hours for floating bank and 8,00+280 ×hours for dead bank. A study of heat absorbed indicated that five rows of tubes between the upper center drum and each mud drum and ten rows of tubes in the outer banks are more desirable than are the present arrangements.

In the discussion of this paper great commendation was expressed concerning the accuracy and value of the investigation. The expense of such tests, while great, is well justified by the higher efficiency and superheat obtained, declared Dr. Jacobus.

Determination of Pipe Bends

As a result of mathematical study and tests, Sabin Crocker and Sterling S. Sanford presented charts which can be used in selecting the proper size and shape of bends to care for a given expansion and in determining the force exerted by a bend in state of deflection. In general the authors recommend bends of larger dimensions than ordinarily used. Their figures are said to be on the side of safety. In some cases the bends tested showed greater flexibility than was anticipated.

While the contribution of Crocker and Sanford was commended, attention was directed by at least two speakers to apparent oversights that make the calculated results differ from test results. The advisability of considering expansion loops made of straight pipes was suggested by a few speakers. Some questions were raised regarding the effect of pressure and temperature on the flexibility and stress in pipe bends.

W. B. Campbell contended that even some of the conclusions from actual tests are not accurate because they are based on ideal conditions.

This contention was carried still farther by Robert Crane, who said that the assumption that the neutral fibre runs through the center of the pipe bend does not result in accurate conclusions. Furthermore, he contended that the fact that some of the calculated results were greatly different from test results should be sufficient reason for thoroughly investigating the cause.

More attention must be given to flexibility of and stress in pipe bends, asserted F. Hodgkinson. Flexibility can often be obtained with loops composed of straight pipes instead of fancy bends. To permit alignment of pipes more consideration must be given to torsional flexibility and means for allowing it.

J. V. Brady related some trouble with bends which had not been properly annealed. They tended to straighten after being placed in service. He also advocated more consideration of straight-pipe loops, saying that no excessive pressure drops had been experienced with an extensive installation of such expansion loops at Hell Gate.

Mr. Whitney called attention to some U bends which did not allow the deflection calculated, whereas double-U bends allowed more than twice the deflection. He contended that designers need not fear ripples or buckling on the inside of pipe bends since they reduce stress in outside fibres and increased flexibility. Seamless tubing was urged for bends requiring large-diameter pipe, because with its use there is not the danger of rupturing the outside of the bends.

John Stevens referred to installations in which flanges had failed without the bends showing signs of weakness. In Europe, he pointed out, reservoirs are being extensively installed between the steam mains and the turbines. Duplication of such practice was recommended in this country.

George Orrok raised a question regarding the effect of operating steam pressures and temperatures on the fibre stress and deformation in pipe bends.

Feed Heating for High Thermal Efficiency

The problem of determining the correct feed-water temperature for high thermal efficiency was presented by Linn Helander. He considered a 25,000-kw. station, investigating the conditions when using single-stage and multiple-stage condensate heaters, both with and without economizers and treating the subject from the viewpoint of thermal efficiency only. For power plants using single and multiple stage heaters of the condenser type, the temperature of the boiler-feed water as it leaves the heater should not be less than 150 deg. F. when using economizers and not more than 260 deg. F. when not using economizers. Heat balances showed that when using single-stage heating and no economizers better results were obtained from heating the feed water by combining steam from the house turbine and that bled from the main unit than when using the steam from a house turbine alone. Double-stage heating with no economizers also showed better thermal efficiencies when using a larger amount of steam from the main unit than from the house turbine.

The increasing tendency to bleed the main units for heating the feed water with the consequent decrease in use of house turbines was the keynote of the discussion. W. M. Keenan said that in the new Brooklyn Edison plant the heaters will be supplied with steam by bleeding the main turbines. He pointed out that for a single stage the best bleeding point is between 20 lb. and 30 lb. absolute pressures. For two stages the best points are 12 lb. and 100 lb. absolute pressures, respectively.

Commenting on modern practices as to the use of house turbines, Prof. A. G. Christie said that in the future large stations will use one or possibly two of these turbines, the main supply of steam for heaters being taken from the main turbines. O. F. Junggren and F. Hodgkinson both expressed the same opinion basing their remarks on the fact that much better over-all efficiency can be obtained by bleeding the main units. Ideal operating conditions, according to Mr. Junggren, depend on producing the maximum power in the turbine and heating the feed water to the limit by bleeding. Mr. Hodgkinson pointed out that turbines of modern design are now provided with four bleeding points, namely, 140 deg. F., 200 deg. F., 50 lb. and 120 lb. absolute pressure.

Higher Pressures and Temperatures

Higher steam pressures and temperatures were the subject of considerable discussion. Two papers on the subject were presented—one by George A. Orrak and W. S. Morrison, the other by B. N. Broido. In the latter paper were given results of tests to determine the heat-transmission coefficients of bare and covered pipes at different steam velocities, superheats and pressures. Suggestions were made regarding velocities to select for best economy of transmission.

The discussion from the floor went into practically every phase of this subject—early attempts at high pressure operation, the question of whether higher pressures and temperatures are the way to greater economy, need of balancing fixed charges against fuel cost, possible effect on continuity of operation, effect of prolonged high temperature on metals, value of alloys for fittings, serious problems with pipe flanges, experiences with high pressures and temperatures in the oil distillery field, need of standardizing pipe fittings, economy of regenerative cycles or superheating between stages, higher pressures versus refinement in operation and the use of factor turbines. Every one agreed that reliability and continuity of operation are paramount and that efficiency, flexibility of operation and simplicity rank about on a par in consideration of any new design.

O. F. Junggren contended that past experience has not indicated so far that we have reached the economic limit of pressure, and that engineering ingenuity can be expected to solve all problems.

H. D. Hibbard emphasized the necessity of investigating the effect of continued high temperatures on the elastic limit and tensile strength of metals.

Gun steel, he declared, reaches its maximum tensile strength at 950 deg.—about 300 deg. above steel used in power plants.

Dr. D. S. Jacobus pointed out that the problem in using higher pressures and temperatures is more with pipe fittings and flanges than anything else, owing to the falling off in elastic limit. Flanges must not spring or distort and hence they cannot have an extreme overhang.

Referring to experience in the oil-distillery field with high pressures and temperatures, Mr. Millikan declared that valves have been in successful operation at pressures and temperatures up to 1,200 lb. and 1,000 deg. superheat respectively. The chief requirement in such valves is that they shall be made of acid open-hearth steel, be symmetrical and have no flat surfaces and be carefully annealed.

W. J. Wohlenberg contended that there is no need of economizers if the regenerative cycle is used. Mr. Orrok maintained that the more times steam is taken from an expansion stage and returned to the input side the higher the economy will be.

Several speakers, notably I. E. Moultrop, contended that before going to higher pressures and temperatures more attention should be given to refinements in operation. John Stevens presented curves which indicated the effect of coal cost and load factor on efficiency and first cost, while Peter Junkersfeld called attention to the use factor of a number of turbine installations running from twenty to thirty hours per year up to six thousand to seven thousand hours per year. He pointed out that whereas the use factor of one-year-old turbines may be only 44 to 58 per cent., it drops off rapidly as the turbines get older, owing to the economy of using a more modern turbine.

On Wednesday night the American Society of Mechanical Engineers held a joint meeting with the American Economic Association. E. M. Herr, president Westinghouse Electric & Manufacturing Company, and Prof. W. C. Mitchell of Columbia University were the principal speakers. — Electrical World.

John Irving, general sales manager of Nova Scotia Steel and Coal Co., is dead. Mr. Irving was president of the Hattie Gold, and while visiting the property he contracted a severe cold which resulted in his death. He was at one time a resident of Toronto and was a member of Toronto Lacrosse Club.

Port Arthur, Ont.—With twenty-three vessels in port one day recently the Port Arthur-Fort William harbor presented a scene of great activity. Fifteen of the largest vessels on the lakes were loading grain; twelve vessels were expecting to clear during the day, taking out 3,225,000 bushels. This is the largest single day's shipment by water so far this year.

Slag Encrusted Boiler Tubes

An elaborate report on a class of boiler trouble, which fortunately does not often worry English engineers, but is more or less prevalent in America, has been made by Mr. Harry H. Bates, one of the stoker engineers of the Westinghouse Electric and Manufacturing Company, Philadelphia. The report deals with the formation of slag on the tubes of water-tubes and the possibilities of its prevention.

At the commencement it is pointed out that "it is a daily occurrence to hear of boiler stations operating at 300 per cent. of rating or more, and it is by no means unusual that 400 per cent. of the rated capacity and more are reached." When boilers are forced to such an extent it is only natural that difficulties should be experienced which would not develop in more normal circumstances, and the choking of the passages between the tubes is among them. The extent of the trouble may be gauged from the photographs we produce, which show the accumulation of slag during less than a week's working, at the end of which, it is said, the boiler ceased to operate.

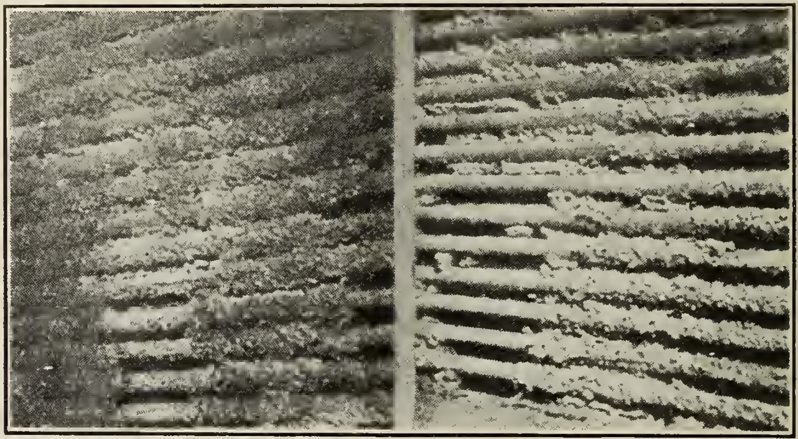


Fig. 1.

The author of the report gives particulars of the principal constituents of coal ash, from which it is assumed the slag must come, and shows that none of them is fusible individually at ordinary furnace temperatures. When, however, they are intimately mixed with basic oxides the melting point is so much reduced that the mixture will flow in the boiler furnace. Such oxides are provided by the pyrites commonly found in coal. The fact that this impurity may be the cause of the trouble is borne out by the fact that some American coals, such as Pocahontas and Elkhorn, which contain very little pyrites, give a minimum of clinker trouble. It is the ferrous oxide produced by the pyrites which reduces the fusing temperature of the slag, while ferric oxide results in a comparatively infusible material.

Mr. Bates suggests that minute particles of slag are carried up from the fire even when the gases are rising at a comparatively low velocity. When these little particles come in contact with the free oxygen in the furnace gas for a sufficient time completely to oxidise them they become solid. If they solidify before touching the tubes or walls they are carried through the boiler as solid ash. On the other hand, in the event of no free oxygen being obtained through the fuel bed, the particles remain in a molten condition, on account of their low fusing temperature in their -ous state, and are deposited on the tubes and walls, where they may either be completely oxidised and solidified or be covered by successive coatings or layers of the same plastic material. That the latter is true to a large extent is shown by layers of a very dark vitreous material covered by a reddish brown layer or protective coating. This reddish coating is largely ferric material, and it prevents further oxidation of the dark ferrous material within by excluding the oxygen from it. A considerable portion of the material on the outer surface, especially on the tubes, is of a friable and non-fusible character, and it is of a completely oxidised nature.

Analyses of the slag taken of various parts of the boiler, where it was more or less liable to oxidation, confirmed the theory that it was necessary to oxidise the ferrous into ferric iron and several means were tried for introducing the necessary oxygen. One of the most promising experiments consisted in raising the boiler so that the height from the fire to the tubes was increased from 13ft. up to 19ft. with the idea of lengthening time during which the globules of slag were exposed to oxidation from 0.72 second to 1.05 second. The change did not, however, prove very effective, and had the disadvantage of exposing more brickwork to high temperatures.

Mr. Bates goes on to argue that furnace construction undoubtedly has much to do with the external encrustation of the tubes with slag. The ratio of the exposed tube surface to the grate area in the case under review was 1 to 1,

(Continued on page 42)

Assembling Parts By Pressure At The Bench

When the Hammer May be Used to Advantage—Steady Pressure Best for Accuracy—Special Fixtures for Locating to Exact Position—Means of Supporting the Work

By FRED HORNER

THE hammer as an instrument for putting together or dismantling tight-fitting parts now holds a secondary place alongside the alternative of forcing by screw or lever pressure. This is particularly so in cases where injury or distortion of the piece must be avoided. In mere breaking-up processes the thing is to do the job in the shortest time, and blows or pressure are used indifferently, according to which gives the quicker results. Frequently a few smart blows will start a hard fit or rusted joint immediately, and here discretion must be exercised, if hammering can be safely done. In considering the small class of forcing that is practicable on the bench, we are faced with the choice of three methods—the vise, the arbor press, and screws or bolts. Each has a sphere of its own. The vise is very powerful, but slow, and owing to the vertical attitude of the jaws, some articles (with their packings which may be necessary,) are awkward to keep in position. The arbor press offers the advantage of a horizontal surface, and is much quicker in operation. It also provides a greater amount of "daylight" than the vise, and freedom below for the projection of shafts. The bolt method generally comes in for situations where neither of the other appliances are available, owing to the conformation of the work, or because it is partly assembled. And, of course, away from the shop, bolts may play a much more important part, as there might not be any convenient alternative.

Use of the Vise

In the vise, the usual objects dealt with are rods, plates, wheels, gears, etc. that require to have pins or bushings forced into or out of them. The chief aim lies in taking the pressure against the piece in such a manner that distortion, or risk of fracture are not likely. Pressure must be preferably localised around the area of the hole where the pin or bush fits, and not allowed to reach to a rim or other distant part. Risks of the sort just mentioned are thus eliminated, and the pressing becomes more effective. Danger of marking finished surfaces exists, from the serrations on the jaws, and so the packing at the back serves a double purpose. Fig. 1 shows the ordinary disposition of the parts, including packings, for pressing in a bush, and Fig. 2 a plan of the opposite condition, that of extraction. Rear packings (or a tube) with clearance are likewise necessary if a pin or bush requires to be pushed into a rod so as to hang out, instead of lying flush. The assembling of parts such as strips or discs with two or more pins concerned sometimes involves the preparation of a special pad or die to effect an even pressure all over the surface, and at the same time clearing the pins.

Special Pad or Die

Fig. 3 gives such a rig-up where three or four pins have first to be pressed into the bottom plate (A) and then plate B pushed down to a certain distance. The pressing plate, C, enables this to be done accurately, the distance between the plates being ascertained by a gauge or other means. Tube packings of small diameter are useful for taking the pressure at the back of an awkwardly-formed article, liable to tilt more or less out of truth when merely resting against the jaw. The tube just surrounds the hole where the pin is forced in, or rests on an equivalent area, so that the resistance comes in exact line with the direction of forcing. An encircling tube offers advantages for some sorts of pressing, in which close contact without risk of slip precludes the use of separate strip packings. This is evident from Fig. 4, illustrating the pushing off of a ferrule from a bush. A similar arrangement suits for forcing on, with the difference that a reduced support such as drawn at the end would not be necessary. If pressing on to an exact distance, not evidenced by the presence of a shoulder as a guide, is wanted, such distance from the end of the work can be controlled by making the forcing ring of suitable length, so that when the ferrule has been thrust far enough, the vise jaw will come into contact with the end of the work.

Accurate Locating

Besides the limitations imposed on length between the vise jaws, there is also the disadvantage that wheels and other specimens extending out some way from a shaft cannot be got into the vise for forcing, hence the arbor press is preferable in regard to these two points. Methods of ensuring a definite degree of projection depend upon the number of articles to be done. For one, or a small number, the mode of actual measurement of work is sufficient. For batches of pieces, the ram may be fitted with a strongly-clamped ring encircling it above the bearing, and adjusted after the first sample has been

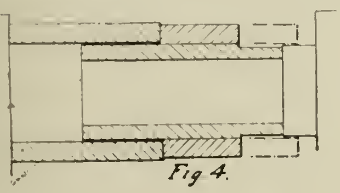


Fig 4.

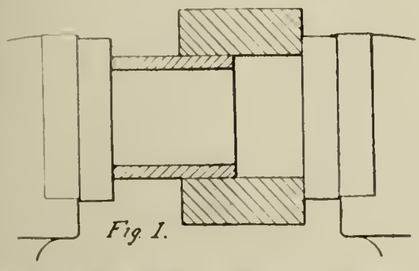


Fig 1.

Fig 4—Thrusting bush from ferrule. Fig. 1—Ordinary method of forcing in vise.

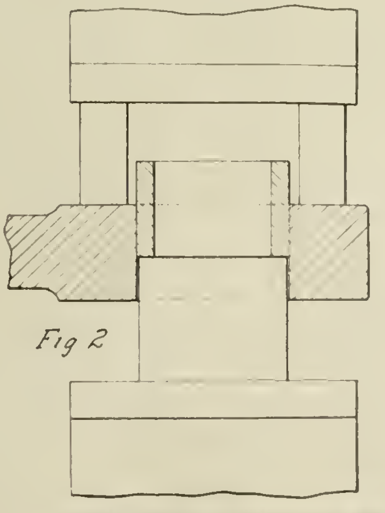


Fig 2

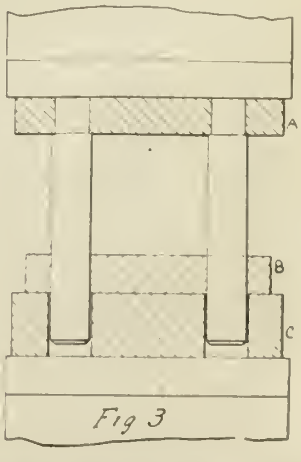


Fig 3

Fig. 2—Bush removal in vise. Fig. 3—Pushing plate down over pins.

pressed. The possible uncertainty, due to the chance of slip of this collar, may be abolished by applying a ring around the pin, after the style drawn in Fig. 5. Shouldered pins, judged by sight as to the flush state of the shoulders, may be pushed a little too far, and then have to be retracted; to avoid this waste of time a close-fitting washer (see Fig. 6) underneath the job will be useful, arresting the shoulder positively. The use of a plate slightly larger than the bush, Fig. 7, is also recommended for flush pressing, in circumstances where the underside of the bush cannot be met and checked by the table or plate.

Bolts and plates chiefly come in when large wheels, frames, and so forth cannot be put in the vise or the press. Methods of application are generally simple, comprising a stout bolt and two plates or hair-pin clamps, one spread over the hole at the rear and the other comes against the bush, the nut being tightened until the latter is home. Solid holes in the wheel or arm spaces or apertures in a framing are essential to permit a set-up resembling that illustrated by Fig. 8 to be employed. A like affair can be utilized to force bushes out, interposing a piece of shaft between the top clamp and the face of the bush, the shaft being just small enough to pass into the wheel hole.

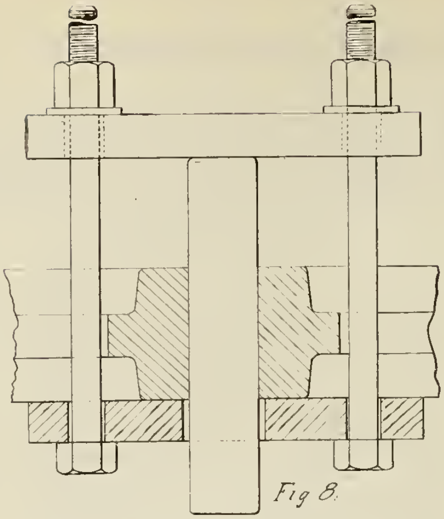


Fig. 8—Rig-up for forcing pin in wheel.

TESTING THE EFFICIENCY OF LEATHER BELTING

Tests made of leather belting by the Leather Belting Exchange, Philadelphia, show that, with a reasonable shop tension, a transmission belt with its flesh side in contact with the pulleys will average only about 50 to 60 per cent. as much power as when the grain side is in touch with them. On the other hand, at higher tension, the flesh side will do much better averaging from 50 to 100 per cent. more power than the grain side, the results depending, of course, on the belt and the conditions of service. For the experiments five 4-inch 30-foot, single belts of different make, weighing from sixteen to eighteen ounces, were used. The conditions were standardized, and the belts were all thoroguhly "run in" before the tests were made.

The following test, conducted at the same time, strikingly illustrates the low efficiency of a new belt. When first put on the pulley, the belt transmitted 12 H.P. at a slip of 1.2 per cent. After turning for five hours it transmitted 19 H.P. with the same percentage of slip; after thirteen hours it transmitted 24 H. P.; while after twenty hours it transmitted 31 H.P. with a slip of 1.6 per cent. According to the horse-power tables its scheduled transmission should have been 26 H.P.

Worrying has the same effect upon your health and your mind that racing the engine while the automobile is standing still has upon a motor car. It uses up a lot of fuel and energy without getting you anywhere, and the more you do it the less fit you are to make any real progress.

MOUNT ROYAL HOTEL IN JAN. 20 POWER HOUSE

POWER PLANT equipment as installed in the new Mount Royal Hotel, Montreal, will be fully described and illustrated in the next issue of Power House, Jan. 20. While the grand opening of the hotel was celebrated Dec. 20, the actual finishing touches were not applied until the beginning of the new year.

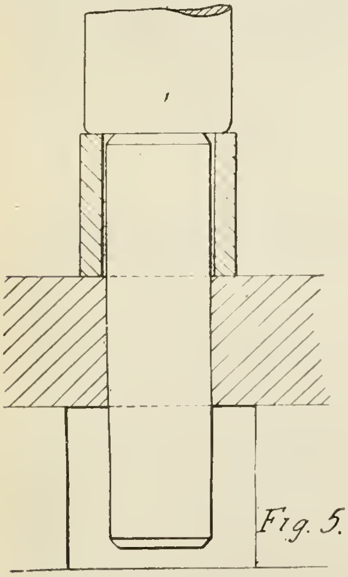
The erection of this hotel has involved a heavy expenditure of money and the employment of a large force of laborers, mechanics and others who were kept busy for the past twelve months supplying and placing large amounts of material. The architects who designed the hotel were Ross & McDonald, Montreal, who are specialists in this class of work. They designed and erected the Chateau Laurier, Ottawa; the Fort Garry, Winnipeg, and the MacDonald, Edmonton. The designer was Water J. Armstrong, Montreal.

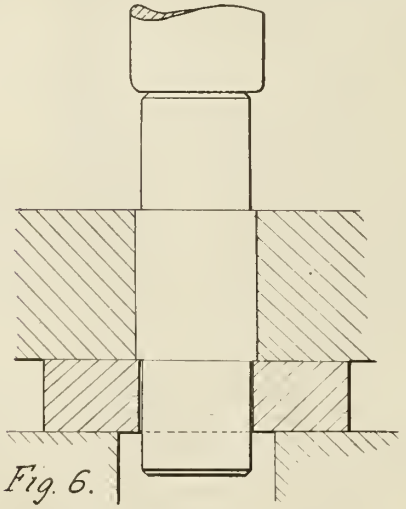
The new building has already been recognized by the architectural profession of Canadian and the United States as one of the most conspicuous buildings of its kind both from the viewpoint of architectural merit and building skill.

The general contractors, Thompson Starrett, Ltd., have had a very efficient staff of men on the job. The heavy stress and strain fell upon the shoulders of R. Miller, a comparatively young engineer, who acted as construction engineer for them.

From the viewpoint of the stationery engineer, the man whom the readers of Power House are probably most interested in is H. M. Bogart, the mechanical superintendent. He it was who had to see that everything mechanical is as it should be, and, as every construction engineer knows, his was the task of taking the "kinks" out of new installations.

The story of the power plant was written by the special representative of Power House, G. J. Soucy, an engineer of experience, who was right on the job, and has prepared a description that is at once interesting and reliable.





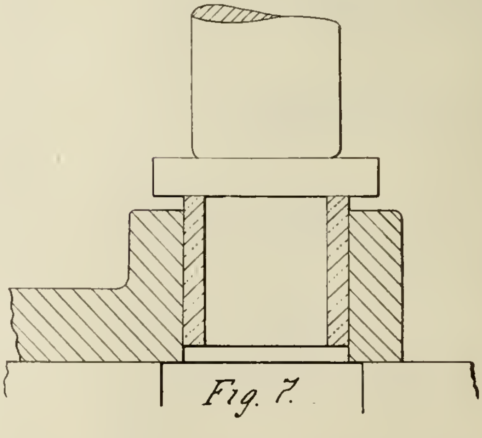


Fig. 5—Stop tube for controlling insertion of pin in arbor press. Fig. 6—Under-washer acting as shoulder stop. Fig. 7—Top plate used to bring bushing flush.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

S. S. MOORE - - Managing Editor
W. B. ROBERTS - - - - - - Editor
B. G. NEWTON - - - - - Manager
H. D. TRESIDDER - Advertising Manager

SUBSCRIPTION RATE
Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year, other countries, $3.00. Single copies, 25c. Advertising rates on request.
THE MACLEAN PUBLISHING COMPANY, LIMITED
143 UNIVERSITY AVENUE.
TORONTO, CANADA
JOHN BAYNE MACLEAN, President
H. T. Hunter, Vice-President.
H. V. Tyrrell, General Manager.

Combustion

WE CANNOT pick up a technical journal relative to engineering but what there is some bold reference if not a leading article upon the subject of combustion. This appears to be one of the most engrossing subjects we have before us at the present time and one of extreme interest both to the factory owner and the engineer. To the factory owner because it is likely to be the one place where he will be able to effectively cut down the cost of operation of his plant and this in no small measure; and to the engineer the place where, with a little careful investigation and research, he is likely to obtain some very encouraging results. It has taken the factory owner a considerable time to realize the saving that could be actually effected in burning coal in a furnace. Formerly it was just a case of burn it, and nothing further. Now after persistent effort on the part of the engineer, who in many cases has been actually instrumental in educating his employer to these views, he is beginning to realize that what can be done in large power stations can also be done in small plants. However, nothing can be effected without the co-operation of both owner and engineer.

During any period of trade depression, the factory owner who is sufficiently far-sighted will be going in for reconstruction or alteration where necessary and having his plant and system tuned up. This will prevent loss of time when the time arrives for the factory to be worked at full production. Now is the time then for investigation and research to be made and we certainly think that those engineers who peruse the contents of this issue will find much food for thought in the article by J. B. C. Kershaw, more especially where he alludes or makes reference to the use of pressure-gas-fired boilers with pre-heated air. The furnace designs are most ingenious and detailed particulars of the nozzles are given for the correct handling and regulation of the gas and air. The sketches embody new ideas which should prove to be very stimulating to those who are paying special attention to this subject. It may not be many years before our present-day apparatus will be a thing of the past, and more economical and effective apparatus will have taken its place. We are on the eve of some wonderful achievements in promoting better means of combustion. We are looking for results in the right spot, and it is the man who works diligently and applies himself to his task who will come out on top. Everybody is looking for more economical methods of burning fuel and there is not a plant in existence upon which some improvement could not be made. Every plant engineer should therefore be particularly receptive to new suggestions and ideas and after a little experimenting it may be possible that you tumble across the very thing the world needs. There may be a large number of engineers who may say the same as the little boy whose teacher told him that some day he might be president of the U.S.A., when he replied, "That he would not mind taking two bith for his chance." This may be how it strikes you at present, but in all sincerity there are very few inventors who did not accidentally tumble across their ideas, and in many cases they had been looking for something entirely different. However, keep your goal before you and with persistent effort progress is sure to be made. Try new ideas out where possible, but always keep an accurate tabulated result of your experiment. In a number of small plants it may be that the engineer has little or no equipment, but that should not deter his efforts. The instruments to be used need not necessarily be very complicated ones, and a man handy with his tools could make the majority of them himself. If you get stuck we would always be pleased to help you out no matter what your difficulty; and do not forget that whether you make a great achievement or not, you are working and heading in the right direction, and are always advancing.

Autogenous Welding

WHEN autogenous welding is concerned in respect to the repairs of a boiler, there has been nobody more liberal and willing than myself to recognize the advantages and economies of such a process, whether this be accompanied by the oxy-acetylene, hydrogen or other gas process, or by the electric arc, and to advocate its adoption wherever possible under existing regulations. The general rule to govern the acceptance of such welds for insurance purposes, is that prescribed by the Boiler Code of the American Society of Mechanical Engineers, par. 186.

There are then given ten illustrations where such work should be accepted or rejected.

From the foregoing it will be seen that the restrictions are manifold in respect to the requirements of such a weld and a man would need to know something about the design of a boiler, to be able to determine just where such a weld would be acceptable. We will presume, however, that repairs have been recommended and the next thing necessary is for the boiler owner to obtain a workman to put these into effect. In all probability he recalls having seen a signboard somewhere down the street that bears the inscription "Expert Welder" and the man is engaged to do the job. Perhaps we find out upon inquiry that he has only just recently started up in business, having taken a course of training, covering a few weeks, at one of the engineering colleges in one of the big cities. We do not protest against this man carrying on his business as a welder but he should be forbidden by law to touch a boiler with a view to repairing it. The Boiler Regulations in the various provinces are pretty rigid, wherein the Department clearly states the qualification required of the man who examines a boiler, but nothing whatever about the man who repairs it, which is a time when most special attention is required.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Question.—Gas engines appear to be regulated by two methods; the hit-and-miss type, which regulates the speed according to the number of explosions required and the throttle governor which regulates the speed by the control of the gas volume.

It is claimed by some, that the throttle governing system, uses considerably more gas than the hit-and-miss system, even when they are both tried out on the same engine. If this is the case with all engines, why use the throttle governor at all?

Brodie.

Answer.—The throttling governor is not the most economical method of running a gas engine, but it is the system that is most often used on account of it causing the least variation in speed in the engine. This is a most important factor when the engine is used for driving electrical machinery, or in the manufacture of various materials and fabrics in our factories.

At this point it would be just as well to explain that the function of a flywheel must not be confused with the duties of a governor. A flywheel is purely to absorb, or store up energy that is imparted to it during the impulse portion of the cycle. So that this energy can be again utilized during any portion of the cycle, until it receives another impulse.

A governor is designed to reduce variation in speed and maintain steadiness in running.

There are several methods of controlling and operating the speed of internal combustion engines:

1. By interrupting the sparking when electric ignition is used.
2. By cutting off the gas supply during any portion of the cycle.
3. By keeping the exhaust valve open or closed during one or two strokes.
4. By regulating or throttling the gas supply.

The first two methods are of the hit-and-miss type, and the second two can be classified as the throttle governor type. There is a third system which is a combination of these two methods, wherein the charge is throttled up to a certain limit and then cut off, but we understand this method is not very much in use.

If, therefore, the variation in speed in a gas engine is a negligible factor, the hit-and-miss control is the most economical means of operation, but where steadiness in running and uniform speed are required, a good type of throttle governor should be fitted.

ECCENTRIC PISTON RING

On the Question Box page of Nov. 20 Power House, there is an item re, "Size of piston rings" in which the questioner is advised to have the rings turned eccentric.

While it is true that rings of this form fit a cylinder bore more perfectly than when made parallel or concentric, I would not advise making them eccentric and for this reason.

The groove in piston must be deep enough to take thickest part of ring. In operation, a piece breaks off the thin end of ring, and works around until it jams under the thicker part. I have had that happen several times. In one case an 18 in. piston got caught, and as the piston rod was screwed into the cross-head it was some job backing it out.

Also for a 12 in. cylinder I would turn the rings 12⅛ in. dia. and ¼ in. to 5/16 in. thick. An 18 in. piston would have rings 18 3/16 in. dia. x ⅜ in. thick. Make groove in piston only deep enough to let rings in flush, so there will be no room for rings to vibrate.

W. C.

Question:—Where can one get an authoritative, up-to-the-minute book dealing with steam automobiles?

R. T. B., Forest.

Answer:—We are afraid there is no book published making a specialty of this type of car. It may be possible, however, that a number of articles have appeared from time to time in the various automobile journals and we think it would be a good plan for you to communicate with these papers when possibly you could procure some past editions which contain some information upon this subject.

We believe there is only one steam car in Canada and that is the Stanley Steamer, address 493 Yonge St., Toronto, who may be able to supply you with descriptive literature. The White Steam Car, we understand, has not been manufacturing since 1909, but it is possible they may very shortly go in for a heavy haulage car. The Detroit Steamer is a small car that will very soon be placed on the market in Canada, but up to the present there is no literature to be had on the subject.

STEAM FOR NOTHING

In many industries, notably paper making, dyeing, brewing and laundries a large amount of low pressure steam is required for heating purposes. The usual practice is to employ the exhaust steam from the engine which drives the factory; and the impression has long been common that the steam so obtained costs nothing. As a matter of fact, however, it costs a good deal, because an engine which does not condense is very uneconomical as a source of power, while it frequently happens that the heaviest demand for steam comes when the engine is running light. In order to solve this problem in a more efficient manner a leading British firm of engine builders have introduced a new type of engine from which the steam is obtained economically in a most ingenious manner. The engine is known as the "Candem compound"—there being two cylinders through which the steam passes in succession. The steam required for heating purposes is drawn from a point between the cylinders. When no heating steam is required the engine runs as an ordinary compound condensing engine while, when the demand for heating steam is great, practically all the work is done by the high-pressure cylinder. Taken all round, this arrangement provides the most economical way of meeting the two demands for power and for steam. Automatic gear is fitted to ensure that the heating steam is supplied at a steady pressure and that the engine runs at a constant speed in spite of change in the load or in the demand for heat. Tests show that the equipment results in a very large saving of fuel as against the use of separate boilers for the provision of power and the supply of heat.

St. John, N. B.—Dr. W. H. Collins, director of the Geological Survey, Department of Mines, on his return from a three weeks' visit to the various field parties who are at work surveying the mineral industry of Nova Scotia and New Brunswick, is most optimistic. He reports new coal beds the existence of which was unsuspected, and deposits of oil shale in both provinces, associated with coal measures. They are not yet being mined, but constitute the basis of an important future mining industry.

Operators' Point of View

BOILER COVERING

I expect a million words have been written in reference to the danger caused by allowing scale to collect inside a steam boiler, which may cause overheated plates and tubes and tend to hurry the act of crystallization or form other undesirable conditions.

There is, however, another dangerous condition often allowed in the boiler room, and a condition which may prove even more dangerous than scale. It is often overlooked because it is not so wasteful of the dollars as scale. The condition I refer to is moisture on the outside of a covered boiler. I saw one boiler top sand covered, with the top plates corroded inward nearly two thirds of their original thickness. This condition was caused by a drip from a leaking pipe which passed over the boiler. Another boiler had a leak at a pipe connection near the top of the boiler under the brickwork. The leak had been in existence probably for months before it was discovered, as the heat evaporated enough of the leaking water to prevent the remainder from dripping into the fire, but it kept the brickwork damp. A section of the plate containing several square feet was so badly corroded that a punch could be driven through it without difficulty with a one-pound hammer. Most engineers have noted how rapidly a hot pipe will corrode away if it is laid in damp ground. The same process operates upon the boiler shell if it is covered with a permanently damp coating whether of brick, sand, asbestos or other material.

James Noble.

Editor's Note:—Asbestos, sand or other forms of porous material are not usually objected to as a covering for a boiler, because any leakage that may occur in the steam is immediately made manifest on the outside in the form of a damp patch, and which gives the engineer in charge sufficient warning when caulking or repairs can be made. With brick covering, however, this dampness will never show on the outside and for this reason brick work is greatly objected to as a covering medium. Where it is used it should be completely removed from the boiler top at least once every three years, so that the plate and seams can be thoroughly inspected to insure that no concealed wasting is taking place.

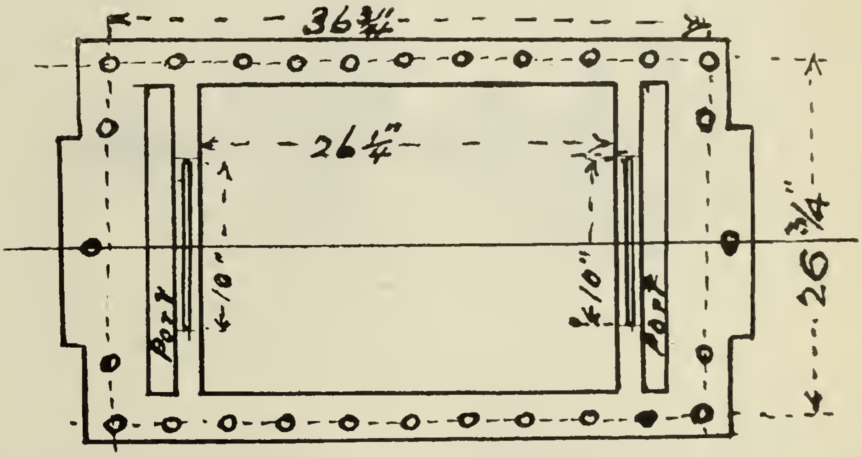
It is concealed dampness that is the danger in every case. If an engineer is aware that water is dripping from a steam pipe upon the boiler covering and percolating through to the plate of the boiler, it is up to him to stop the leakage immediately and not blame the insulating material for allowing it to soak through. Boiler insulating material should be porous and if the engineer watches out for the first indication of leakage in the form of a damp patch and immediately investigates the cause, there is little fear of concealed wasting occurring about the top part of his boiler at least.

PISTON VALVE CHAMBER

The piston valve chamber of a 24 in. x 36 in. horizontal engine was taken off to be rebored. It was noticed that the gasket was gone some 7 in. or 8 in. in the middle of the bars, allowing steam to escape to the wrong side of piston. Also by applying a straight edge to the faces they proved to be slightly hollow.

After reboring, some futile attempts were made at getting a joint to stay in but the job was satisfactorily accomplished by using two strips of copper ¼ in. x ½ in. x 10 in. long, let ¼ in. into the cylinder casting, and ¼ in. into the chamber casting.

The accompanying sketch shows the application of copper strips, the 1/16 in. gasket being cut away where the copper is let in.—Vancouver.



Gauge Glasses. Annealing important but certain conditions demand special treatment, such as where glass is subjected to great temperature and sudden changes of heavy shock and strain under these conditions of high temperature. This treatment requires careful study of strains and manner in which they are produced. Boiler gauge glass cut to length on wheel with wet abrasive and ground on wet stone stands up better than same piece of glass annealed. Need of healing by fusion of microscopic cracks caused by cutting with wire or wheel depending upon local frictional heat. Heat treatment consists in heating glass to 1,300 deg. F. (or other suitable temperature) and cooling very rapidly and evenly in the air and allowing it to become naturally strained. H. W. Hess, Glass Worker.

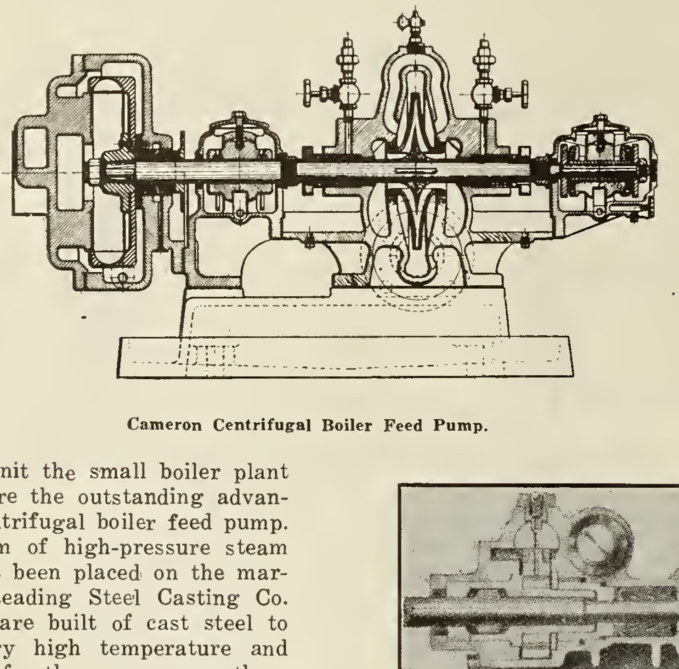
Hamilton Bridge and Iron Works have been awarded the steel contract for the erection of an addition to the factory of the Zimmerman-Reliance Co. of Hamilton. Steel sash work goes to the Trussed Concrete Steel Co., Toronto.

Corrosion. If oxygen of water can be removed and be prevented from re-entering, corrosion difficulties must ordinarily cease. Two ways of accomplishing this. One is to bring water into contact with large mass of replaceable iron or steel having large surface, so that oxygen can use itself up on low-priced metal. The corrosion method of removing oxygen from boiler feed water is exemplified in Europe by the Kestner process, in America by the Speller process. Description of Kestner "degasser," which is nothing more than tank full of steel turnings and provided with valves and piping of such nature that feed water may be passed through bed in either direction at will.—Industrial Digest.

Progress in New Equipment

The new Cameron single-stage, turbine-driven centrifugal boiler feed pump is designed for boiler plants having up to 2,000 boiler horsepower and using steam pressures of 150 pounds or less.

The outstanding feature of this pump is its simplicity. The single-stage impeller and turbine rotor are mounted on the same shaft. The absence of a coupling and the compact design results in a remarkably large capacity per unit of floor space required.



Cameron Centrifugal Boiler Feed Pump.

With this unit the small boiler plant can now secure the outstanding advantages of a centrifugal boiler feed pump.

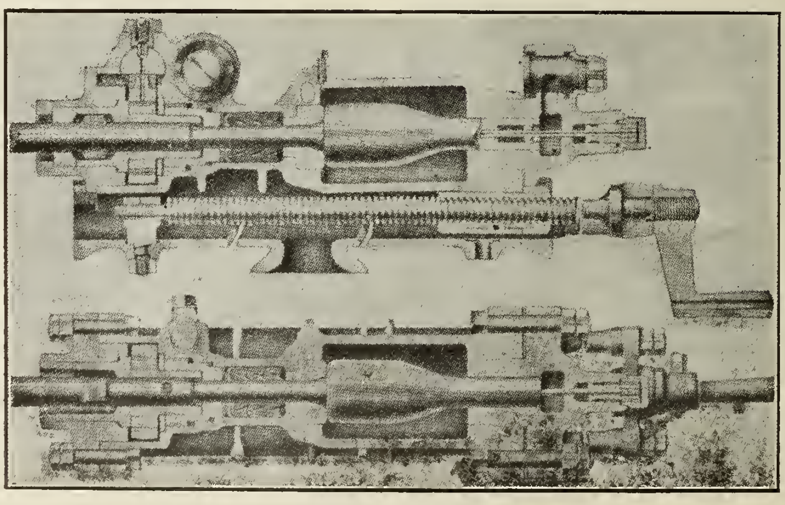
A new form of high-pressure steam valve has just been placed on the market by the Reading Steel Casting Co. These valves are built of cast steel to withstand very high temperature and pressures and for the same reason there are special features embodied in the design of the body and bonnet. The valve is equipped with a split wedge supporting two metal discs and mounted on an adjustable and universal stem-nut, giving the whole unit great flexibility and still remaining simple in structure and design.

Magnetic chucks are very efficient for holding small pieces for grinding, as the entire face of the chuck can be covered with such parts, thereby supporting each other firmly, so that a large number can be machined at one time, resulting in a much larger production than would be possible by handling the pieces separately.

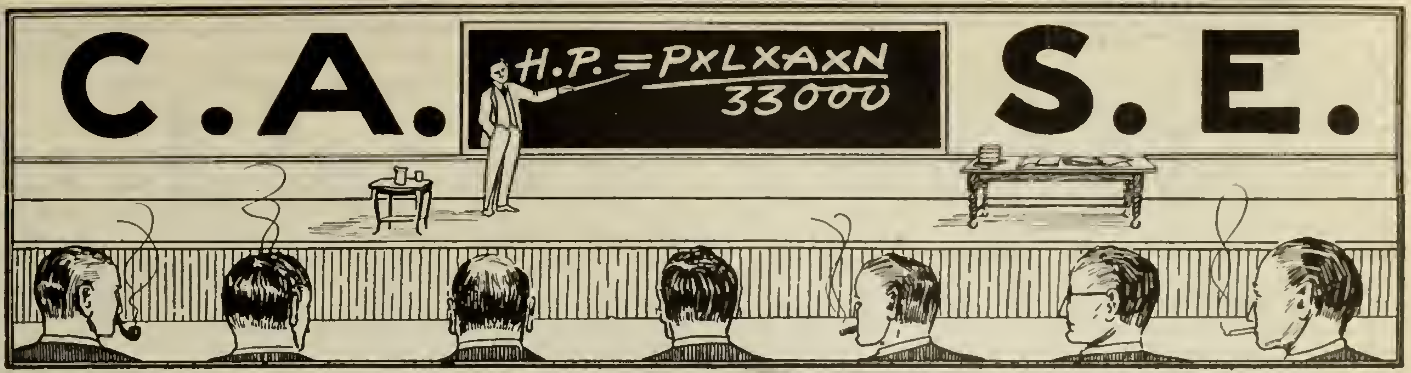
The Dustless Wave Rock Drill is operated by the pressure waves travelling periodically along the pipe, being fitted with a hammer element which is thrown forward by each wave of pressure. Surrounding the hammer is a space called a capacity, filled with water, and, due to the difference in diameter between the striking end and the piston end of the hammer, a displacement takes place on the forward stroke of the hammer which compresses the water in the capacity. As the pressure wave passes and the pressure in the line drops below the mean pressure, the force on the annulus being greater than the force on the piston end, returns the hammer back to the original position, ready to receive the next pressure wave. The apparatus used for this demonstration of this drill has been described as follows:

A steel vessel in the shape of a bottle, mounted like an ordinary gun, is filled with any liquid, and fitted to a rifled barrel. Between these two parts is a valve designed to act automatically at a pre-determined pressure. By means of an ordinary hand pump, connected by a copper tube to the bottom of the vessel, more fluid is pumped into it. The pressure of the fluid is thus increased to the pre-determined point at which the valve operates, and the energy which has thus been stored is released and acts on the base shell, which is projected through the rifled barrel in much the same manner as that when the customary propellor is used. The recoil is stated to be less than that experienced with the ordinary gun, and the barrel is not damaged by corrosion.

The Rock Drill has been designed to withstand the rough usage to which it is inevitably subjected under practical mining conditions. A distinct feature of this Rock Drill is the independent rotation of the drill steel; no splines whatsoever are required for this purpose. Any ordinary standard drill steels can be used and the cradle is made to suit standard rigs. Water—the medium for carrying the Wave Energy—is continuously passed under pressure through the drill point, which is easily controlled by the Operator. This water is used for washing out and turning into sludge the debris of pulverised rock as it is created by the Drilling.



New Wave Rock Drill.



A meeting of the Toronto No. 1 C. A. S. E. was held on Tuesday evening, Jan. 3rd, at Cumberland Hall. There was a very fair attendance of members considering notices had not been sent out, which was due to the sickness of the secretary, G. A. Browne. We feel sure that the friends of Mr. Browne will be pleased to hear that he has since recovered, also that his little son, who was knocked down by an automobile two weeks ago, is now fair on the way to recovery. Unfortunately his son had two ribs broken in this accident, when one of his lungs was punctured and he lay in a very critical condition for several days.

A paper was read on "Boiler Appliances and Accessories" by R. McLean, chief engineer of Massey Harris, which proved to be of a very interesting nature. Many questions were asked by the various members, and Mr. Bly, former president of the association, took an active part in the discussion and brought out some very interesting side lights. Particular attention was given during the lengthy controversy to the following subjects:

The action of springs in "pop" safety valves.

The action and ultimate effect of vacuum and pressure upon the hollow elliptical tube of the mechanism of a pressure gauge.

Some troubles that have developed in different plants with water-columns and the water pipe connections.

The cause of fusible plug failures.

A discussion on the different types of blow-down valves, dealing with the comparative merits of each, and giving the objections to various kinds of gate valves.

It is possible that a number of these questions will be revived at some future meeting.

SOME CURRENCY

We are informed that rye is to be the medium of exchange in Oldenburg, Germany. Rye notes are to be issued based upon the value of rye and will be worth a certain quantity of rye. After four years, the holder of the notes is to receive the gold value then prevalent for the amount of rye indicated on the certificates.

What would some of the old timers have thought about a "Rye" currency in Canada, at least for a week or two over the Hogmanay.

ANNUAL BANQUET

On the evening of Dec. 20 the Atlas Engineering and Machine Co. and the Grant E. Cole Co., of Toronto, held the first of what the management hope will be their annual banquet at the Walker House, Toronto. A splendid program was carried out, made the more spicy by song and music from Messrs. W. Dawson and Fielding. Splendid addresses accompanied the toast. Mr. A. C. McNaughton proposed a toast to "Our Organization," responded to by L. S. Elsie. Mr. McNaughton briefly outlined the story of the birth of both companies and their association with each other. Mr. Elsie's reply was apt and manifested the spirit of aggressiveness on the part of the company. A toast to "Our Products" was moved by Mr. W. Williams and responded to by Geo. E. Cole.

Canadian industry was toasted by H. D. Tresidder, responded to by Major Anthes. The theme of both these gentlemen's remarks dealt with the wonderful development Canada had made industrially, and the particular relation thereto of the products of the companies under whose auspices they were meeting that night. They urged loyalty on the part of every employee from message boy to president, loyalty to the product, to the company, and to the field they were serving. These features, they said, formed an important place in a healthy development of Canadian industry. Mr. Attwood, the inventor of the Attwood pump, was enthusiastically received and told the story of his life's association with this industry. The following members of the staff and friends were present:

G. Smart, H. Attwood, A. Northern, Z. Turner, S. Glasier, H. Moore, N. W. Kingsland, H. D. Tresidder. Major Anthes, Capt. Watherspoon, T. M. Jones, C. Cox. F. Dawson, A. K. Fielding. L. S. Elsie, G. E. Cole, H. Augur, W. Jamieson, S. Roberts, A. C. McNaughton. W. W. Attwood, H. Angus, W. Williams. E. Jones. H. Fletcher, A. Howarth. F. Haskell, J. Seed.

It seemed rather strange that such an early opportunity should have been given to Mr. Attwood, who, after having spoken at some length about the development of his pump, was almost interrupted in his remarks by the announcement from the check room man that the coat of Mr. Auger was leaking. At first it was thought a pumping demonstration was to be given, but it was found afterwards that this unfortunate occurrence had nothing whatever to do with Mr. Attwood's remarks and that the report was nothing but moonshine.

NEW BOOKS

Steam Vessels by the National Boiler and General Insurance Co. Ltd., of Monchester, England, 8½ x 5½ inches, 40 pages, price 2/-.

This book treats in a very liberal way with the design, construction and working of vessels subjected to steam pressure, and contains 35 illustrations. It deals primarily with kiers, digestors, concentrators, stills, drying cylinders, etc., with line drawing describing the apparatus, also defects and wasting that are liable to occur and how to obviate this by inspection. It should prove to be particularly useful to the manufacturers and users of such apparatus who wish to promote greater safety in the use of such appliances.

NEW PUBLICATION

The power equipment of the plant of the Marquette Cement & Manufacturing Company, Lasalle, Ill., is described in a leaflet published by the De Laval Steam Turbine Company, of Trenton, N. J. In this plant direct current is used for the operation of cranes, hoists, crushers and other machinery, and is found of particular advantage where variable speeds are required. The current is supplied by a direct current generator of 3,750 kw. capacity, driven by a De Laval compound geared turbine. The latter has two shafts, the pinions of which drive the gear coupled to the generator shaft. This arrangement makes it possible to combine a large number of turbine stages, as required for high efficiency, with the advantages of short, rigid shafts. Cement dust and other impurities, such as water, sludge, and lint are removed from the lubrication system by a centrifugal purifier made by the same company.

Port Arthur, Ont.

Plans are being prepared for terminal elevator to cost $900,000 for N. Bawlf Grain Co. Ltd., 571 Grain Exchange, Winnipeg. Work will be done under supervision of the Engineers, C. D. Howe & Co., Whalen Bldg., Port Arthur.

SLAG ENCRUSTED

(Continued from page 34)

which, he says, is very low, and the lower the ratio, under set conditions of fuel and fuel bed, the higher will be the furnace temperature. It is apparent that the higher the furnace temperature the greater will be the tendency for the ash to fuse and stick. It has become common practice now to have the ratio of exposed surface to grate surface as high as 1.87 to 1, and is seldom less than 1.2 to 1. By increasing this ratio the amount of heat radiated up and absorbed is very materially increased, with a consequent reduction in furnace temperature. Unfortunately, the construction of the investigated installation did not permit changing the ratio, and, for comparative purposes, it was necessary to refer to a neighboring station with a similar type of stoker and boiler, and using a similar coal. This second plant has had practically no trouble with slag on tubes, and uses only the soot blowers while the boilers are in operation.

An interesting difference in the two stations was the first two rows of tubes in the former were staggered, and slag impinged on and stuck to both rows. The second row caused more trouble than the first row, as the slag took the form of icicles or stalactites, and when they became long enough and the velocity of the gas became high enough, the "icicles" bent sideways until they touched the lower tubes. This effectively sealed the gas passage of that part of the boiler. The second installation had the first two rows set one above the other. The material which struck the bottom row of tubes adhered, but the rapidity of the formation was far less. On account of this arrangement, the gases were sufficiently cooled by passing between these tubes to prevent the slag from sticking to the higher tubes, and there was no further tendency for this slag to adhere to the boiler surfaces.

When it is considered that the ash is very finely divided in the coal, and that some of it is certain to be carried up with the gas, it appears that the most fruitful field for development of means for slag prevention is in furnace and boiler design. This belief has already been justified. At the same time there is still need for further development of apparatus for mechanically removing soot and slag from boiler tubes.—The Engineer.

St. John's, Nfld.—According to report, the British Treasury has signed a guarantee for $10,000,000 recommendation of the Trades Facilities Commission for the establishment of pulp and paper mills at Humber, Newfoundland. The Newfoundland Government has guaranteed the contractors, Armstrong Whitworth Company, a similar amount. The initial work has already begun.

WORKING INSIDE OF BOILERS

Some time ago, two boiler makers were badly scalded while working inside of the mud drum of a water-tube boiler. A new mud drum had been connected to the boiler, and when it was tested leaks were found, and it was necessary to do some calking and riveting in order to make the job tight. The boiler was set in battery with a number of others which were under steam, and all the boilers were connected to a common main blowoff pipe. The stop valve in the blowoff pipe leading to the new mud drum had been closed, but for some unknown reason it was afterward opened and left open. This latter fact was not known to the man in charge of the boiler plant, however, and he, assuming that the stop-valve was still closed, proceeded to blow down one of the other boilers. Some of the escaping steam entered the new mud drum through the open blowoff valve and caused the accident of which we are speaking. The cries of the scalded men were unheard, but one of the victims succeeded in crawling out of the drum, and he then closed the valve and so made it possible for his companion to get out.

Unfortunately, accidents of this general nature occur every little while. They are wholly unnecessary, because they can be prevented by merely closing, and keeping closed, all valves which may admit steam or water to a boiler in which men are inspecting, cleaning, making repairs, or doing other work. The mere closing of the valves is not enough. That is quite evident, without any argument; and if it were not, the example we have given above, would prove it. The valves must be kept closed. In practice, too many men have access to them. If only one man were allowed to operate them, and he were known to be thoroughly competent and responsible, the possibility of accidents would be greatly reduced; but the moment we depart from this principle, and let two or more men tinker with the valves at will, the hazard becomes very real and serious, because each man is altogether too likely to assume that somebody else has taken the necessary precautions.

There ought to be a cast-iron rule in every plant, requiring men who are about to enter a boiler to give notice of their intention, first of all, to the chief engineer, or the person in charge of the boiler-room. The man in authority should then close the valves himself, or name some one particular individual and instruct him to do so; and the man in charge should also take effective measures to prevent anybody else from touching the valves again, until he gives further orders. After the valves have been closed they should be locked, or protected by placing locked shields or covers around the valve wheels or handles. When the work inside the boiler has been completed, and all the tools and materials have been removed, and the men have come out for the last time, they should report to the man in charge of the valves. Then, and only then, the valves may be opened without danger of scalding somebody.

Montreal.—An extension to the departmental store of the Henry Morgan Co. will shortly be proceeded with by the Morgan Realities Co. The main frontage of the new building will be on Union Ave., and will run northward from the present store on St. Catherine St. In addition there will be built a new central steam heating plant at the corner of Aylmer and Mayor St. The heating plant will contain four 200 h.p. water tube boilers by Goldie & McCulloch Co., Galt. The boilers, 160 lbs. pressure, will be equipped with improved side dump stokers by the Underfeed Stoker Co. of Canada, also Diamond valve-in-head type of soot blowers. The stokers will be designed to operate at 200 per cent. of rating. Provision will be made in designing the boilers so that superheaters may be added later if desirable. The vacuum system of heating will be used and the heating load is estimated to be about 800 horsepower. The plant will be so designed that the coal will be dumped or unloaded from trucks direct into large coal hoppers in front of the boilers. The coal, as required will be discharged first into a combined lorry and thence directly into the stoker hoppers.

Of the steam jet type, a modern ash conveyor will be installed to remove the ashes from the basement and discharged then into a large elevated storage bin outside the building. Trucks will load direct from the storage bin hopper and transferred thence to a convenient ash dump.

Alex. Wilson, Montreal, is the designer of the new building and heating plant.

STAINLESS SURFACE TO STEEL

The discovery of a process for the electrodeposition of chromium on any metal article is reported from Sheffield, England. It hinges in part on the discovery of stainless steel, but unlike previous discoveries along that line, it deals with a surface treatment of the article only. It not only makes the surface stainless and permits a high polish to be put on it, but it is said to be cheaper than ordinary stainless steel in the production of large articles. The surface of the treated article is very hard, and the deposit is not likely to wear off. One of the difficulties, however, is to prevent stripping or peeling, which is often seen in silver-plated articles.

What is believed to be the thickest seam of black coal discovered in the world is being exploited in Queensland, Australia. The seam is entirely free from clay bands and is 93 feet thick in places. The mine is 280 miles from the nearest seaport.—Dearborn Independent.

Electric Cranes

We manufacture high class Electric Cranes of every type and for every purpose.

Overhead Travelling Cranes for the most onerous work of lifting a complete locomotive or for the exact work of handling moulds and molten metal and for ordinary requirements where lightness and speed count most.

Giant, Goliath, Gantry and Transporter Cranes for shipyards, railway yards, and general manufacturing purposes.

ELECTRIC CAPSTANS

Travelling and Stationary Jib Cranes with fixed radius jibs or fitted with Patent Balanced Lever-Luffing Jibs for use on docks, in shipbuilding yards and other places where the load must be handled at speed between obstructions that necessitate the radius to be altered frequently and as a part of the "cycle of operations."

SHEER LEGS to which Luffing-Jib may be applied.

CHARGING MACHINES for Open Hearth and Re-heating Furnaces.

WINCHES AND HOISTS

Electric Portal Jib Cranes fitted with Patent Balanced Lever-Luffing Jibs

Conveyors

for handling raw materials such as coal, coke, ashes, clinker, ore, stone, lime, etc., automatically and with a minimum of labour.

The B. & W. line of Mechanical Handling Machinery includes Bucket and Tray Conveyors, Suction Ash Conveyors, Automatic Railways, and all the details thereof including coal and coke breakers, loaders, dumpers, weighing machines, etc.

We shall much appreciate an opportunity of going fully into details of any of our manufactures with intending purchasers.

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA COLLEGE ST. (ST. HENRY) MONTREAL

TORONTO OFFICE, BANK OF HAMILTON BUILDING

What is PLIBRICO? JOINTLESS FURNACE LINING

PLIBRICO is a plastic furnace lining in unbaked form that meets all furnace requirements and that can be installed by anyone who can use a mallet and trowel. When baked, it forms a one-piece, jointless furnace lining that is resistant to temperature to 3,100 degrees F.

PLIBRICO outlasts ordinary fire brick two to four times. It eliminates the joints—the root of all furnace trouble—and so gives a lining which will not crack, fall off or bag.

Write for new fifty page booklet

It is delivered only in steel containers of distinctive appearance as shown below.

Ask for booklet—"Modern Furnace Building." Write to—

JOINTLESS FIRE BRICK CO.
1142 Clay St., Chicago, Ill.

Distributors: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's Ltd., Calgary, Alta.

Emergencies Prove Its Superiority

It may not be often that the oil film fails in any of your bearings, but the possibility is always present. It is emergencies such as this that test the value of your bearing metals. Magnolia Anti-Friction Metal protects your shafts and bearings from damage in such temporary contingencies. With the lowest frictional coefficient of any known bearing metal—proven by U.S. and foreign government tests—it runs cool with less lubricant and is a safeguard against hot boxes and melting out where lubrication is neglected or may fail for any reason.

Try out a sample Magnolia-lined bearing and test its many advantages for yourself.

Magnolia Metal Company
113 Bank St., New York

CHICAGO Fisher Bldg. SAN FRANCISCO Pacific Bldg. MONTREAL 37 Shannon St.

MAGNOLIA ANTI-FRICTION METAL
TRADE MARK

The C. P. R. are contemplating the erection of a new hotel in the Laurentide mountains.

Canada Sugar Co., Montmorency street, are about to remodel their power plant. Chas. E. Burows will be in charge of alterations.

Announcement is made that the General Engineering Co. will succeed the firm of Gelinas & Pennock, Montreal. The new firm, in addition to the lines formerly handled, will add the following: London Steam Turbines, Troy, N. Y., and Flexatilac Gasket Co., Camden, N. J. They expect to open a branch office in Toronto to handle their Ontario trade.

Chas. A. Sargent western manager for Darling Bros. Ltd., engineers, formerly of Montreal, died at Chicago last month after a short illness whilst on a business trip.

Mr. Sargent, who lived in Winnipeg, was prominently identified in sporting circles and was also a member of the Kiwanis Club in that city. He was born in Montreal 44 years ago. At 14 years of age he entered the business of Messrs. Darling Bros. Ltd. as an apprentice and remained with them until the time of his death, having worked his way up until he became western manager, he being the firm's oldest employee.

NEW BOOK

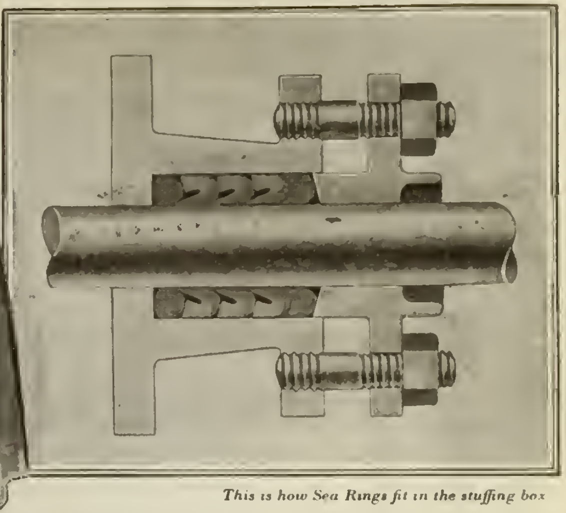
We have received from the branch office of the Ingersoll-Rand Co., 260 St. James St., Montreal, a book illustrating many of the products of the company, amongst which are sections given to ammonia compressors, oil engines, air compressors, electric hoists and marine oil engines. This book deals with the design and efficiency of various machines and is beautifully illustrated.

Lubricating Oils. Lubricating distillates require further refining. Chemical treatment consists in thoroughly mixing distillate with sulfuric acid and allowing sludge to settle. Oil then transferred to second agitator where it is neutralized with caustic soda or other alkali. It is then washed with water to remove the excess of alkali and the alkaline reaction products. Disagreeable odor of lubricating distillates due to sulfur and nitrogen bodies. Sulfuric acid treatment removes unsaturated hydrocarbons, sulfur and nitrogen compounds and asphaltic and bituminous substances. Details of process given.—Petroleum Age.

High-Pressure Steam Heat. The use of reducing valve in a steam-heating line does not, in itself, have any effect on the economy of the heating. If a steam motor is substituted for the reducing valve, the heating value of its exhaust is decreased by the amount of heat turned into work by the motor. Line drop is merely distributed throttling and has no direct effect on the final heating value of the steam. By generating at high pressure and transmitting through a small line, with large line drop, the heat loss from the line may be made much smaller than when the pressure is low throughout the system. E. Buckingham. Mechan. Eng.

Passenger steamers in the Canadian service head the list among the large steamships built during the year, according to Lloyds Register of Shipping report, just issued. Thirty-two ships exceeding 10,000 tons are listed. Of these the Canadian Pacific "Empress of Canada," 21,517 tons, in service between Vancouver and the Orient, was the largest Canadian steamship.

Plant for the reduction of bituminous coal into coke at Sydney, N. S., is being considered by the Government as a safeguard against recurrent coal strikes in the United States. The supply from the proposed Sydney station would be designed especially for central Canada. A similar station may be established in the west if necessary, but it is calculated that British Columbia or Alberta coal either in its natural form or as briquettes, will not come east of Winnipeg.



This is how Sea Rings fit in the stuffing box

An *Idea*—

not a tradition— made this packing

Nothing in the engineer's list of materials has seen so little change in fundamental design as ordinary rod and plunger packing. The Johns-Manville Sea Ring represents the first radically successful improvement since the first stuffing-box was invented.

Sea Rings pack by "self-expansion"—not by gland pressure. The cylinder pressure they pack against is trapped in the U-shaped section causing the lip of the ring to automatically press against the rod to prevent leakage. The force of the lip pressure varies with the cylinder pressure so that packing friction on the rod is reduced to the minimum never more than necessary.

Minimum friction means minimum packing wear—Sea Rings last years where ordinary packings last months.

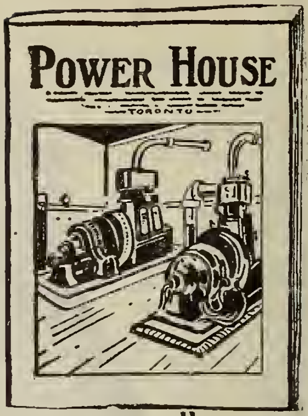
It also means power saved—One test on a triplex pump showed a saving in electric driving power of $55.91 a year per stuffing box.

Sea Rings are far more economical than ordinary packings.

Canadian Johns-Manville Co., Limited
Toronto Montreal Windsor Winnipeg Ottawa Vancouver

Johns Manville Service
Covers the Continent
Through—
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials



DO YOU Manufacture Industrial Equipment?

Are you a manufacturer of twist drills, hack saws, mechanics' tools, wire guards, bolts, rivets, paints—do you manufacture lines of any description that can be used in machine shops, metal-working plants, power plants or foundries? If you do the publications you see illustrated here (Canadian Machinery, Canadian Foundryman, and Power House) can build a bigger demand for your products.

This group of technical newspapers is read by the men who are prospective buyers of your lines. You can bring to the attention of these men the reason why they should demand your goods when purchasing from their dealers. You can effectively do this by placing a message in the paper which serves the field in which your products are sold.

CANADIAN MACHINERY AND MANUFACTURING NEWS is published weekly and covers the machinery, iron and steel and general metal-working industries of Canada.

POWER HOUSE is published twice a month; it serves steam, electrical, water and gas power plants, and the power houses of all general manufacturing plants.

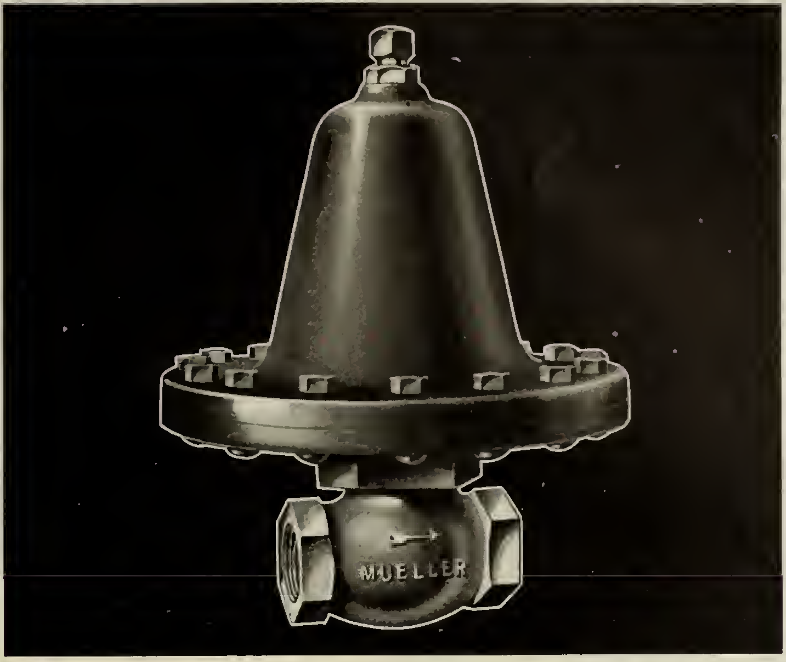
CANADIAN FOUNDRYMAN AND METAL INDUSTRY NEWS is published monthly; it serves the grey iron, steel and non-ferrous foundries.

These publications reach proprietors, managers, purchasing agents, foremen—the men who direct the purchasing of goods. A message to these men in any of the MacLean Technical Newspapers is certain to have a strong influence.

Write for complete Data.

MACLEAN TECHNICAL NEWSPAPERS

153 University Avenue, TORONTO
Montreal, Winnipeg



Make
Canada
Prosperous
by
Buying
Canadian
Products

If The Pressure Becomes Excessive

Untold damage may result if fixtures are not protected. Preventive insurance by the use of a Mueller Relief Valve can be had at slight cost. Built to give service and satisfaction, each valve adapted for its particular installation it will fulfill the requirements in every instance.

It is dependable under all circumstances, does not stick even after long periods of inactivity and responds instantly when service is demanded.

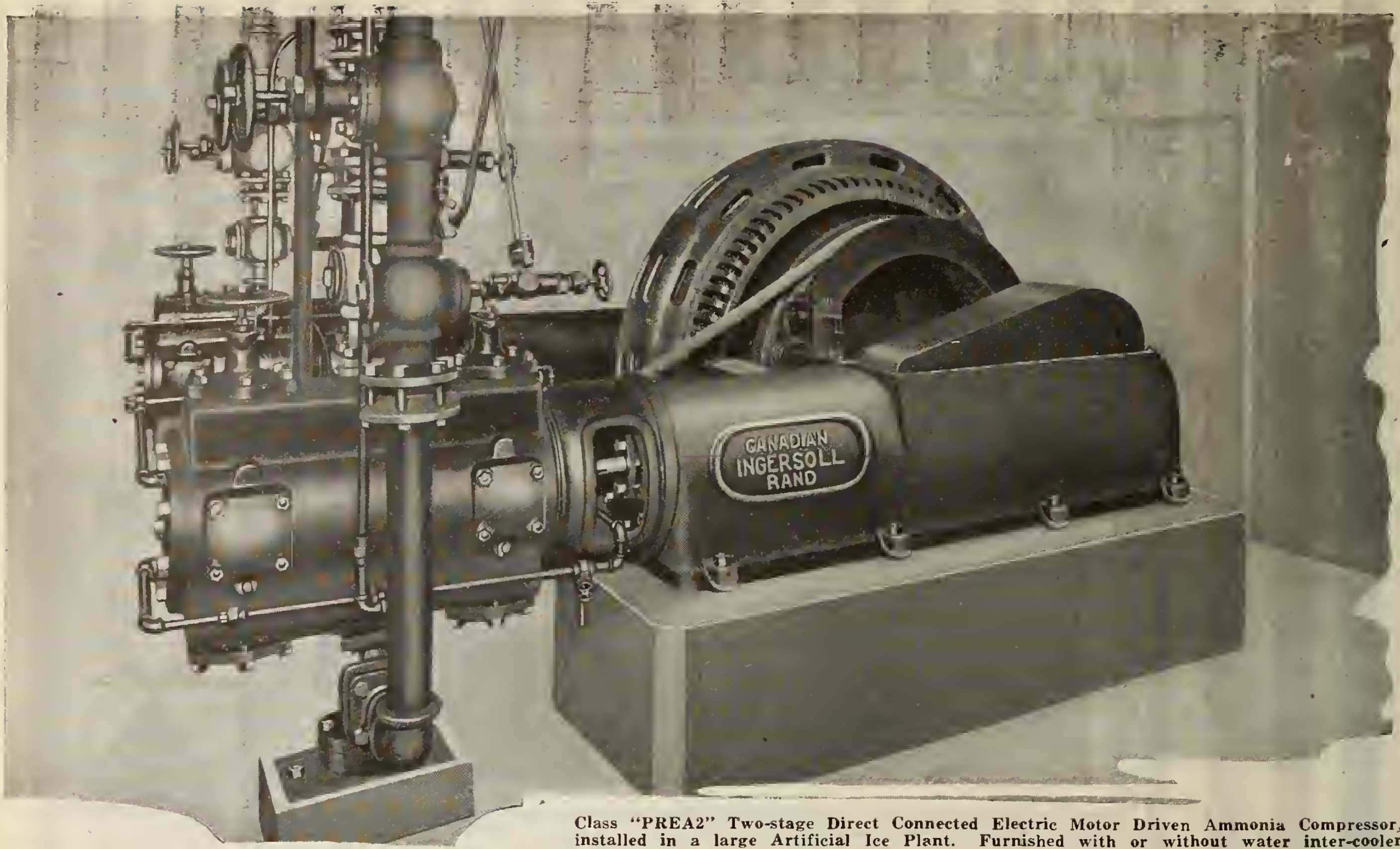
Highly sensitive, positive in action, easily adjusted—it provides the Factor of Safety for all steam, air, oil or water lines.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Illinois, U. S. A. **Branches, New York and San Francisco**

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing: Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.



Class "PREA2" Two-stage Direct Connected Electric Motor Driven Ammonia Compressor, installed in a large Artificial Ice Plant. Furnished with or without water inter-cooler between stages.

Ingersoll-Rand

Ice and Refrigeration Plant Equipment

Ammonia Compressors
Built for either single or two stage operation, and for belt, steam, oil engine or direct connected electrical motor drive.

Air Compressors
Can be furnished in all sizes and for any commercial discharge pressure. These units are particularly suitable for supplying air for agitation, Air Lift Pumping or for general power purposes. Any type of drive.

Air Hoists
Built in five sizes for from 1,000 to 10,000 pounds capacity. These hoists are extensively used for lifting ice cans and for general hoisting work. They are easy to move about the plant, and simple to operate.

Pneumatic Tools
A complete line of riveters, drills, grinders, etc., for erection, assembly and repair work.

Cameron Pumps
For pumping brine, water and other liquids. These can be furnished in direct-acting type for steam or compressed air drive, or in centrifugal type for belt, motor, steam, oil or gas engine drive.

Price Oil Engines
Of the direct-injection, four-cycle type. Horizontal, single cylinder types of 50 and 100 H.P., and vertical, multi-cylinder types from 105 to 1,000 H.P.

A.C.-1.

Announcing
INGERSOLL-RAND AMMONIA COMPRESSORS

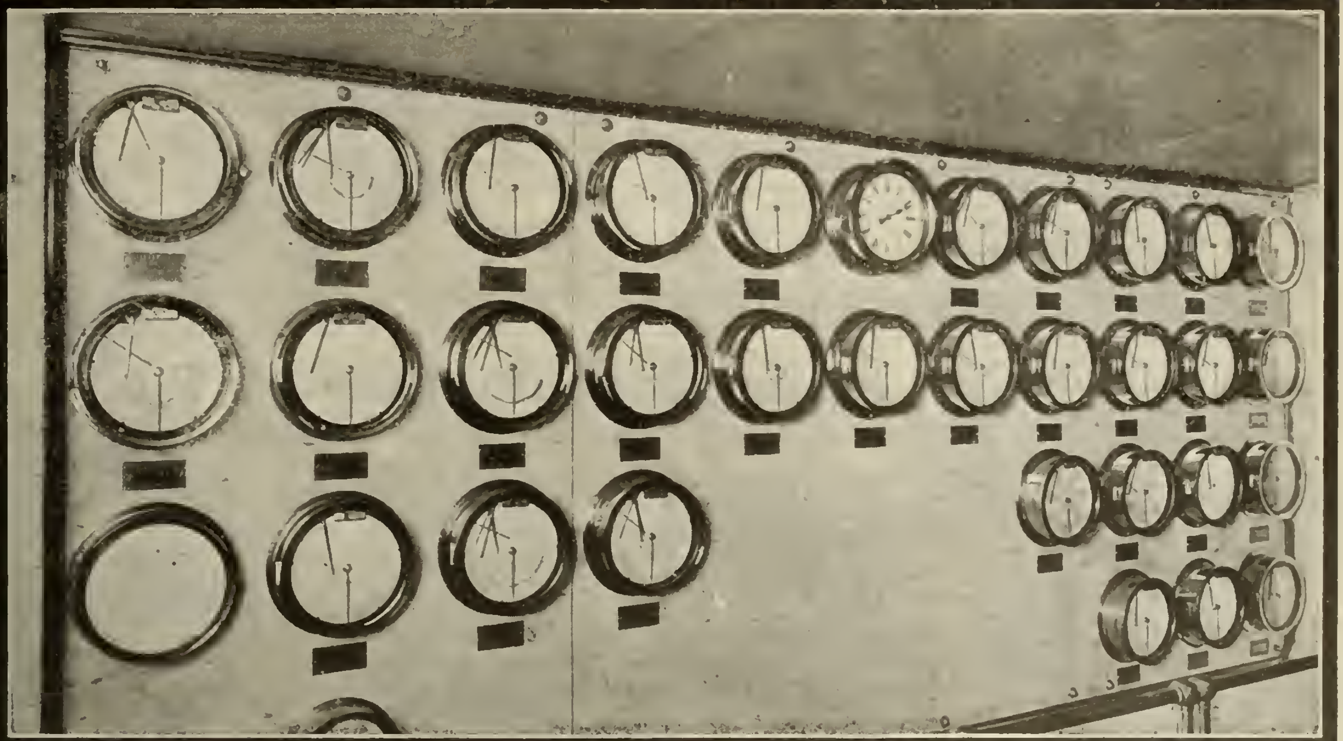
The Canadian Ingersoll-Rand Company take pleasure in announcing that they are now offering a complete line of Ammonia Compressors, designed especially to meet the requirements of modern raw water ice manufacturers, ice cream factories and cold storage plants in general.

These Compressors are available in straight line and duplex types and for belt, steam, oil engine or electric motor drive. They are built in sizes suitable for small, medium or large plants and embody every feature that tends to provide for high economy in operation.

Descriptive literature and complete information regarding any or all types will be promptly furnished on request.

Ingersoll-Rand

Drills Condensers Vacuum Pumps Gas Compressors



A SHINING EXAMPLE

OF THE POSSIBILITIES IN INSTRUMENT CONTROL

We make Indicating and Recording Liquid Level Gauges, Thermometers, Pressure Gauges, CO2 Recorders, etc., for use on:

- *Boilers*
- *Feed Water Heaters*
- *Economizer Inlets and Outlets*
- *Steam Lines*
- *Flue Gases*
- *Condenser Discharges*
- *Hot Wells*
- *Turbine Exhausts*
- *Turbine Bearings*
- *Turbine Oil Pumps*
- *Generator Fields*
- *Fuel Oil Pumps*
- *Fuel Oil Storage*
- *Transformers, etc.*

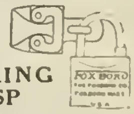
Constant and intelligent use of the instruments illustrated above enables one of New York's largest hotels to insure the comfort of its guests twenty-four hours a day, 365 days a year. At the same time, the close control which these instruments make possible has brought about very important savings in coal.

The thirty-two Foxboro Instruments record temperature of hot water for laundry, kitchen and house, temperature of drinking water, boiler feed water, city water, ground floor ventilation air, outside air temperature, low pressure return and outgoing brine temperatures on ice machines.

The pressure gauges record pressure of city water, high pressure air system, house hot water, hydraulic elevator, boiler "blow down," high and low pressure steam returns, annex steam heating system, boiler steam pressures, house heating system and ammonia pressure on ice machines. A Foxboro Liquid Level Gauge records depth of water in tanks on the roof.

The Foxboro round case and inverted pen arm account for the neatness and compactness of the board and the clean records produced. Time has demonstrated the wisdom of choosing Foxboro Instruments which combine permanent accuracy with long life. Their superior construction and quality of workmanship is the real reason why engineers everywhere place their confidence in Foxboro as "The Compass of Industry."

Write to Dept. C.F. for information on the application of Foxboro Instruments to your problems.



SPRING HASP

This is the latest of the many exclusive Foxboro features which take Foxboro out of the class of ordinary instruments. A push of the hand—the Spring Hasp closes the case dust-tight automatically, thus assuring a clean record and protecting the mechanism at all times.

FOXBORO

TRADE MARK

THE COMPASS OF INDUSTRY

FOXBORO, MASS. U.S.A.

New York Chicago Boston Tulsa
Pittsburgh Philadelphia San Francisco Birmingham

Peacock Brothers, Limited, 179 Delorimier Avenue,
Montreal, Canada

4755

Representing the Leading Manufacturers

In addition to manufacturing and distributing Fairbanks-Morse products, The Canadian Fairbanks-Morse Co., Limited, represents the leading manufacturers of mechanical goods.

When ordering from our nearest branch, you are ordering from the manufacturer whose product has proved itself the acknowledged leader in its particular field. Here are some of the well known lines we handle:—

- **Fairbanks Scales**
- **Pratt & Cady Valves**
- **Palmetto Packing**
- **Strong Steam Traps**
- **Allen Engines**
- **Landis Threaders**
- **Graton & Knight Leather Belting**
- **Yale Chain Hoists**
- **Gould's Pumps**
- **Fairbanks Valves**
- **Durabla Packing**
- **Foster Regulators**
- **Fairbanks-Morse Gas and Oil Engines**
- **South Bend Lathes**
- **Dick's Balata Belting**
- **Norton Grinding Wheels**
- **Fairbanks-Morse Generators**
- **Fairbanks-Morse Pumps**

Each department is in charge of men who can give you valuable help in the solution of your problems.

Canada's Departmental House for Mechanical Goods

The CANADIAN FAIRBANKS-MORSE CO. LIMITED

St. John Quebec Montreal Ottawa Toronto
Hamilton Windsor Winnipeg Regina
Saskatoon Calgary Vancouver Victoria

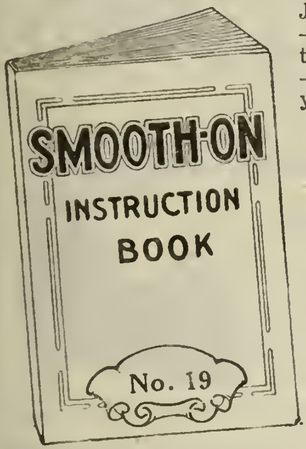
SMOOTH-ON IRON CEMENTS

What Other Engineers Know About Repair Work, This Free Book Tells You

It is full from cover to cover of practical ideas developed to meet actual engine and boiler room emergencies. There is no theory in

SMOOTH-ON

Instruction Book No. 19



Just 144 pages of real facts — facts that if you knew them might save you hours — or days — and dollars in your next repair job.

Write for your copy of this valuable book—you need it in your work—It's FREE.

Smooth-On Iron Cements are sold in 5-lb., 10-lb., and 25-lb. tins; also in larger sizes.

THE CANADIAN ASBESTOS CO.
Dept. 52A
36-48 Youville Square
Montreal, Que.

If your Supply House cannot supply you with Smooth-On —write us direct.

Feed Your Engine Dry Steam

When supplied with dry, hot steam, it's natural that your engine should show greater efficiency than when supplied with steam saturated with moisture. The installation of the

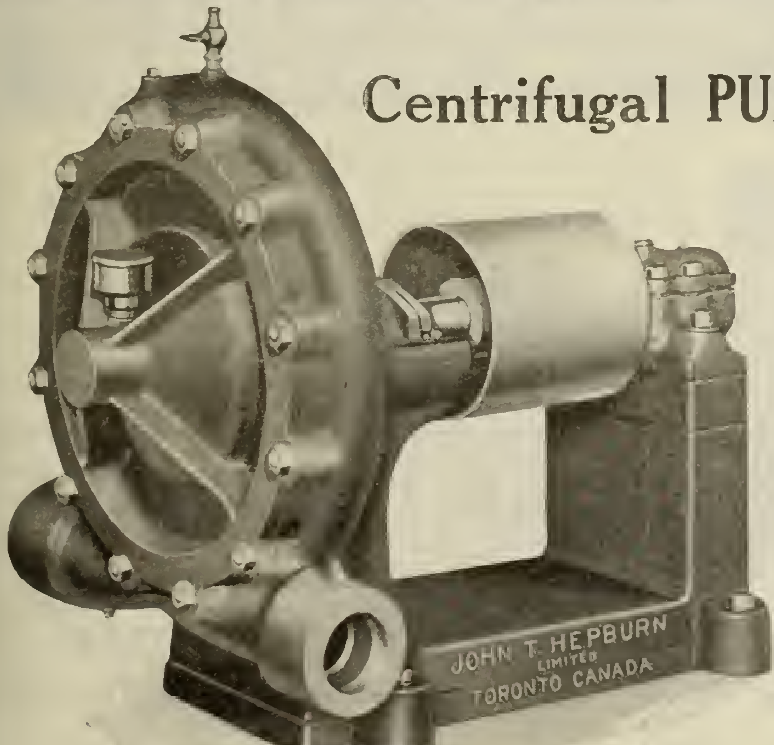
ANDERSON STEAM SEPARATOR

ensures a supply of dry, hot steam under all conditions and is a safeguard against the possibility of breakdown. Its action is positive and the moisture, once separated, cannot be picked up again.

You really need the Anderson—let us tell you more about it.

THE V. D. ANDERSON CO.
West 96th St. Cleveland, Ohio

Centrifugal PUMPS Reciprocating



The selection of a pump, be it large or small, certainly involves an important responsibility, for few buyers can afford the expense and trouble which usually follows the installation of unsuitable or low grade equipment.

All we ask is that your judgment be based solely on our pump and your acceptance given only after its pumping capabilities have been proven conclusively.

We can also quote attractive prices on cranes, derricks, hydrants and all kinds of special machinery.

JOHN T. HEPBURN, LTD. ENGINEERS AND IRON FOUNDERS **18-40 Van Horne St., TORONTO**

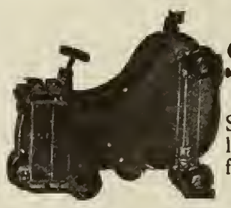
HINTS TO BUYERS

“Pop Off” Steam
Carries Ashes Away

“Into the hole and away they go” describes ash removal with a Green Steam Jet System. At the Kewanee Boiler Co., they use “Pop off” waste steam to do the work.

Write to Dept. X for descriptive literature.

GREEN ENGINEERING COMPANY
175 Kennedy Avenue
EAST CHICAGO INDIANA



McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

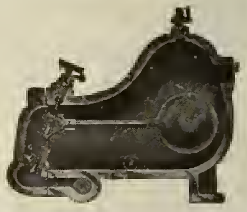
May We Send One for Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

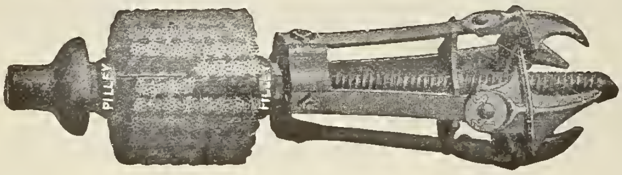
Send for Catalogue

THE GARTH COMPANY
6 Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T.J. CUNERTY** *Company*
Room 240 17, Queen St, East Toronto

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE
MEANS ECONOMY

Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.

WILLIAMS' SUPERIOR

Drop-Forged Wrenches

Over 40 Standard Patterns in 1,000 Sizes

J. H. WILLIAMS & Co., Limited

"The Wrench People"

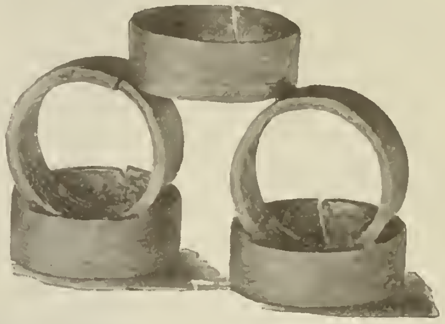
78 Thorold Road St. Catharines, Ont.

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

Made In Canada



Approved Packing for Condenser Tubes

This "John Crane" Metallic Packing Process (patented) renders condensers absolutely leak-proof and saves tubes from destructive stress and corrosion.

In marine service (and there is none harder) and in power house installations, "John Crane" Packing is standing up better than anything else ever devised, both in new and replacement installations. We invite inquiry and opportunity to demonstrate. Booklet on request.

FLEXIBLE METALLIC PACKING CO.

WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS PACKING & GENERAL MFG.
Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B.C.
"MADE IN CANADA."

The "ALBANY" Water Sealed
ROTARY PUMP

MECHANICAL SIMPLICITY
HIGH EFFICIENCY
LOW MAINTENANCE COST

FOR FUEL-OIL BURNING

For Forced Lubrication

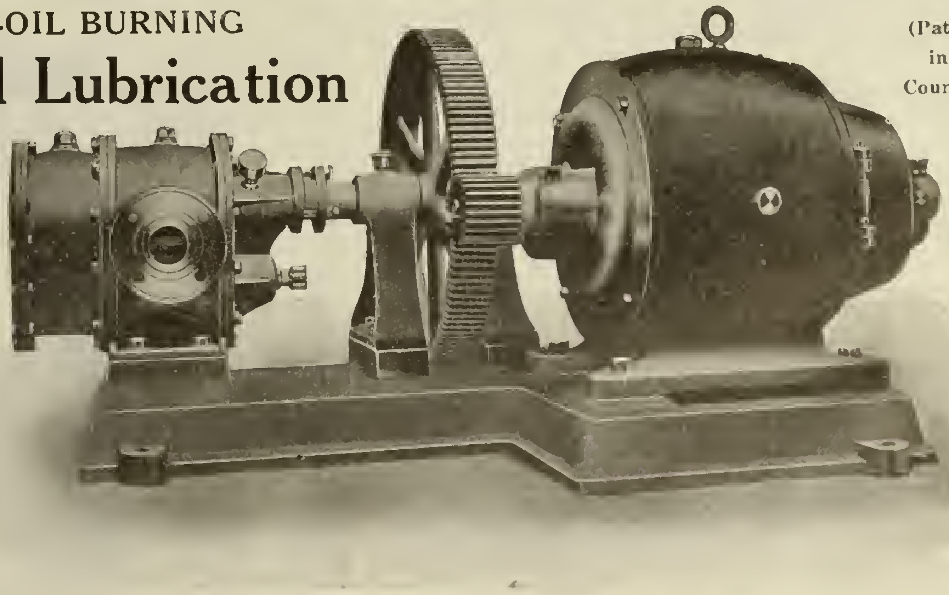
(Patented in all Countries)

The lubrication system at the new Queenston plant of the Hydro Electric Power Commission is operated by Albany Pumps.

It has been successfully used for domestic water supply, also to handle wine, vinegar, acids, gasoline, etc. Capacities from 100 to 60,000 gallons per hour.

Submit your pump problems to us.

Write to-day



As a Vacuum Pump of its type, it has no equal.

Made-in-Canada

ALBANY PUMP COMPANY

159 Richmond Street W., Toronto, Ont.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we willtell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
Arthur S. Leitch Co., Ltd., Toronto.
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

AMMONIA PLANT EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
Under-feed Stoker Co. of Canada, Ltd. Toronto.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co.,: Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W. R Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd., Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
D. K. McLaren Limited, Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. McLaren Limited, Montreal, Que.

BELT HOOKS
D. K. McLaren, Limited, Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, FABRIC
D. K. McLaren Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. McLaren, Limited, Montreal, Que.

BELTING, SOLID WOVEN
D. K. McLaren, Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

CORD CLOTHING
D. K. McLaren Limited, Montreal Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd., Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Suply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co. Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren, Limited, Montreal, Que

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CHIMNEYS
Arthur S. Leitch, Co., Toronto.

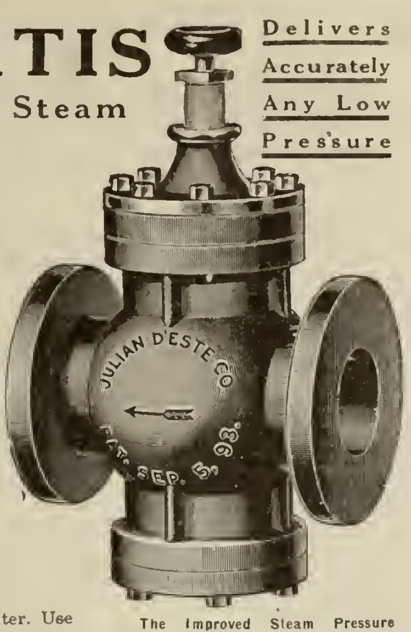
CURTIS

Improved Steam Pressure Regulator

Delivers Accurately Any Low Pressure

A compact, self-contained Regulator suitable for any boiler pressure. It delivers accurately and uniformly any lower pressure from one to within a few pounds of the initial pressure.

It has no levers, weights or projections; no glands or packing; no drip or leak of steam or water. Use it for efficient service on steam-heating apparatus, slashers, jacket kettles, air or water pumps, pulp mills, etc.



JULIAN D'ESTE CO.
PAT. SEP. 5, 93.

The Improved Steam Pressure Regulator is a lock valve, very simple and sensitive. Send for descriptive pamphlet.

JULIAN D'ESTE COMPANY

Main Office: 26 Canal St., Boston, 14, Mass.

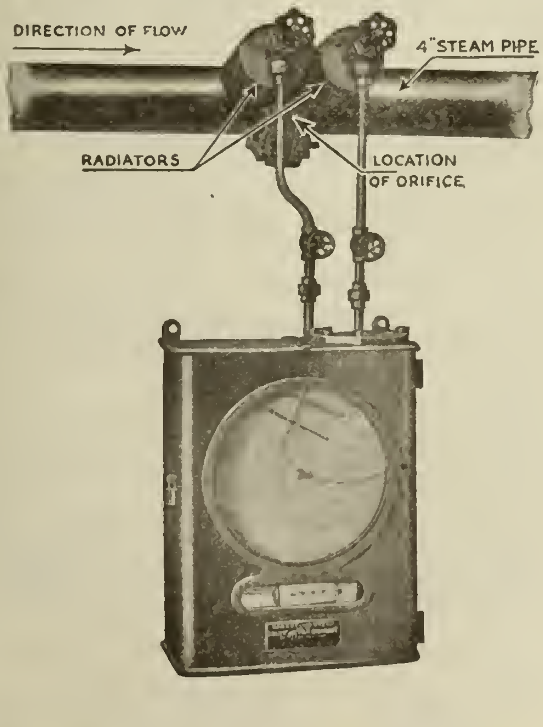
DE LAVAL Oil Purifiers are keeping clean the lubricating oil used in America's largest power plants. In smaller plants, such as the one pictured here, they are just as economical and efficient.

There is a De Laval Purifier to fit **your plant.** Bulletin 105 will tell you all about it.

The De Laval Company, Ltd.

Montreal Winnipeg Peterborough Ont. Edmonton Vancouver

It Will Pay You to Meter Your Steam



BAILEY FLUID METERS

Usually the purpose of a fluid meter is to measure the total flow, but it is equally important that the rate of flow be recorded continuously to show the variation in certain operating conditions or demand, or else to indicate whether or not certain conditions have been maintained as desired.

Even though an operator uses a flow meter only for the purpose of regulating a process, it is important that the meter draw a continuous record so as to show at all times how closely these results are being accomplished.

The accuracy of Bailey Fluid Meters for this service is unquestioned. Bulletin No. 31 describes them fully. Shall we send you one?

Bailey Meter Co. Limited

177 Delorimier Ave. Montreal, Que.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CARBONIC ACID GAS
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

COUPLINGS
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & **Lamb, Montreal.**

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injetor Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR DRIVES
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E. London, Ont.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co. Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E. London, Ont.

EXHAUST HEADS
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto and Boston.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N. Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER HEATERS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., Erie, Pa.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Frick Co., Waynesboro, Franklin Co., Pa.
Graver Corp., East Chicago, Ind.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Scaife & Sons, Wm. B., Pittsburg, Pa.
York Mfg. Co. York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane, Limited, Montreal.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N. Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FUEL ECONOMY DEVICES
The Boiler Repair and Grate Bar Co., Toronto, Ont.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

M. BARRY WATSON
B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer
Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W

Save 10 to 20% of your fuel—the Sturtevant Economizer soon pays for itself.

Our sales-engineers will show you how, and refer you to working installations so you can see for yourself. Ask for folder 609.

B. F. STURTEVANT CO.
OF CANADA, LTD.
MONTREAL GALT TORONTO

FOR SALE

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison, & Son, R. R. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

FOR SALE
Fuel Oil Storage Tank
10,000 GALS. CAPACITY.

This is a new tank. We have not yet taken delivery of it, and offer it at a very attractive price.
MR. VOGAN, The MacLean Publishing Co., Ltd, 143 University Ave., TORONTO.

VICTORIA FOUNDRY COMPANY
LIMITED

Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations
Write for our latest catalogue
Patterns Machine Work

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES
4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines--the Indicator--Lubrication--PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught--HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration- Cooling Towers--Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you 1 monthly until $12 is paid.

Signature ______
Occupation ______
Employed by ______
Residence ______
Reference ______

THE VENTURI METER

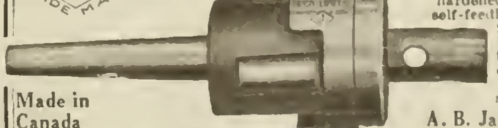
Measures hot and cold water, sewage, brine, chemical solutions, oil, gas, air and steam.
Bulletin on request.
BUILDERS IRON FOUNDRY, PROVIDENCE, R.I.
Canadian Representatives: General Supply Co. of Canada, Ltd., Ottawa, Montreal, Winnipeg, Vancouver; Allen General Supplies, Ltd., Toronto, Ont.

INVESTIGATE THE
ADVERTISEMENTS
APPEARING IN EVERY ISSUE
OF POWER HOUSE

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING
Oil Burning Systems Installed
Full line of Power Plant Equipment and Supplies.
LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL.

REGISTERED J TRADE MARK

Jardine's Self-feeding Tube Expanders



All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel, it is withdrawn without danger of breaking mandrel or straining expander

Made in Canada

A. B. Jardine & Co., Ltd.
Hespeler, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Canadian Johns-Manville Co., Ltd., Toronto.
Johns-Pratt Co., Tbe, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HANDHOLE
Canadian Raybestos Co. Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Peldam Asbestos (Canada) Co., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Stesm Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.

GASKETS, LEAD, COPPER AND SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD AND LEATHER
Sbell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio,
Penberthy Injector Co., Windsor, Ont.

HANGES, GAUGES, AMMONIA, OIL, GAS, AIR
Schaffer & Bundenburg Mfg. Co., American Stesm Gauge & Valve Co. Division, Brooklyn, N. Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
W. J Wall, Montreal.

GAUGE, RECORDING
Jas. Morriaon Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICRDMETER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div- Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTERS
Can. Fairbsnka-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton,
Leitch Co., Arthur S., Toronto, Ont.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal
Canadian Steam Boiler & Equipment Co., Toronto.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E. London, Ont.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRATE BARS, FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.
The Boiler Repair and Grate Bar Co., Toronto, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicago, Ind.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HDPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicago, Ind.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal,
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INDICATING THERMOMETER, SARCD
Sarco Co., Inc., New York.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LACE LEATHERS
Can. Johns-Manville Co., Ltd., Toronto.
D. K. MacLaren Ld., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mo.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MARINE CASTINGS
Mueller Mfg., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

METERS, F.M.
Canadian General Electric Co., Toronto.
The Bailey Meter Co., Cleveland, Ohio,
Can. Johns-Manville Co., Toronto.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Imperial Oil, Ltd., Torono.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunbam Co., Ltd., Toronto.
Superbeater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Direct Separator Co., Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.

OILING SYSTEMS
Lunkenheimer Co., Cincinnati, Ohio.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos Canada Co., Toronto.
Beveridge Suppy Co., Montres.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC
Canadian Raybestos Co., Ltd., Peterborougb, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, H. P. ROD
Canadian Raybestos Co., Ltd., Peterborougb, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont.

PENSTOCKS
W. M. B. Scarfe & Sons, Pittsburgh, Pa

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
The Superheater Co., Limited, Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE STEEL
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

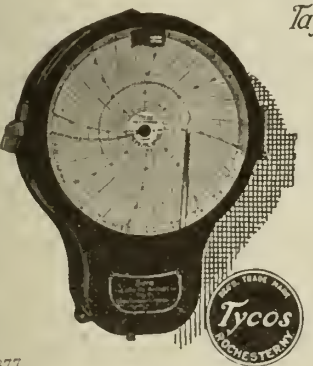
PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co., Cincinnati, Ohio.

Tycos and Steam Pressure

Where accurate measures of steam pressure and temperature are essential there is a *Tycos* recording pressure gauge or a *Tycos* recording thermometer to do the work thoroughly. These are especially efficient on long steam pipe lines where pressure measurements are required at both ends.

Request our catalog for power plants.



Taylor Instrument Companies
Tycos Building
110-112 Church Street
Toronto, Ont.

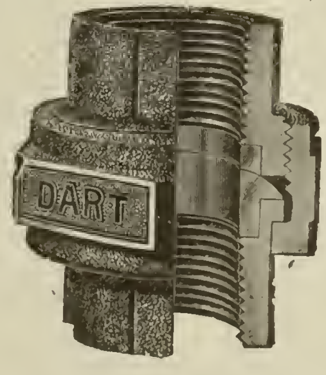
There's a *Tycos* or *Taylor* Temperature Instrument for every purpose.

Tycos
REG. TRADE MARK
ROCHESTER, N.Y.

INDICATING - RECORDING
CONTROLLING

877

Bronze to Bronze At the Joints



Never Leak
Ask Your Jobber
Dart Union Co. Ltd.
Toronto

Columbia
Recording Thermometers

This advertisement is one of a series, each one of which covers one of the many "Columbia" exclusive features. In this way we believe we can best meet the inquiries we are constantly receiving for definite information.

THE ACTUATING MEDIUM

The actuating medium of the "Columbia" Recording Thermometer is Mercury, the standard basis of temperature measurement. Its superiority as the actuating medium of the industrial thermometer is attested by the fact that it is employed in all thermometers of the glass tube type where accuracy is essential. The most sensitive test thermometers and delicate clinical thermometers are mercury actuated. That is why mercury is employed in the "Columbia" because it is the only substance having all the fundamental requisites necessary to measure temperature with absolute accuracy, being extremely sensitive and responding instantaneously to the slightest temperature changes. And the action of mercury is uniform. The record given by the "Columbia" can, therefore, be relied upon as being absolutely accurate and true.

The Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO DIVISION

(of Brooklyn, N.Y.)

Makers of Columbia Recording
Thermometers and Gauges with
TIME PUNCH

TORONTO BRANCH
67-69 Frederick St. Phone: Main 2578

MONTREAL AGENTS:
Patton Mfg. Co., 284 Beaver Hall Hill

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co,, Toronto, Ont.

PUMPING MACHINERY
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Pratt & Cady, Hartford, Conn.
Smart-Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H, McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Pratt & Cady, Hartford, Conn.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, GAS
Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Masa.
The Garth Co., Montreal.
Northern Equipment Co., Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co., (Inc., Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
Boving Hydr. & Eng. Co., Ltd., Lindsay.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

OIL PUMPS FOR FUEL OIL BURNING SYSTEMS.
Albany Pump Co., Toronto, Ont.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal,
The John H. McGowan & Co. Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMP TANK, RECEIVER
American Steam Pump Co., Batle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jas. Morrison Brass Mfg, Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa,
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Canadian Johns-Manville Co., Ltd., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Tayor Instrument Co., Toronto, Ont.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamieson Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
inde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co,, Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Sarco Co., Inc., New York, N. Y
Taylor Instrument Co. Toronto, Ont.

REGULATING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co, of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal,
Beldam Asbestos (Canada) Co., Toronto.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co,, Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester Mass.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamb, Montreal,

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London.
Waterous Engine Works Co., Brantford.

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd., Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch, Co., Ltd., Toronto,

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co,, Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM JETS
Green Engineering Co., East Chicago, Ind.

STEAM SPECIALTIES
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
The Reliance Gauge Column Co., Cleveland, Ohio.
Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM CALORIMETERS
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Sarco Co,, Inc., New York.

STEAM TRAPS
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Julian D'Este Co., Boston 14, Mass.
Sarco Co., New York, N. Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co,, Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.

STOKERS
Canadian Planet Engineering Co., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd., Montreal.
Green Engineering Co., East Chicago, Ind.
Underfeed Stoker Co., of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto,
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
Sturtevant, Co., B. F., Toronto and Boston.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. and Eng. Co., Ltd., Lindsay.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STATIONARY
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, LOCOMOTIVE
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STEAM SHOVEL
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

NOW
15¢
Pre-War Price

A New Year's gift from

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

Is a reduction in price

without any change in the high quality of its editorial contents

Our definitely permanent policy of supplying in MACLEAN'S the work of Canada's best writers and the artistic craftsmanship of famous illustrators and artists has won us the materially strengthened support of Canadian readers and advertisers.

It is therefore with a great deal of pleasure that we offer you now Canada's National Magazine which, while it has steadily competed with the best magazines of this continent on the score of its editorial contents, now competes in the matter of price. Beginning with our

JANUARY FIRST ISSUE

MacLean's will be sold for Fifteen Cents

A few of the features of our January First Number:

"The War of the Captains"
Albert Richard Wetjen

"An English Girl—God Bless Her!"
Dorothy Barlow
Winner of the War Bride Competition.

"Girding for the Fray"
J. K. Munro

And many other fine features well up to the MACLEAN standard.
All our regular departments and

The Review of Reviews
A running Story of World Progress in Literature, Science and Government.

Now on Sale at all News Stands

Now
On Sale
MACLEAN'S
"CANADA'S NATIONAL MAGAZINE"
for
Jan 1st

"SAFETY"
Plastic
Metallic
Packing

For steam, water, air, gas, etc., is practically indestructible and may be used over and over again. It is

Packing in Cotton Tubes

GUARANTEED
TO LAST THREE YEARS
WITHOUT RENEWAL

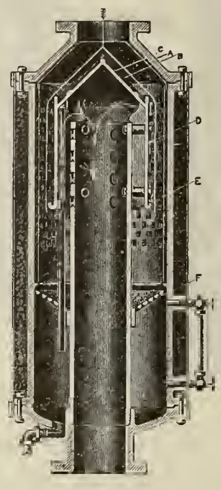
It is made of an alloy of the finest anti-friction metals, just hard enough for long service but not hard enough to damage any rod. The metal is combined with the best lubricating material, making it practically SELF-LUBRICATING AND FRICTIONLESS.

Send for full particulars also about our "Safety" Superheat Sheet Packing.

Packing in Bulk.

STEEL MILL PACKING Company
Windsor EST. 1899 Ontario
AGENTS WANTED

10,000 Sweet's Separators are serving discriminating steam users around the world.



Half of them sold on repeat orders. This record is backed by authentic tests, copies of which are mailed on application. For live steam mains or exhaust lines made in sizes from 25 pounds in weight to 25,000 pounds.

Read our story before buying.

Sweet's
Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. - Syracuse, N.Y.

General Sales Agents

Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N. Y

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Canadian Johns-Manville Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.
Waterous Engine Works Co, Brantford.

TANKS, OIL, KEROSENE, GASOLINE
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa
Waterous Engine Works, Brantford

TANKS, WATER
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

THERMOMETERS, INDICATING AND RECORDING
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.
Uehling Instrument Co., New York, N.Y

THERMOSTATS
Sarco, Inc., New York, N.Y.

TOOLS SMALL
J. H. Williams & Co., Brooklyn, N. Y.

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
Sarco Co., Inc., New York, N.Y.
Wason & McDonald Co., Philadelphia.
Taylor Instrument Co., Toronto, Ont.

TACHOSCOPES
The Reliance Gauge Column Co., Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and Am-American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.

TRAPS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Grant E. Cole Co., Toronto, Ont.
Julian D'Este Co., Boston, 14, Mass.
Sarco Co., Inc., New York, N.Y.

TRAPS, DUMPING
Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F. Toronto and Boston.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ld., Toronto.
Sturtevant Co., B. F., Toronto and Boston.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal.
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg, Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES OF ALL KINDS
Reading Steel Casting Company, Inc.
Pratt & Cady Division,
Bridgeport, Conn.
Reading Steel Casting Company, Inc.
Reading Valve and Fittings Division,
Bridgeport, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Shell Bar Boico Supply, Ld., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

VALVES, ACID RESISTING
Kerr Engine Co., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.
York Manufacturing Co., York, Pa.

VALVES, AIR
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
H. Mueller Mfg. Co., Ltd., Sarnia.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, ATMOSPHERIC RELIEF
The Edward Valve Mfg, Co., East Chicago, Ind.

VALVES, BACK PRESSURE
Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jenkins Bros., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
The Edward Valve Manufacuring Co., East Chicago, Ind.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BLOW-OFF
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.
Watson & McDaniel Co., Philadelpbia, Pa.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Jenkins Bros., Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia Ont.
Penberthy Injector Co, Windsor Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
The Edward Valve Mfg. Co., East Chicago, Ind.

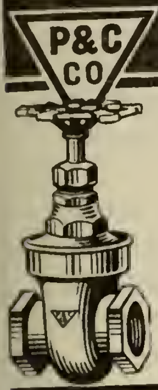
COCHRANE MULTIPORT VALVES
Canadian General Electric Co., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.

VALVES, FORGED STEEL
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES, FOOT
Kerr Engine Co., Walkerville, Ont.
Shell Bar Boico Co., Walkerville, Ont.
Smart-Turner Mach. Co. Ltd., Hamilton

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.



PRATT & CADY VALVES

P&C CO

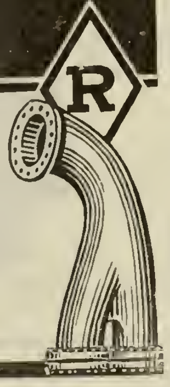
Pratt & Cady Bronze and Iron Valves are made for all purposes and pressures. They give long and satisfactory service.

Reading Steel Casting Co. Inc.
Pratt & Cady Division
Bridgeport, Conn.
Canadian Representatives:
CANADIAN FAIRBANKS-MORSE COMPANY
MONTREAL.

READING STEEL FITTINGS

Reading Open Hearth Fittings come in all shapes and sizes—flanged and screwed — for oil, water, gas and steam lines.

Reading Steel Casting Co., Inc.
Reading Valve & Fittings Division
Bridgeport, Conn
Canadian Representatives;
CANADIAN FAIRBANKS-MORSE COMPANY
MONTREAL.

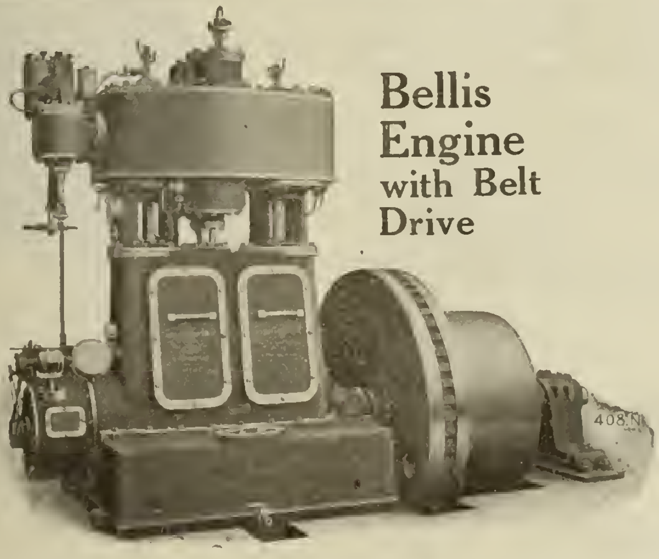


Building a one-piece furnace lining without special forms.

BETSON'S
TRADE MARK
PLASTIC FIRE BRICK

Makes practicable, solid, one-piece furnace lining, including front and back arches, side walls and baffles. It costs but little to install in any make or type of boiler. It saves fuel, annoying shut-downs, costly repairs, and increases the amount of power from the fuel used.
Complete details of the many uses, methods of installing, how to order, measurement blanks, etc., are contained in a booklet of information which we will gladly send you. Tell us the individual to whom it should be addressed.

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6, Rome, N.Y.
Canadian Distributors:
INTERNATIONAL CHEMICAL CO.
26-6 Adelaide St., Toronto, Ont., Canada.



Bellis Engine with Belt Drive

BELLIS & MORCOM LTD., BIRMINGHAM ENGLAND

Steam Engines
Steam and Exhaust Turbines
Air and Gas Compressors
Diesel Engines

Water Softeners

Feed Water Meters

Semi-Metallic Packing for Centrifugal Pump Spindles

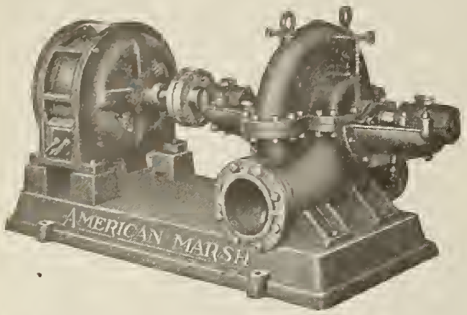
Maxim Silencers for Air Compressor Suctions, Gas Engine Exhausts, etc.

ASK FOR CATALOGUES

AGENTS:
LAURIE & LAMB, BOARD OF TRADE BUILDING **MONTREAL**

AMERICAN-MARSH PUMPS

Centrifugal and Direct Acting



Designed for use in power plants where absolute reliability and high efficiency are essential. For over thirty-five years American-Marsh Pumps have been recognized as standard throughout the Dominion. There are over 160,000 in successful operation.

The sturdy rugged construction and heavy cast bronze fittings insure long life and a minimum repair expense.

American-Marsh Centrifugal Pumps are built with the same painstaking care that characterizes the construction of the direct acting line.

The Line includes:

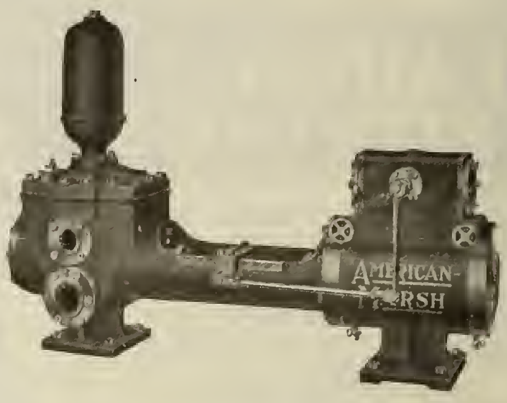
Boiler Feed Pumps
Air Compressors
Deep Well Engines
Centrifugal Pumps
Jet Condensers
Vacuum Pumps
Condensation Pumps
Sump Pumps

May we send you our general Catalog?

AMERICAN STEAM PUMP CO.

BATTLE CREEK, MICH.

CANADIAN AGENTS:—A. R. Williams Machinery Co., Ltd., Toronto; Williams & Wilson, Ltd., Montreal; London Engine Supplies Co., Ltd., London; A. R. Williams Machinery Co., Ltd., Winnipeg; Mechanics' Supply Co., Ltd., Quebec; Gorman's Ltd., Edmonton and Calgary; J. T. Allan Ritchie, Vancouver.



INDEX TO ADVERTISES

A
Albany Pump Co. 53
American Steam Gauge & Valve Mfg. Co. 59
American Steam Pump Co. 64
Anderson Co., V. D. 51
Armstrong Cork and Insulation Co., Ltd. 11
Audel Co., Theo 57

B
Babcock & Wilcox 43
Bailey Meter Co. 55
Betson Plastic Fire Brick Co... 63
Beveridge Supply Co. .... —
Builders Iron Foundry 57
Buyers' Directory, 54, 56, 58, 60, 62

C
Canada Cement Co., Ltd. 5
Canadian Fairbanks-Morse Co., Ltd. 50
Canadian Raybestos Co. .... —
Canadian Sirocco Co., Ltd. ... 17
Canadian Ingersoll-Rand Co. ... 47
Can. Johns-Manville Co. 45
Carruthers, J. A. 16
Classified Adv. Section 57
Cole Co., Grant E............. 16
Counerty, T. J. 52
Crane Packing Co. 53
Crane, Ltd. 6

D
DeLaval Steam Turbine Co. 8
DeLaval Co., Ltd., The 55
Dart Union Co. 59
D'Este Co., Julian 55
Diamond Specialty Ltd. 16
Direct Separator Co. 62
Durabla Mfg. Co. 18

E
Elk Fire Brick Co. 52
Engineering & Machine Works of Canada 13

F
Foxboro Co. 49
Frick Company 12
Flexible Metallic Packing Co... 53

G
Garlock Packing Co. 19
Garth Co., The 52
Gelinas & Pennock Reg'd...... 15
Goldie & McCulloch Co. 20
Greene, Tweed & Co. .....Inside Front Cover
Green Engineering Co. 52
Gutta Percha & Rubber Ltd... 4

H
Hints to Buyers 52
Hepburn, John T. Co... 51

J
Jamieson Cold Storage Door Co. 12
Jardine, A. B. 57
Jenkins Bros. ....Inside Back Cover
Jointless Firebrick Co. 44

K
Kerr Engine Co. 14

L
Laurie Engine Co. 57
Laurie & Lamb 63
Leitch, The Arthur S. .... —
Leonard & Sons. Ltd., E....... 18
Linde Can. Refrig. Co. 10
Lunkenheimer Co. 7

M
McLaren, D. K. Co. 3
McGowan Co., John H. 14
Magnolia Metal Co. 44
Moncrieff Ltd., John.......... 12
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Mueller Mfg. Co. 48
Murphy Iron Works ... . —

N
Northern Crane Works 12

P
Pilley Packing & Flue Brush Mfg. Co. 52
Pratt & Cady Co. 63

R
Reading Steel Casting Co. 63
Refrigeration Dept. 10
Reliance Gauge Column Co., The —

S
Schaeffer & Budenberg Mfg. Co. 59
Smooth-On Mfg. Co. 51
Superheater Co. 64
Sturtevant & Co., Ltd, B. F... 57
Steel Mill Packing Co 62

T
Taylor Instrument Co. 59

U
Underfeed Stoker Co., of Canada, The 9

V
Victoria Foundry Co. 57
Vilter Mfg. Co. 10

W
Wall, W. J. 12
Waterous Engine Works Co. . 1
Watson, M. Barry 57
Watson & McDaniel Co. 52
William & Co., Ltd., J. H. 53

Y
Yarnall-Waring Co. 8
York Mfg. Co. 11
Young Pump Co. of Canada. .. —

SUPERHEATERS

ELESCO

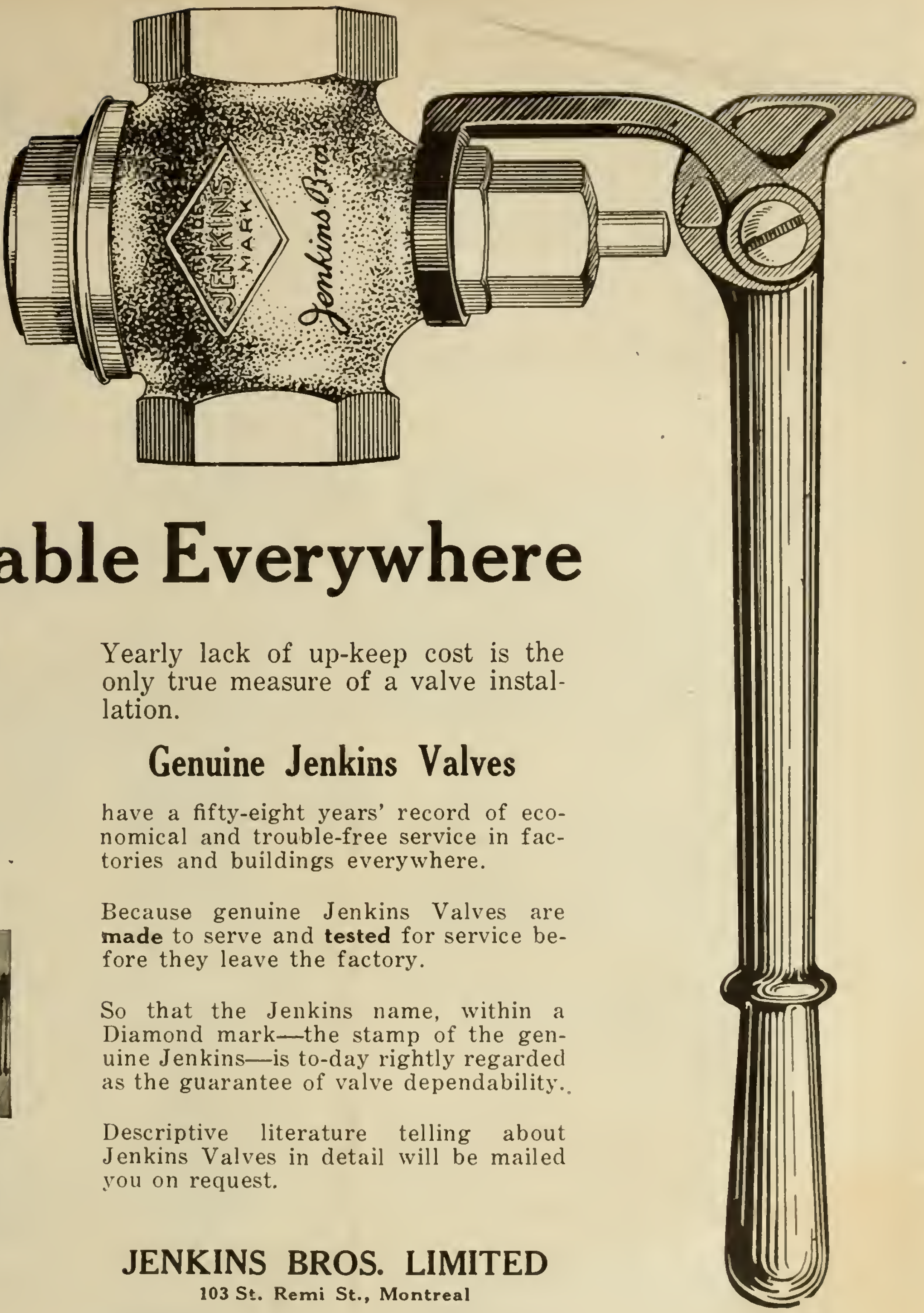
DESIGNING ENGINEERS AND MANUFACTURERS
OF ELESCO STEAM SUPERHEATERS AND
PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR
LOCOMOTIVE SERVICE; BOILER FEED PUMPS
FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

WESTERN REPRESENTATIVES
TAYLOR ENGINEERING CO., LTD.,
VANCOUVER, B.C.

THE SUPERHEATER CO., LIMITED.
Transportation Bldg., Montreal

MADE IN CANADA
WORKS AT SHERBROOKE, QUE



Dependable Everywhere

Yearly lack of up-keep cost is the only true measure of a valve installation.

Genuine Jenkins Valves

have a fifty-eight years' record of economical and trouble-free service in factories and buildings everywhere.

Because genuine Jenkins Valves are **made** to serve and **tested** for service before they leave the factory.

So that the Jenkins name, within a Diamond mark—the stamp of the genuine Jenkins—is to-day rightly regarded as the guarantee of valve dependability.

Descriptive literature telling about Jenkins Valves in detail will be mailed you on request.

JENKINS BROS. LIMITED
103 St. Remi St., Montreal
TORONTO VANCOUVER
European Branch—6 Great Queen St., Kingsway, London W.C. 2, England

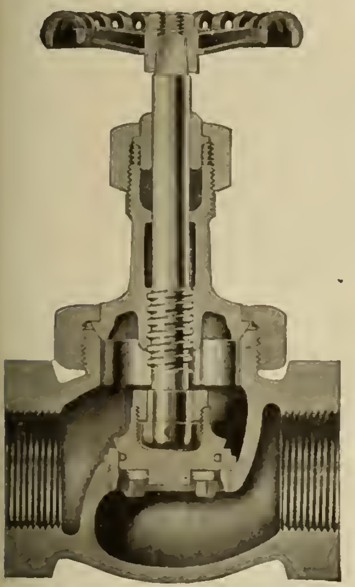


Fig. 500.
"STERLING"
Regrinding Bronze Globe Valves
(Sectional View).

Fig. 720.
JENKINS
Rapid Action Valve

Jenkins Valves
SINCE 1864

MORRISON'S

Steam Goods
AND
Specialties

An unconditional guarantee, plus over sixty years of manufacturing experience is behind the Morrison Line of Steam Goods and Specialties, which includes Power Plant Accessories and Fittings for every purpose.

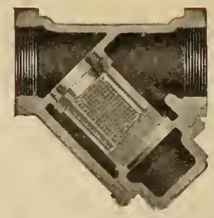
Morrison Steam Goods are approved by Provincial and Marine Inspection Departments. Each article is thoroughly tested before leaving the factory.

The fullest information gladly given—tell us your requirements.

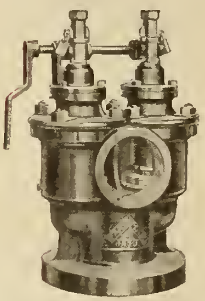
"Every Installation
is a
Demonstration of Merit."

Our Monthly Bulletin will interest you--let us put your name on our Mailing List.

Model "C" Safety Valves. Excellent valves of the single seat type with side exhaust. Working pressures up to 200 lbs. per sq. in.



Morrison Strainers—Eliminate damage caused by scale and grit in the pipe line Thousands in use.



J.M.T. Twin Safety Valves. Iron Body, bronze mounted, for working pressures up to 200 lbs. per sq. in.

Pressure and Vacuum Gauges. Accepted as standard in Canada. They include steam, water, air, ammonia, etc., also combinations for every purpose.

Atlas Gate Valves. Parallel Seats. Outside thread construction. Made in sizes ½" to 2".

Morrison Injectors. Dependable under all conditions.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W. TORONTO

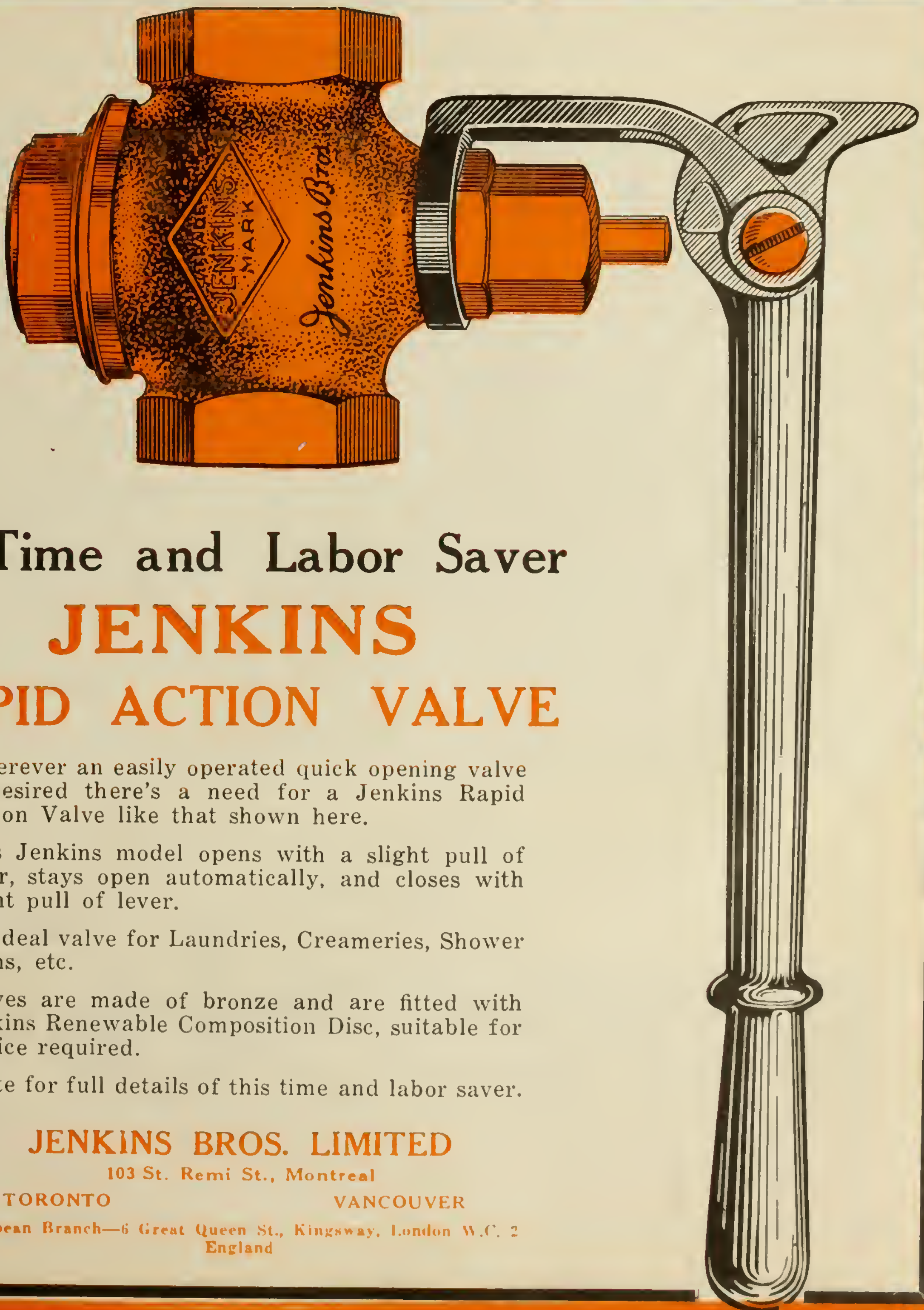
Featuring Mount Royal Hotel Power Equipment

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power ; the operation of Refrigerating Machinery ; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street. E. C. NEW YORK, BOSTON, CHICAGO

Vol. XVI—No 2. Publication Office, Toronto—January 20, 1923 Published Semi-Monthly. Canada, $2; U.S. $2.50 a year



A Time and Labor Saver

JENKINS

RAPID ACTION VALVE

Wherever an easily operated quick opening valve is desired there's a need for a Jenkins Rapid Action Valve like that shown here.

This Jenkins model opens with a slight pull of lever, stays open automatically, and closes with slight pull of lever.

An ideal valve for Laundries, Creameries, Shower Baths, etc.

Valves are made of bronze and are fitted with Jenkins Renewable Composition Disc, suitable for service required.

Write for full details of this time and labor saver.

JENKINS BROS. LIMITED
103 St. Remi St., Montreal
TORONTO VANCOUVER
European Branch—6 Great Queen St., Kingsway, London W.C. 2
England

The *Importance* of
Water Softening and Filtration
In the Modern Power Plant
is a *Proven Fact*

not an experiment

"PERMUTIT"

Water Softening and Filtration Systems
are Giving General Satisfaction

There are in Canada more than one hundred and fifty
"Permutit" Systems, with a daily capacity of
over thirteen million gallons

We *Guarantee* Results

Send for our free booklet, "Reducing Fuel and Boiler Plant Operating Costs."

W. J. Westaway Company, Limited

Hamilton - Ontario

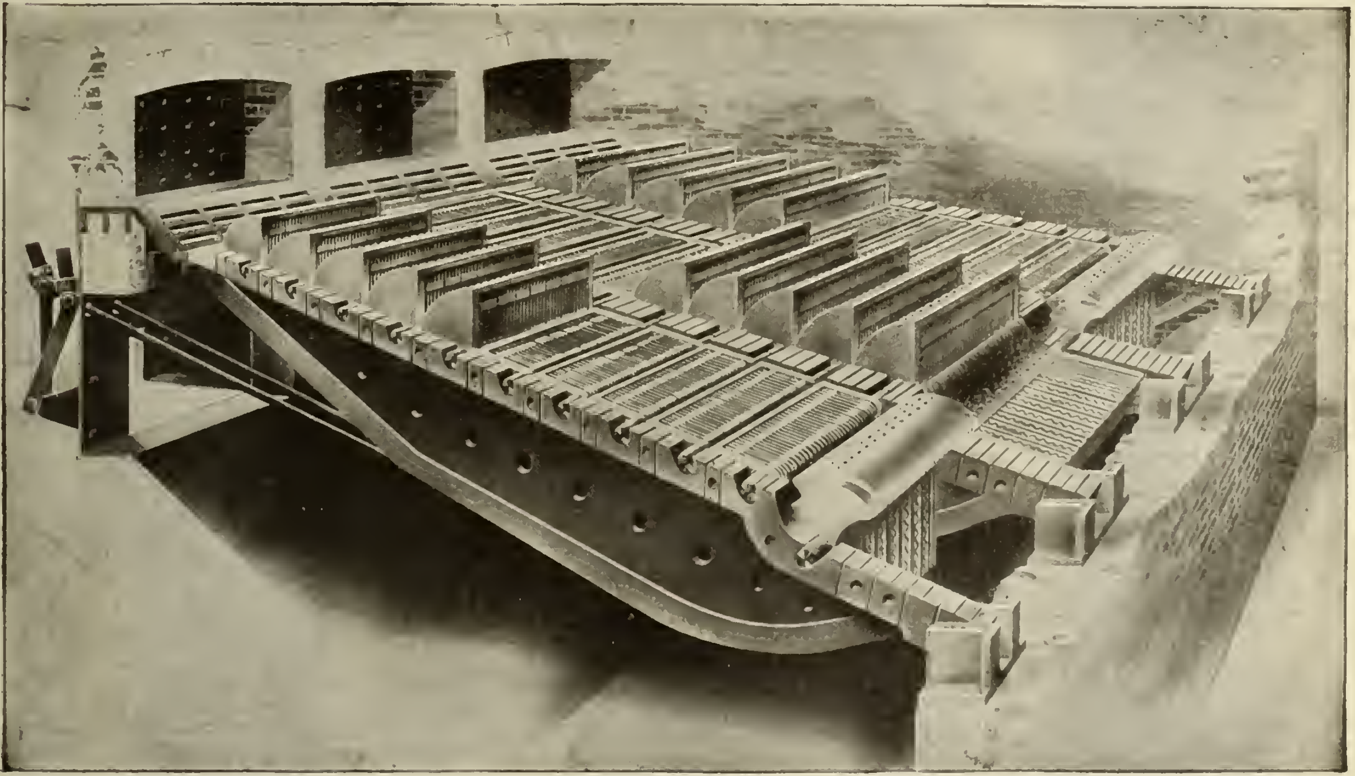
Hamilton Office:
"The Westaway Building"
Main & McNab Streets

Demonstrating Department:
"The Westaway Building"
Main & McNab Streets

Montreal Office:
Room 400,
McGill Building

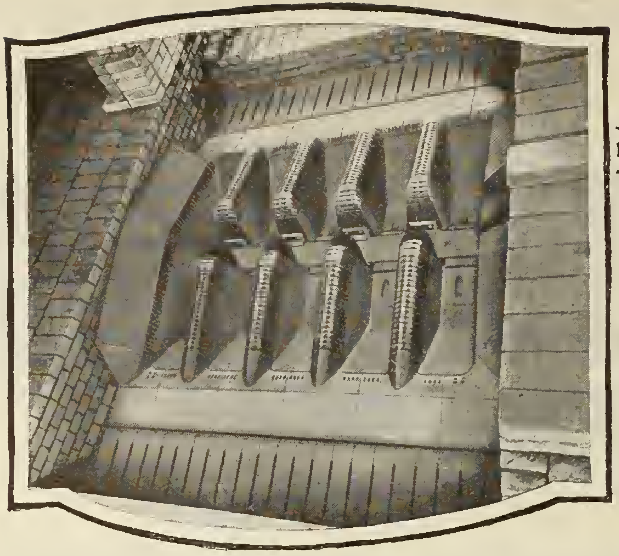
Files Stokers

Hand Operated



Waterous

BRANTFORD, ONTARIO, CANADA



Trade-mark

"Lateral Retort" is a trademark. It is known by this sign: the arrows show the path of fuel travel.

Sectional view

It fulfills conditions met by no other stoker!

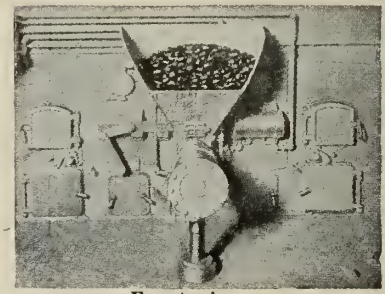
THE *"Lateral Retort"* Stoker should not be considered either as a substitute for, or an improvement on, the multiple retort type of stoker. It is rather a new type of multiple retort stoker—a type that makes multiple retort stoking possible in many plants that otherwise would be compelled to install an inferior type of stoker.

By embodying a multiple retort arrangement in a single stoker that follows the general design of simple side-cleaning stokers, a number of problems are solved in a remarkably simple way.

For instance, the necessity for basement ash pits is eliminated, since an excavation of 6 to 18 inches provides sufficient space for the two pits into which the ashes are discharged by the simple, side-dump plates. This greatly reduces installation cost and makes the "Lateral Retort" Stoker highly adaptable to old boilers in existing plants. Moreover, since the stoker is set very low, ample combustion space is insured when it is placed under low set boilers. Thus in many ways the "Lateral Retort" Stoker stands alone. It is the only side-cleaning stoker in which the coal is underfed throughout, giving the greater fuel economy and overload capacity of multiple retort stoking; and therefore it is the one moderate priced, economically installed stoker that in any way rivals the multiple retort type.

Conditions met by no other stoker. Are they your conditions?

The catalog will help you decide.



Front view

Under-Feed Stoker Co., of Canada, Ltd.
146 King St. West, Toronto.

Sales Agents for Jones Under-Feed Stokers, Riley Under-Feed Stokers, and Murphy Automatic Furnaces

Alta. and West Sask.:
Mr. J. Twomey,
Camrose, Alberta.

Man. and East Sask.:
W. W. Hicks & Co.,
Winnipeg.

British Columbia:
E. A Earle, Limited,
Vancouver, B. C.

Quebec
The Cleaton Co., (Can.,)
Ltd, Montreal, Que.

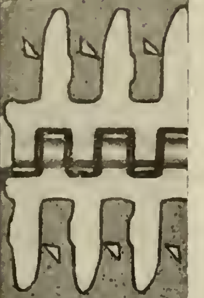
RILEY JONES
The UNDER-FEED STOKER COMPANY OF CANADA LTD.
MURPHY

The *"Lateral Retort"* Stoker
Trade Mark

ALLIGATOR

TRADE MARK REG. U.S. PAT. OFFICE

STEEL BELT LACING



Why Men Change to ALLIGATOR

Strength comes first in belt lacing. Then follow: durability, ease and speed of application, efficiency in service, range and cost.

Alligator is the Strongest Belt Lacing on Earth—and the most permanent. It is applied with a hammer in an average time of only three minutes.

Mechanically perfect because it binds the long burden bearing belt fibres in equal service. "Every Tooth A Vise." Rocker steel hinge pin endures in any service where the belt will run. The finished joint is flexible, separable and smooth on both sides.

There is a size for every thickness of belting and the price is so reasonable that **its use immediately becomes an economy.**

If you are not using Alligator now, write us for sample and our interesting book "Short Cuts to Power Transmission." A trial of Alligator will be no less convincing than an analysis of its points.

Sold through "Jobber-Dealer" trade channels the world over.

Flexible Steel Lacing Co.
4657 Lexington Street Chicago, Ill.
In England at 135 Finsbury Pavement, London, E. C., 2

"JUST A HAMMER TO APPLY IT"

"Never Lets Go"

The Safe and Certain Boiler Cleanser

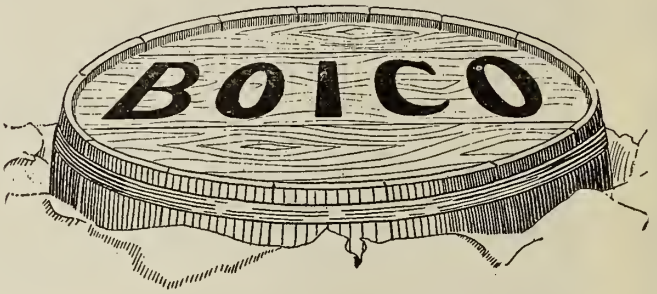
PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., **Toronto**

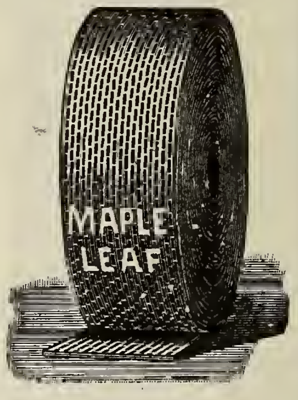
Sales Agents: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.
We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility

DOMINION BELTING CO., Ltd., Hamilton, Canada - Quebec Branch: 51 Duluth Bldg., Montreal

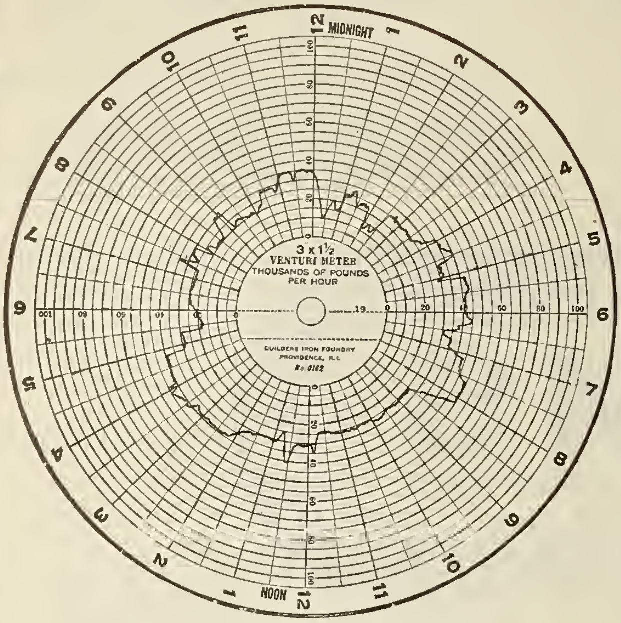
GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

BUILDERS VENTURI IRON FOUNDRY



A Venturi Meter Chart
Showing Economical Boiler Feeding

Squeeze the B.T.U.s From Your Fuel

With the mounting cost of fuel, the problem of economy in the boiler plant becomes still more important. A strict and careful watch must be kept of this end of an industrial establishment if the cost of the finished products is to be kept down. Many thousands of power plants have installed one or more

VENTURI

"VENTURI"—Registered.
Boiler Feed Meters.

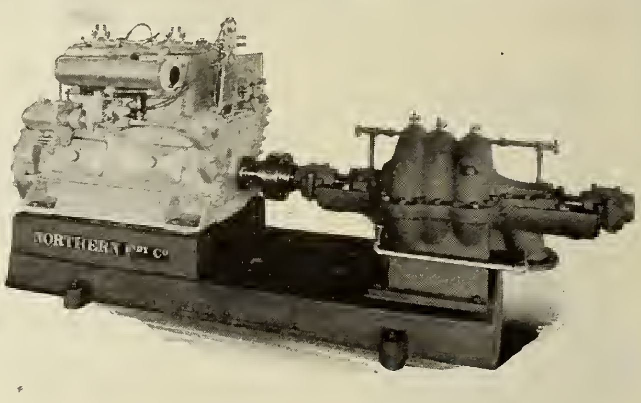
to give accurate daily records of how steam-making units are being operated. The Venturi is durable and needs little attention. It indicates the momentary rate of flow, registers the total flow and makes a record of the flow on a 12-inch chart. It is the standard meter for boiler feed measurement.

Bulletin No. 93 gives details

BUILDERS IRON FOUNDRY, Providence, R.I.

NEW YORK CHICAGO PITTSBURGH PHILADELPHIA ATLANTA DALLAS SAN FRANCISCO
LOS ANGELES PORTLAND, ORE. TORONTO OTTAWA

Sterling
THE ENGINE OF REFINEMENT FOR THE FINEST BOATS THAT FLOAT



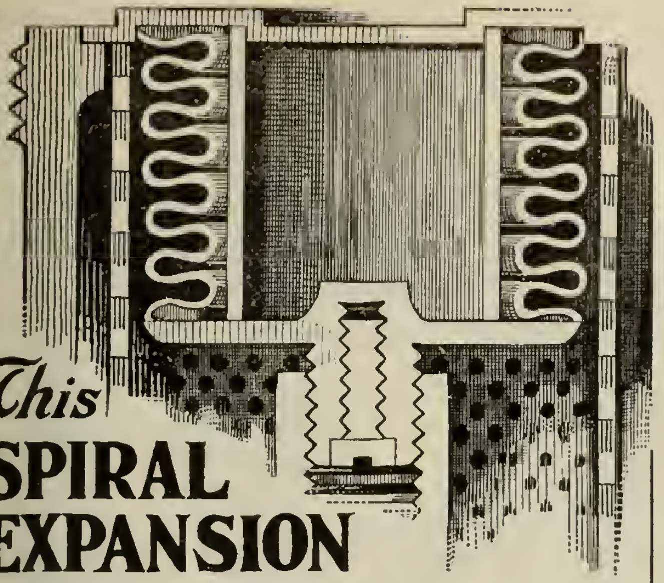
When Power is Off!

Towns without reserve equipment, or with massive cumbersome reserve plants that take hours to get in operation, dependent on one man, usually absent; such towns have no standby power plant.

At Markham, Ont., for reserve, a Northern 4″ 3 stage centrifugal, 600 Imp. G.P.M., 265 ft. head, 1,400 R.P.M., and a 100-H.P. STERLING high duty gasoline engine.

STERLING ENGINE CO., *(Dept. C-4)* **BUFFALO, N.Y.**

40 to 300 H.P. at 1,200 - 1,500 R.P.M.



This

SPIRAL EXPANSION

Gives Longer Life

Instead of an annularly corrugated expansion element, the Radiator Trap Sarco contains a spirally corrugated tube. With this design the movement at any turn of the tube is so slight as to be hardly detectable. The movement is distributed over the whole area instead of being confined to a few points, and this lengthens the life of the tube and the efficiency of the trap.

Wear on the valve is minimized, too. The bronze metal cone, which fits snugly into the socket seat, works freely in all directions, distributing wear evenly and insuring perfect contact at all times in the

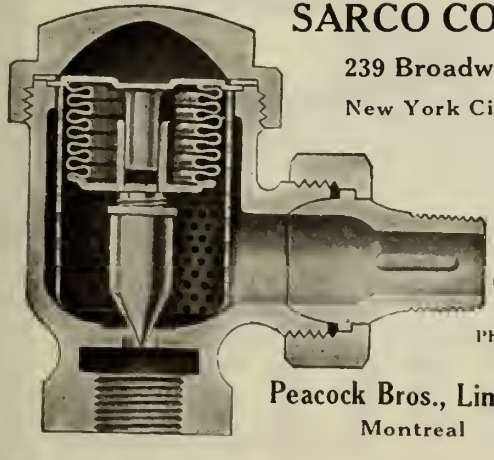
RADIATOR TRAP

SARCO

Another feature of the Sarco that adds to its long life is the construction which prevents scale and dirt collecting in the valve. Line contact only is had between the cone and seat of the valve and this makes it practically impossible for scale to collect. The Radiator Trap Sarco is of unusually heavy construction and it is factory adjusted.

Other important advantages are explained in our Booklet J-107. Send for it.

SARCO CO., Inc.
239 Broadway
New York City

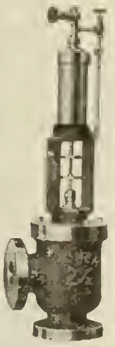


Buffalo
Chicago
Cleveland
Detroit
Philadelphia

Peacock Bros., Limited
Montreal

FISHER

TRADE MARK
REGISTERED



20 Years— Still in Service

W. B. Brady, Superintendent of a nationally known organization, says:

"The Fisher Governor which we installed in 1903 on our hydraulic pumps is still in service. Considering the length of time this governor has been in service, it is hardly necessary for us to give our opinion of its worth."

Fisher Pump Governor

(Type 1)

is our regular piston type governor which is so widely used and recommended for the automatic control of pumps. It is used on steam turbines, underwriters' fire pumps and pumps for water works, hydraulic elevators, boiler feed, railroads, mines, air compressors, etc.

Tested, approved and listed as standard by the National Underwriters' Laboratory.

Fisher Pump Governors are constructed in different types, handling up to 10,000 lbs. discharge pressure.

These governors are but a few of the complete Fisher Line. Our extensive experience with pressure regulating problems enables us to satisfactorily fill your every want — for pump governors, reducing valves, steam traps, float valves, etc.

Write for our interesting book,
"POWER PLANT SPECIALTIES."

The
Fisher Governor Company
941 Fisher Avenue, Marshalltown, Iowa, U.S.A.

Agencies in all principal cities

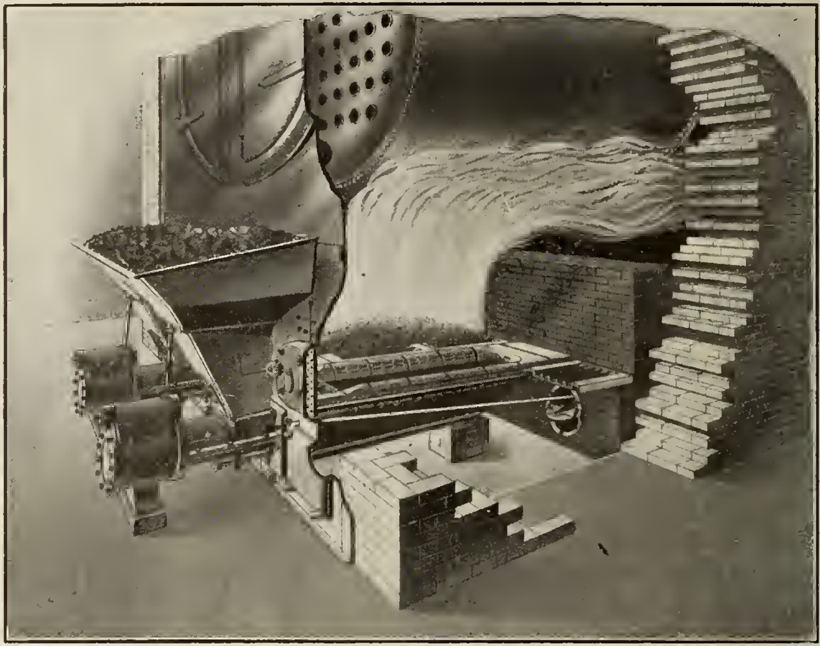
MACLEAN STOKERS

There's a Correct Way to Fire Your Furnace

to get the best results from every pound of fuel used, and that is by the method exemplified in the **MacLean Underfeed Stoker** which regulates both the supply of coal and air. The result is a large saving of coal because of complete combustion. The **MacLean Stoker** saves labor and needs little attention, meeting varying demands for steam automatically.

We will gladly estimate what the MacLean Stoker could save in your plant.

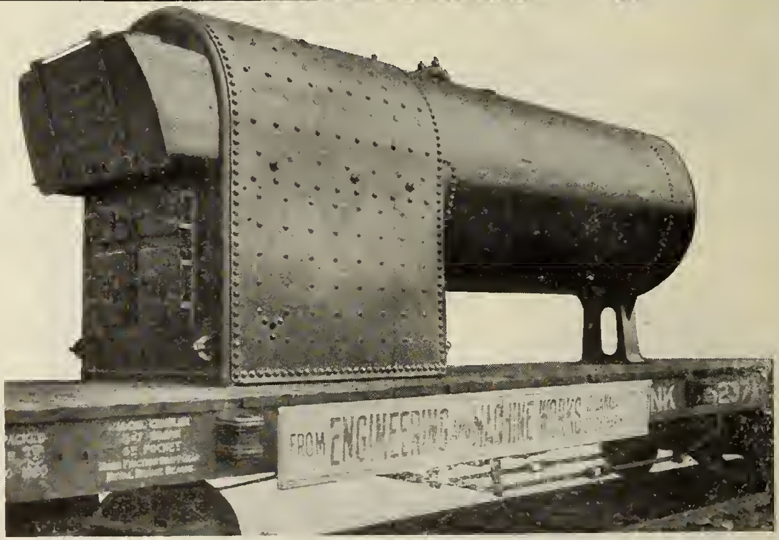
MacLean Underfeed Stoker Co.,
Limited
95-97 King Street East,
Toronto - Canada



The Coal It Saves Soon Pays Its Cost

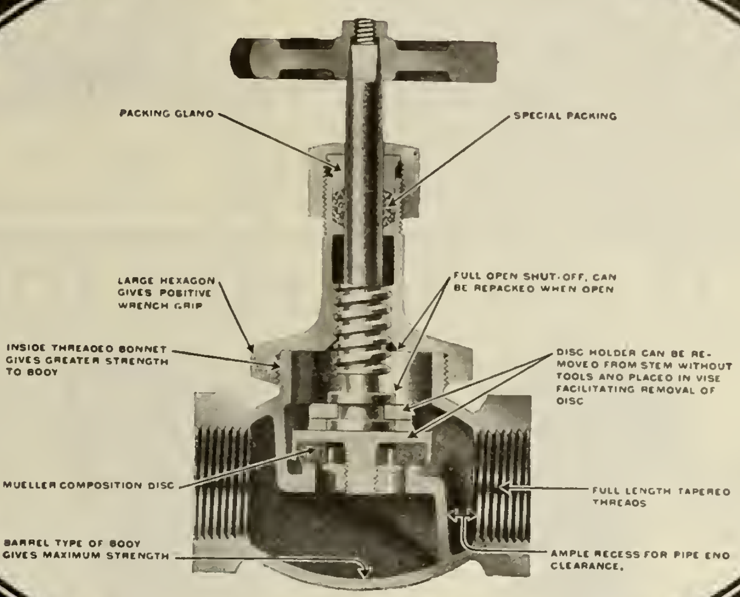
A First Class Heating Boiler

To ask a janitor to worry and fuss with a worn out, inadequate heating boiler is bad enough, but when the waste in fuel is considered, the loss will be seen to be serious. The Keystone Heating Boilers we make, in various sizes, with smoke consuming grate when required, are models of efficiency, economy and convenience. Costs low, too.



Engineering and Machine Works of Canada, Limited
ST. CATHARINES, ONT.
Eastern Sales Offices: HALL MACHINERY CO., Sherbrooke, Que. and Birks Bldg., Montreal

Make
Canada
Prosperous
by
Buying
Canadian
Products


PACKING GLAND
SPECIAL PACKING
LARGE HEXAGON GIVES POSITIVE WRENCH GRIP
FULL OPEN SHUT-OFF, CAN BE REPACKED WHEN OPEN
INSIDE THREADED BONNET GIVES GREATER STRENGTH TO BODY
DISC HOLDER CAN BE REMOVED FROM STEM WITHOUT TOOLS AND PLACED IN VISE FACILITATING REMOVAL OF DISC
MUELLER COMPOSITION DISC
FULL LENGTH TAPERED THREADS
BARREL TYPE OF BODY GIVES MAXIMUM STRENGTH
AMPLE RECESS FOR PIPE END CLEARANCE.

The Valve With Ten Points of Excellenec

Compare the valve of any other make with this Mueller Steam Valve A-3006—test them—and note the result. This Mueller valve is a great achievement and has incorporated in its design all the up-to-date features experience has proved to be of value.

The ten good points of the Mueller A-3006 are shown in the above illustration. If you use valves, write and we will be pleased to send you a sample.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Ill., U. S. A. **Branches, New York and San Francisco**
Mueller Metals Co., Port Huron, Mich.; Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

© 1917 H M Co

FLAME BRAND

HIGH TEMPERATURE CEMENTS

RED FLAME
PLASTIC CEMENT
WHITE FLAME
INSULATING CEMENT
BLUE FLAME
FIRE BRICK CEMENT

"MONO" TRADE MARK
REG U.S. PAT. OFF.
BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE

KING REFRACTORIES CO. INC.

SOLE CANADIAN REPRESENTATIVES:

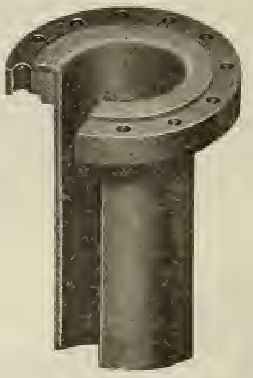
GRANT E. COLE CO.

Represented in
VANCOUVER, WINNIPEG,
MONTREAL, HALIFAX

21-23 River St.
TORONTO, CANADA

P♔H FLANGED PIPE JOINTS

SCREWED



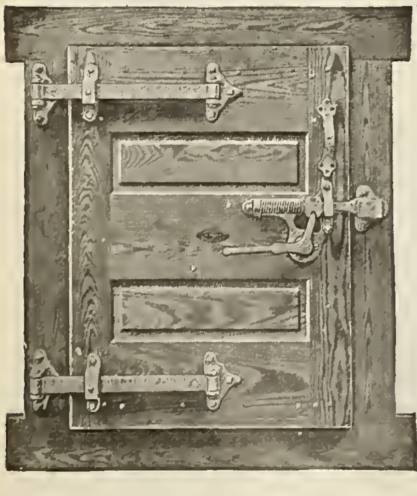
P.H. LAP

P♔H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

Head Office: 100 CHURCH STREET, TORONTO, Ont.

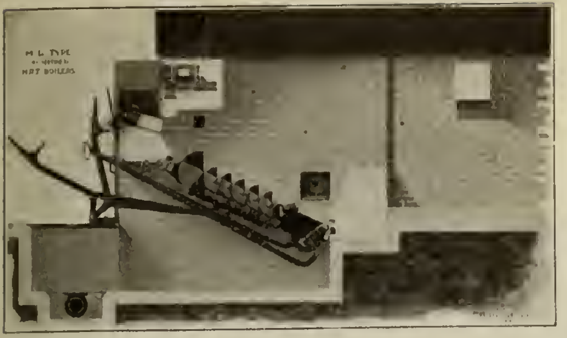


Jamison **HEAVY DUTY**
Cold Storage Doors
Scientifically Built

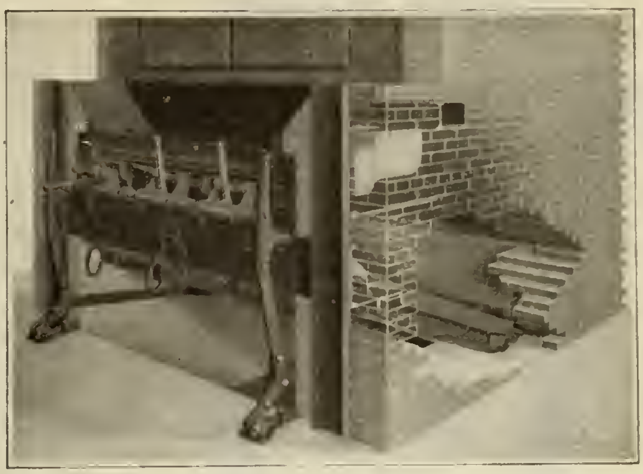
The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

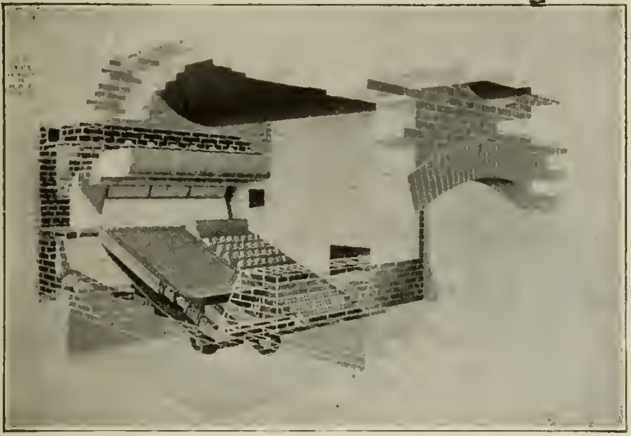
Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)
HAGERSTOWN MARYLAND, U.S.A



Type M.L. as applied to H.R.T. Boilers





The COKAL HOPPER-FEED STOKER

—for the plant that puts service ahead of "frills"—

THE CoKal Stoker has been installed in hundreds of prominent plants, not because it costs less but because the management was convinced that a stoker costing twice as much could accomplish no more.

These plants were willing to pay any amount for stoker service—but not one cent for frills! They wanted an "automatic" stoker, until they found that the CoKal, although not called automatic, did exactly what "automatic" stokers do. Then they refused to pay a premium for the word "automatic." If you want a full-fledged mechanical stoker—and won't become prejudiced because its price is much lower as a result of eliminating costly frills—then you will be interested in the new CoKal Hopper-Feed type.

How the fuel is mechanically fed and distributed is explained by the illustrations. Half swings of the long levers distribute the coal lengthwise and sidewise, filling up holes in the fuel bed and insuring even burning. A few swings of the short levers operating the feeder blocks force the fuel onto the stoker. Little if any more labor is required than is demanded by an automatic stoker—and the power drive of the automatic type, with its many expensive auxiliaries, is eliminated, permitting a far lower first cost. The "Coke-All" method of combustion means maximum fuel economy. Extreme simplicity insures reduced maintenance cost. Boiler capacity is greatly increased. Hand cleaning of fire is eliminated. No stoker is more responsive to load demands. Heavy peak loads are easily met.

Get the whole story of mechanical stoker service at hand stoker cost. Ask for booklet to-day.

GENERAL ENGINEERING COMPANY REG'D.

SUCCESSORS TO

GELINAS & PENNOCK Reg'd.

207 St. James St. Montreal, Canada

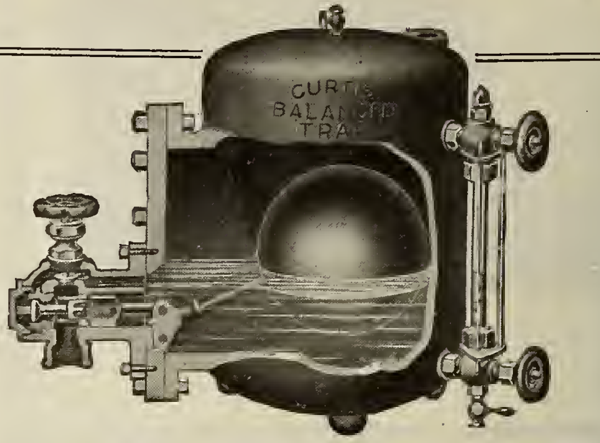
Better tools make better workmen and there are no better tools than

WILLIAMS'
SUPERIOR DROP-FORGED HAMMERS
ALL KINDS; ALL SIZES.

Made-in-Canada

J. H. WILLIAMS & CO., Limited
"The Drop-Forging People"
78 Thorold Road St. Catharines, Ontario

Curtis Engineering Specialties

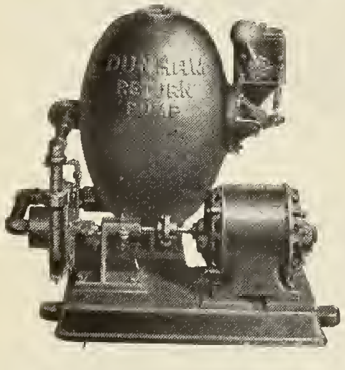


Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

Write for our No. 50 Catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.



The Dunham Return Pump
Type R. L. P.

HANDLING CONDENSATE
WITH THE
DUNHAM RETURN PUMP

This Dunham Return Pump is designed to automatically pump condensate from heating systems, or process work, back to boiler, heater, hot well or other storage. It is an automatic, electric driven, centrifugal pump, stopped and started from a float switch.

The waste of condensate from heating systems where returns are below the boiler water line can be entirely eliminated by the use of the Dunham Return Pump. The condensation from the heating system is returned to the boiler as it accumulates, resulting in improved heating and a saving of fuel.

Dunham Return Pumps are absolutely automatic in action and operate without attention, day or night. There are none of the difficulties caused by low pressure steam pumps when fires are banked for the night.

Full particulars will be sent upon request.

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE
(Made in Canada)

C. A. DUNHAM CO., Limited, TORONTO, ONT.
Halifax Vancouver Winnipeg Ottawa Montreal Calgary
London : 18 St. Thomas St., S.E.1.

The New Mount Royal Hotel is one of many Canadian installations of

The Taylor Stoker

That this new and up-to-the-minute hotel should be Taylor Stokered is not surprising for gradually the Taylor Stoker is becoming recognized as the safest investment where steaming capacity with absolute reliability is imperative.

Adaptability, flexibility, ease of operation and upkeep and economy of fuel and space are other features that are causing discerning engineers to specify Taylor Stokers.

Among our many other Canadian installations are the following:

Atlantic Sugar Ref. Co.,	4000	RBHP	Ford Motor Co.	3400	RBHP
Bathurst P. & P. Co.	1000	"	Goodyear T. & R. Co.	2100	"
Brunner Mond Co.	3600	"	Montreal L., H. & P. Co.	6000	"
Dominion Coal Co.	2000	"	Proctor & Gamble Co.	2600	"
Dominion I. & S. Co.	2800	"	Public Service Corp.	1200	"
Dominion P. & T. Co.	6600	"	Riordon Co., Ltd.	5700	"

St. Maurice Paper Co. 600 RBHP

If you are not entirely familiar with the features of the Taylor Stoker that make it a most profitable investment in any boiler room we will be pleased to furnish full details upon request.

THE TAYLOR STOKER COMPANY, LTD.

TORONTO, ONTARIO

Principal Sales Office: 416 Phillips Place, Montreal, Que.

WEIR PUMPS—of Course

Installed in the Mount Royal Hotel

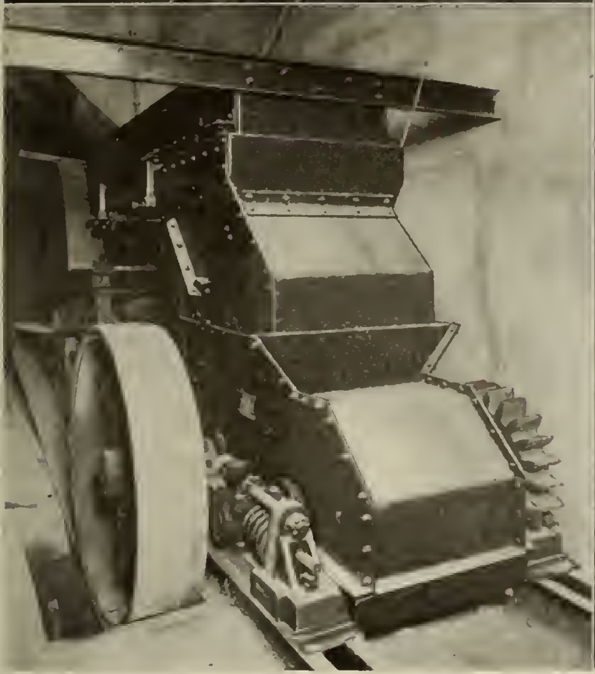
It is only fitting that the largest hotel in the British Empire should be equipped with "WEIR" Boiler Feed and General Service Pumps.

RELIABLE ECONOMICAL

We will help you solve any practical pump problem. WRITE US.

PEACOCK BROTHERS LIMITED

MONTREAL



MOUNT ROYAL HOTEL IS LINK-BELT EQUIPPED

The Mount Royal Hotel can point with pride to the modern and efficient method of handling coal and ashes in their boiler house. Both the coal and ashes are handled by Peck Carriers—a sturdy, dependable machine which has been adopted by many of the foremost power plants of North America.

The choice of Link-Belt equipment was in direct keeping with the Mount Royal's ideas of power plant efficiency and economy of operation.

The illustrations show views of the Peck Carrier, upper and lower runs, and the Link-Belt coal crusher.

Let us send you in convenient form, further information on the efficient handling of coal and ashes. Write for Book No. 220

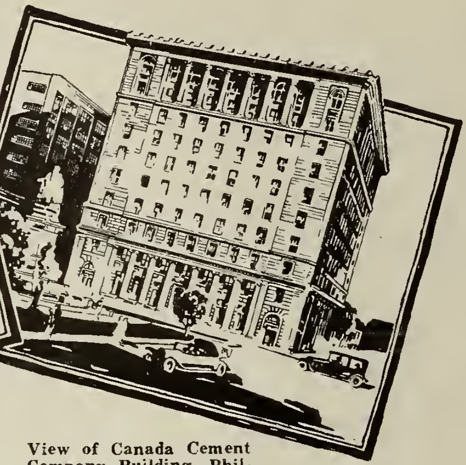
1145

CANADIAN LINK-BELT COMPANY LIMITED

TORONTO—Wellington & Peter Sts.
MONTREAL—10 Gauvin Lane

LINK-BELT

View of new Mount Royal Hotel, Montreal, Completed 1922.



View of Canada Cement Company Building, Phillips Square, Montreal, Completed 1922.

Artistic, Fire-Resisting Buildings of Concrete

The new Mount Royal Hotel and the Canada Cement Company Building add to the architectural achievements of Canada's greatest city.

It is particularly gratifying to have Concrete and Concrete products aid in this accomplishment. The facing and stone trim, manufactured by the Canadian Benedict Stone Co., Ltd., in Montreal, is used on the Mount Royal Hotel. The same stone is used on the Canada Cement Company Building.

This manufactured stone is reasonable in cost as well as pleasing in appearance. It is being used in many of the important structures now under construction in Ontario and Quebec.

The foundation and floors of the new hotel are reinforced concrete and the Canada Cement Company Building is Concrete throughout.

These two beautiful structures are fire-resisting—a most important consideration in a hotel and office building. Our confidence in the fire resisting qualities of the Canada Cement Company Building is evinced by our decision to carry no insurance whatsoever on the building.

We have literature on the possibilities of Concrete in office buildings.

We shall gladly mail copies free to anyone interested.

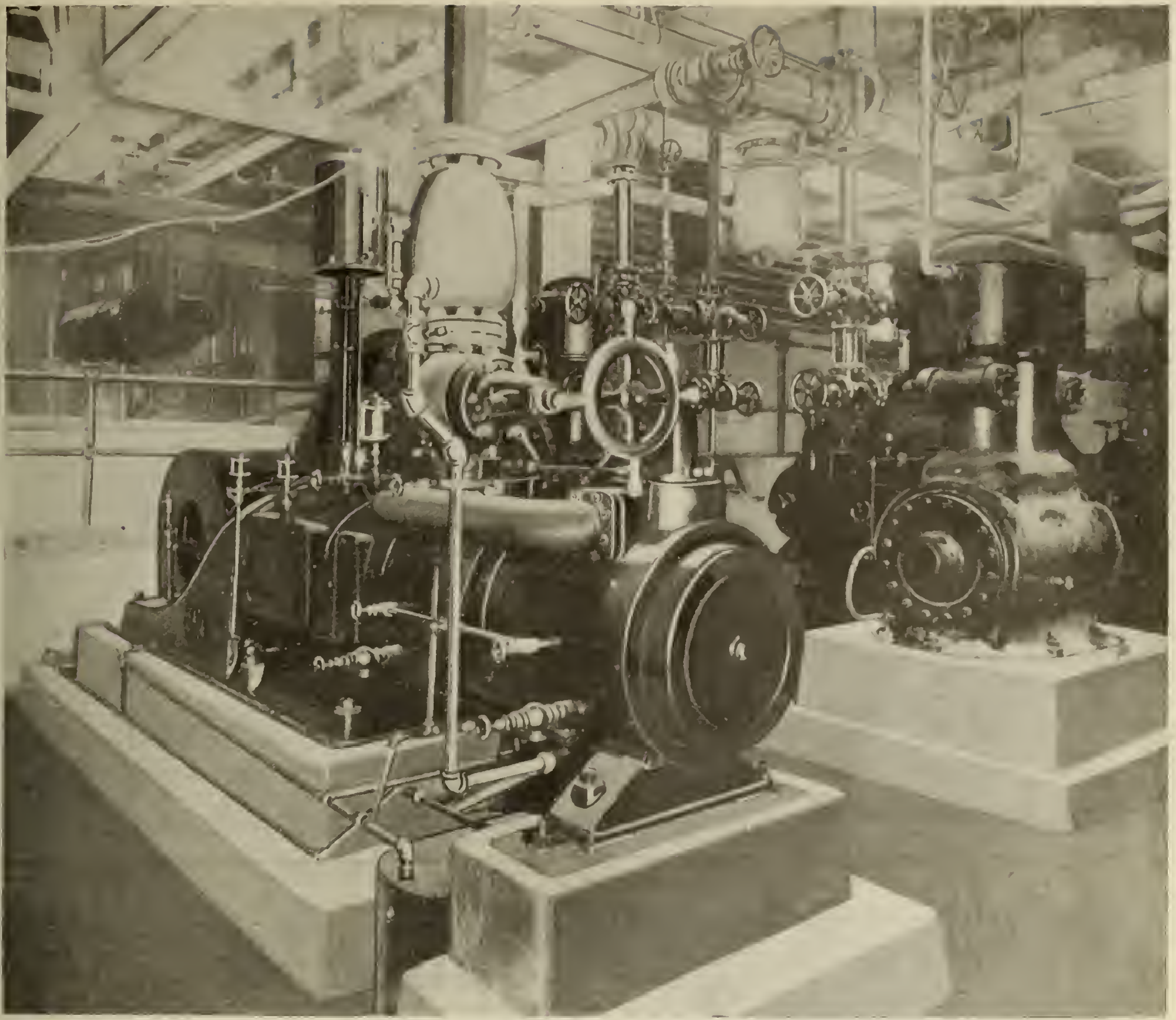
CANADA CEMENT COMPANY, LIMITED

Canada Cement Company Building - Phillips Square, Montreal

Sales Offices at

Montreal Toronto Winnipeg Calgary

CANADA CEMENT
CONCRETE
FOR PERMANENCE



View showing Frick Uniflow Engine Driven Ammonia Compressors in Main Refrigerating Plant of the Mount Royal Hotel

A unique feature of this installation is that the ammonia compressors are driven by Frick Uniflow Poppet Valve Steam Engines—the first to be installed in Canada. The Uniflow principle reduces cylinder condensation to a minimum while the poppet valves permit operation at high speed and with high temperature steam, thus effecting an economy never before reached with steam engines.

In addition to the main plant, a separate automatically controlled Frick refrigerating unit is installed on the 11th floor of the hotel to take care of the requirements of the kitchen, dining room refrigerator, etc., in connection with the convention halls and grand ball room.

The world wide reputation of Frick ice-making and refrigerating machinery and the satisfactory service it is giving everywhere made "Frick" the natural choice for the Mount Royal Hotel.

Frick Company Established 1853 Incorporated 1885 **Waynesboro, Pa.**

Manufacturers of Ice Machinery Superior since 1882

MOUNT ROYAL HOTEL, Montreal

In the Power Plant of this new hotel which is described in a leading article in this issue, Bailey Meters are used for the measurement of steam generated and distributed.

Each boiler is equipped with a Bailey Boiler Meter that indicates, records and integrates Steam Flow, records Air Flow, Flue Gas Temperature and Steam Pressure on a single chart.

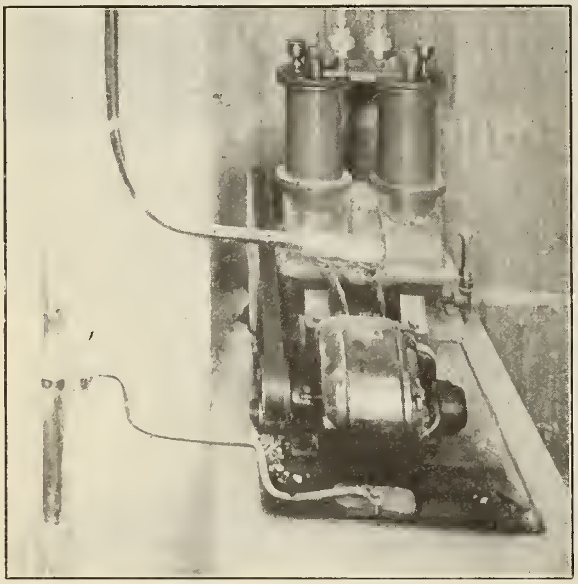
The total feed water is measured by a meter that records and integrates the Flow of Water and records Water Temperature. Meters to record and integrate Steam Flow are used on the steam lines to the kitchen and the laundry.

With the whole story on the chart there is no guess work about the results being obtained.

Made in Canada

BAILEY METER COMPANY LIMITED

177 Delorimier Ave. **Montreal, Quebec**



Robbins & Myers

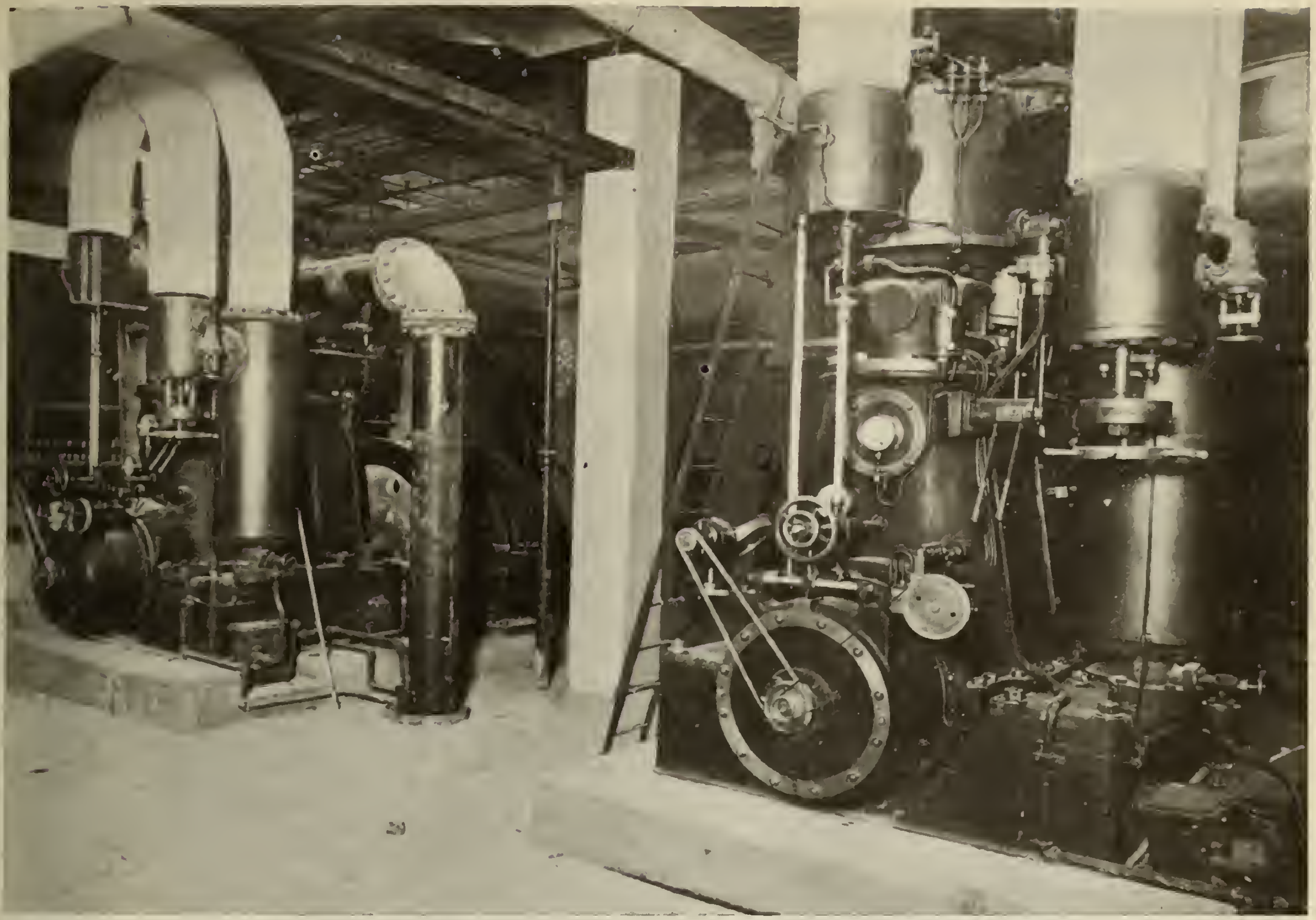
Motor and Air Compressor Installed in the Mount Royal Hotel Montreal

It is a noteworthy fact that wherever unfailing reliability is essential, the choice naturally turns to R. & M. equipment.

Because of their absolutely dependable service and low maintenance cost, R. & M. products are found in every class of industry, whether the service conditions are normal or severe.

Robbins & Myers Co. of Canada, Limited

Brantford, Ontario



Belliss & Morcom Equipment

IN THE

"Mount Royal"

Following the lead of many of Canada's most modern plants, Belliss & Morcom Equipment was chosen for the "Mount Royal."

Illustration is from a photograph showing installation of two Electrical Generators, driven by two Belliss & Morcom Vertical High-Speed Compound Steam Engines.

The high standard of quality embodied in the design of these Belliss & Morcom Engines is characteristic of all power plant equipment handled by us.

We are experts in the design and installation of power plants—prepared to advise and co-operate in every way to secure the best results as to Economy and Efficiency in your plant. Put your most difficult problems up to us.

Send us your enquiries for Steam Engines, Gas Engines, Oil Engines, Diesel Engines, Steam Turbines, Air Compressors, Condensing Plants, Centrifugal Pumps, Boiler Feed Pumps, Water Meters, Hydraulic Pumps, Pressure Filters, Gravity Filters, Water Softening Plants, Refuse Destructors, Activated Sludge Sewage Disposal Plants.

Laurie & Lamb

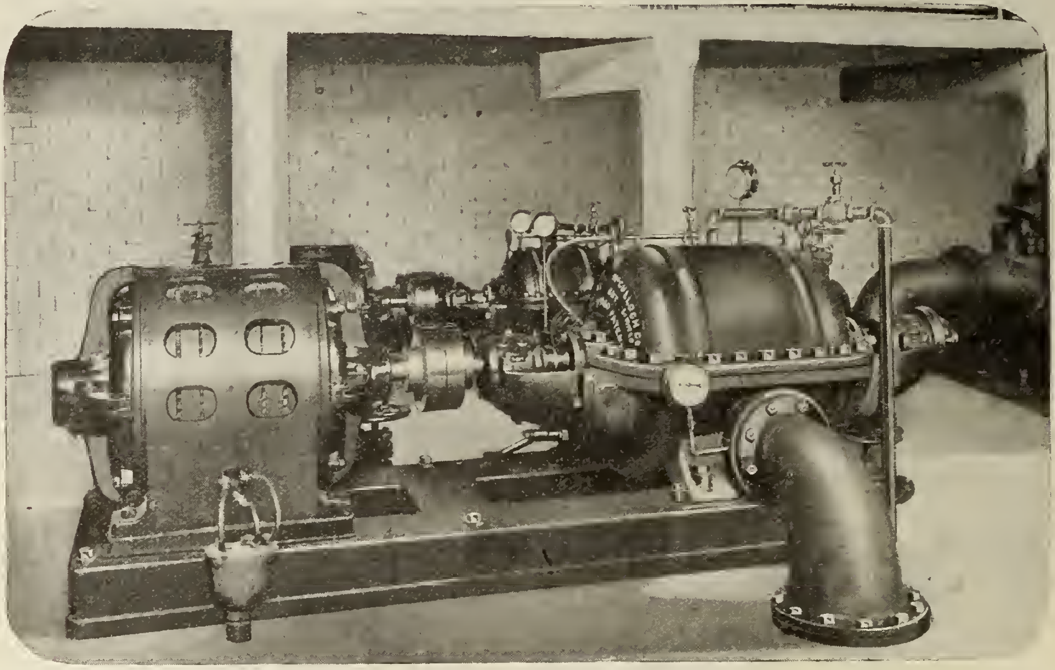
Engineers

BOARD OF TRADE BLDG. MONTREAL, QUE.

GMC

GOLDIE & McCULLOCH
Dependable Power Plant Equipment

Efficient
Operation & Repeat Orders



The two Pumps shown have been in operation at the Guelph Waterworks Pumping Station for about two years, since which time two more Motor Driven Rees Pumps have been installed and we are at present building two Gasoline Engine Driven Pumps for this same plant. Many other original installations have been followed by repeat orders which can mean only one thing—satisfied users.

REES RoTURBo PUMPS

are made in several different types and to suit any and every pumping condition. Ask for Catalogue, Prices, etc.

THE GOLDIE & McCULLOCH CO.,
LIMITED.
Head Office and Works, GALT, Ontario, Canada

Toronto Office
Suite 1101-2,
Bank of Hamilton Bldg

Quebec Agents
Ross & Greig
400 St. James St., Montreal

Western Branch
248 McDermott Ave.,
Winnipeg, Man.

British Columbia Agents
Robt. Hamilton & Co.,
Vancouver, B. C.

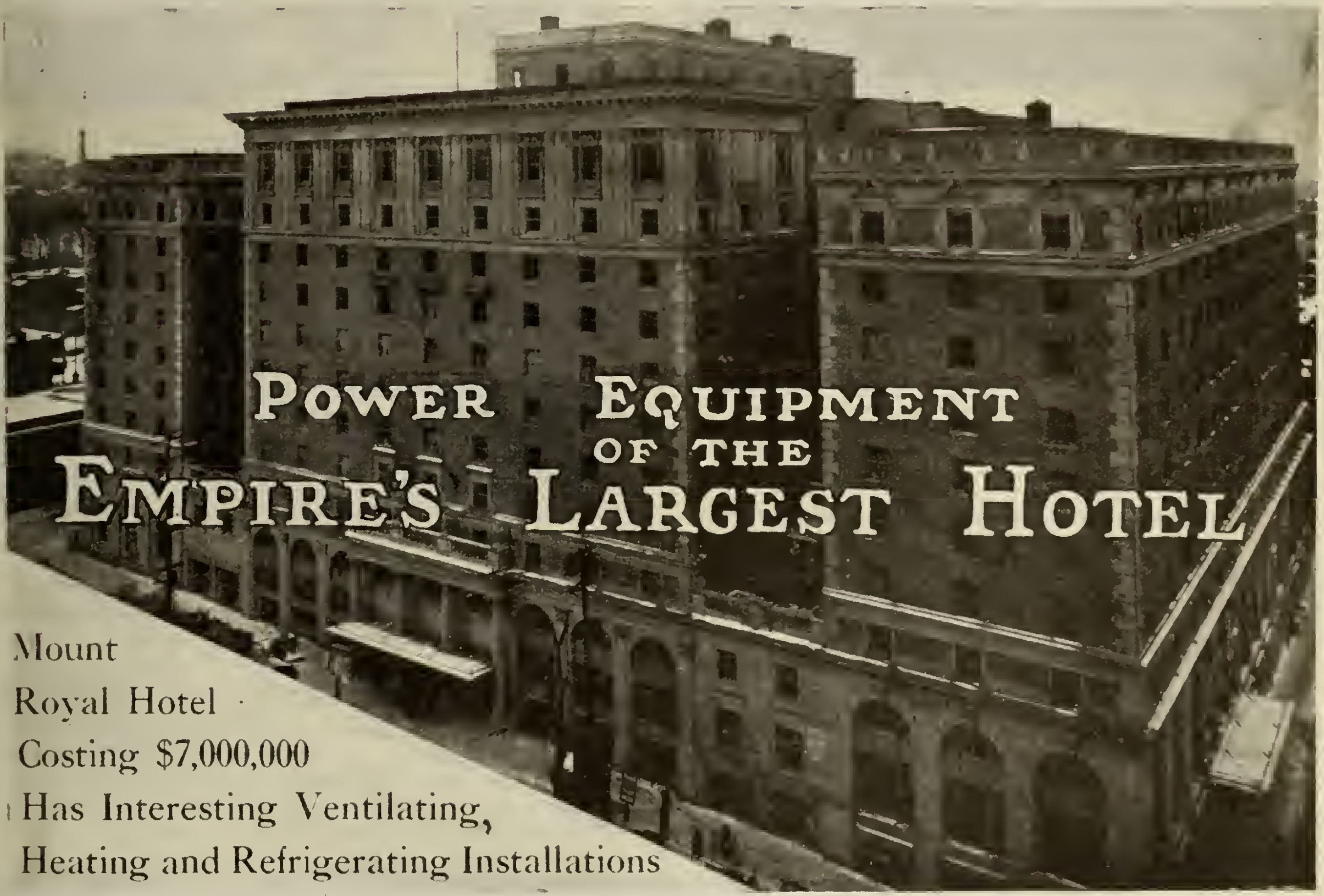
POWER HOUSE

Members of the
Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly



POWER EQUIPMENT OF THE EMPIRE'S LARGEST HOTEL

Mount Royal Hotel Costing $7,000,000 Has Interesting Ventilating, Heating and Refrigerating Installations

By J. G. Soucy

DURING the last 10 years there has been felt a growing need for additional hotel accommodation in Montreal, designed not only to meet the needs of the travelling men and the ever-increasing number of tourists, but to meet the growing demand for better and larger accommodation for general conferences and international conventions. The Mount Royal, with its many beautiful and convenient appointments, was the logical outcome of such an unmistakable demand. The hotel is under the direction of the United Hotels Company of America.

Much could be written about the commercial importance of this enterprise from both a national and an international aspect, but the outstanding purpose of this article is to describe features of the power plant equipment, which are of particular interest to our readers.

The hotel has a most convenient location, just one block north of the busy corner of St. Catherine and Peel Sts. The main entrance is on the east side of Peel St. It is in the heart of Montreal's busy shopping district and convenient to all theatres, railroad depots and boat landings.

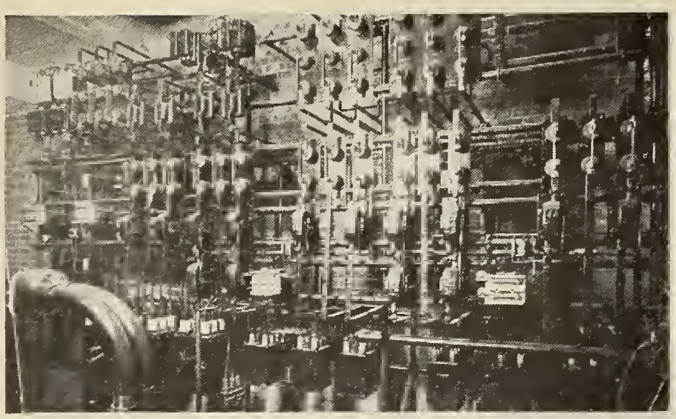
Just north of it is Mount Royal and to the south flows the majestic St. Lawrence, with its important shipping facilities. To the east are to be seen large industrial centres, here and there studded with churches and office buildings. A little to the south, is the great financial centre, while to the west are fine residential districts.

The Finished Undertaking and General Plan

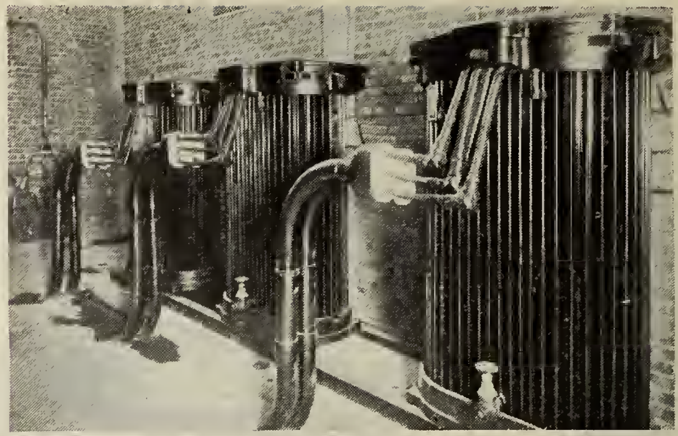
Some idea of the magnitude of the undertaking may be gained from the fact that the building is 130 feet high, occupies a space 306 ft. long by 227 ft. wide, or an area of 70,000 sq. ft., weighs approximately 150,000 tons; it has cost more than $7,000,000 to build and required over one year to complete. There have been more than 1,500 men employed directly on the site, which included laborers, mechanics and artists; besides a large staff of expert architects, accountants, draftsmen, mechanical and electrical engineers, superintendents, supervisors and inspectors.

Away from the site, hundreds of workmen were provided employment in quarries and forests, brick-kilns, cement works and saw-mills, steel works, foundries, and machine shops; various kinds of factories and warehouses, in stores and studios, all for the purpose of providing structural beauty and supplying necessary comfort to the travelling public.

Besides being one of the finest hotel buildings in Canada from an architectural standpoint, it is fireproof throughout. It is the largest hotel in the British Empire, if not in the world. It has 1,100 rooms with bath and toilet conveniences, a large, commodious vestibule and main corridor, as well as two large convention halls. One of these halls, known as the grand ball room, has a seating capacity of 2,000 and the other of 1,200; also, there are several private dining rooms besides the large main dining room.



High Tension Bus-Bars.



High Tension Transformers.

The ground floor is occupied by stores and there are 10 stories above for the accommodation of guests, the tenth floor being used for banquet and convention halls. In the "Pent House" above the roof, additional separate and complete units for ventilation, refrigeration, etc., are installed. The ground floor further contains the most complete and up-to-date kitchen bake ovens, cold storage, refrigerators and general storage spaces. Below is the basement which contains the most modern laundry equipment, refrigerating and ice-making machinery, also power plant for heating, lighting, ventilation, steam-driven refrigerating apparatus, steam-driven electrical generating sets and switchboards, also water softening and filtering systems.

Architecture—Georgian and Italian Renaissance

The exterior architecture of the building is "Georgian," and the materials used were well selected for the style so adopted. The principal materials used consist of Stanstead granite and Canadian Benedict buff stone also Hocking Valley and Upper Kittanic light buff brick. The interior design is generally what is known as "Italian Renaissance."

The "Georgian" is a neo-classic style of architecture which flourished in England from 1715 to 1800, during the reign of the Georges. It is a combination of the Italian and the Palladian styles, divested of excessive ornamentation.

The architects were Ross & MacDonald, 1 Belmont Place, Montreal. The general contractors were Thompson, Starrett Company, Ltd., Drummond Building, Montreal, A. G. Moulton, vice-president and general manager.

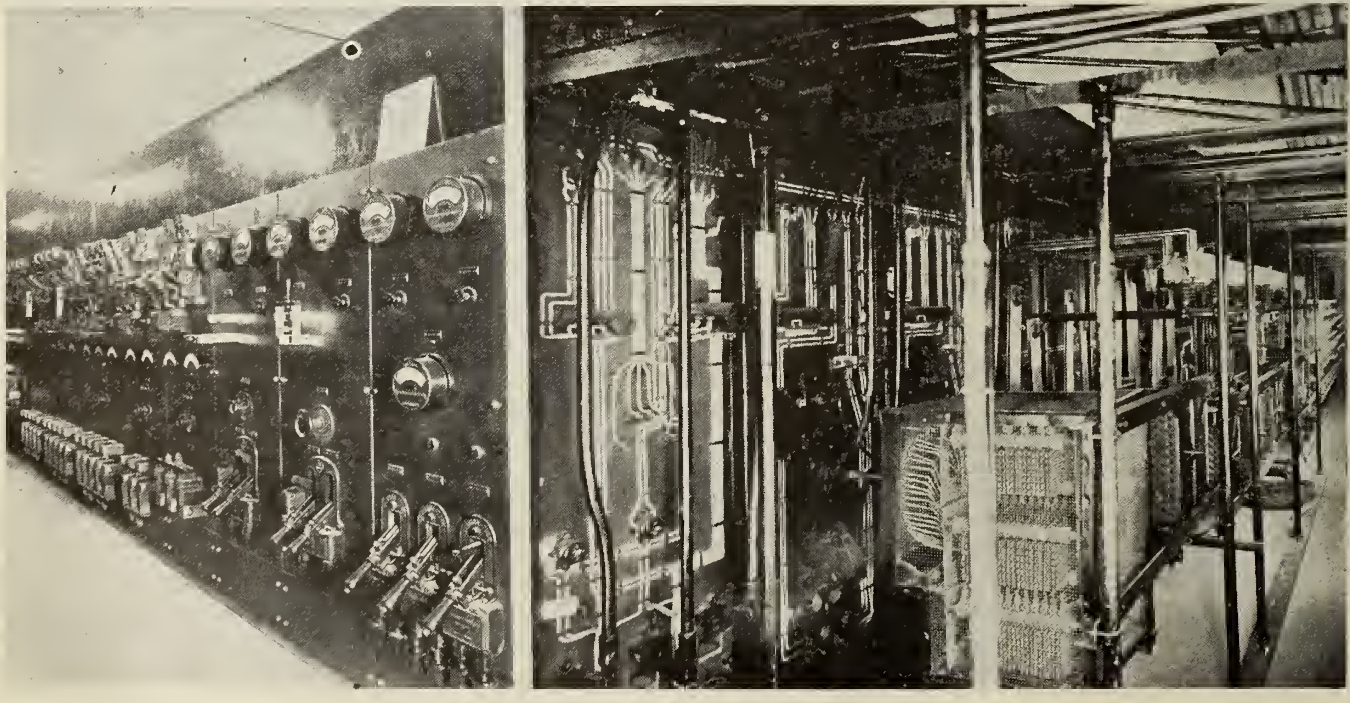
Power Plant and Equipment

Some idea of the amount of power plant equipment required to meet the needs of this hotel may be gained from the fact that there is about 8,000,000 cubic feet of space to be lighted, heated and ventilated; besides the fact that the hotel may be called upon to entertain, feed and otherwise look after the personal comforts of four to five thousand people at any time, and provide sleeping quarters, fully equipped with bath, toilet, etc., for 1,100 to 2,500 persons.

The basement and sub-basements are probably better ventilated than the average hotel or private home, and the whole arrangement is so complete in every detail that nearly all the wants or needs of its patrons can be supplied within the confines of this building.

Ample space and capacity is provided for store-rooms, kitchen bake ovens, laundries, work-shops, ice-making, refrigerating and cold storage; also an abundant supply of fresh air and cold drinking water to each room.

The drinking water is supplied from an artesian well, 10 inches in diameter and 830 feet deep, (875 feet below street level). The well penetrates and gets its supply from two veins, located respectively at levels of 362 and 830 feet below the basement floor. The supply would seem ample, as a test made showed a capacity flow of 7,200 gallons per hour of pure water at 42°F. The water is elevated from the 91 foot level



Main Switch Board Showing Equipment on Front and Back.

by means of an Ingersoll-Rand A No. 7 Type V.A. Imperial air lift or ejector, and the air compressors used will be described later in this article. The water, after passing through suitable filters, is circulated through brine-cooled coils which reduces its temperature to that desired for human consumption. The brass pipes through which it is circulated are all covered with heavy cork insulation made by Armstrong Cork Company, Montreal. The surplus water goes into the two large storage tanks on the roof used for general supply.

Coal Handling Equipment

The coal is provided in carload lots, or unloaded from boats at Windmill Point, and hauled in 5 ton trucks to the site where each load is carefully weighed on a Canadian Fairbanks-Morse platform scale after which it is dumped into one of the four manhole openings in the sidewalk, all of which are directly over the large coal storage bunker space provided. The storage capacity of the main coal bunker is 500 tons, and the general dimensions are 30 x 100 x 30 feet high.

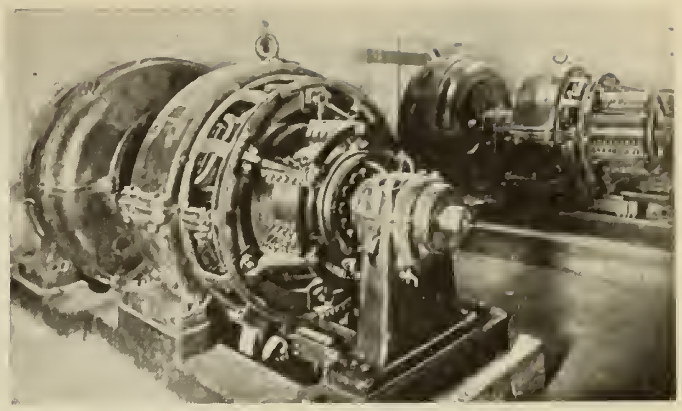
Elevator Controls "Pent House."

Coal in storage is reclaimed by means of openings in the floor leading to hand controlled loading or feeding chutes which discharge into the bottom or horizontal section of a Canadian Link Belt bucket type of "Peck Carrier." This conveyor has a capacity for reclaiming coal at the rate of 20 tons per hour.

Gauge Board in "Chef's" Room.

Run-of-mine coal is dumped into a large steel hopper over the crusher section of the conveyor, while stock coal is unloaded over any one of the four other openings and falls directly into the main storage space provided in front of the boiler. One of the special features of the conveyor system is, that all three motors used are connected in series so that, in case of a break-down, plugging is avoided as the crusher and feeder motors would be stopped automatically, in case the conveyor section is not running.

The electric motors used in connection with the coal conveying apparatus are all of the 220 volt, d. c. General Electric shunt wound type. They vary in size as follows: The feeder motor is 5 h.p., the crusher motor is 15 h.p. and the conveyor driving motor is 5 h.p.

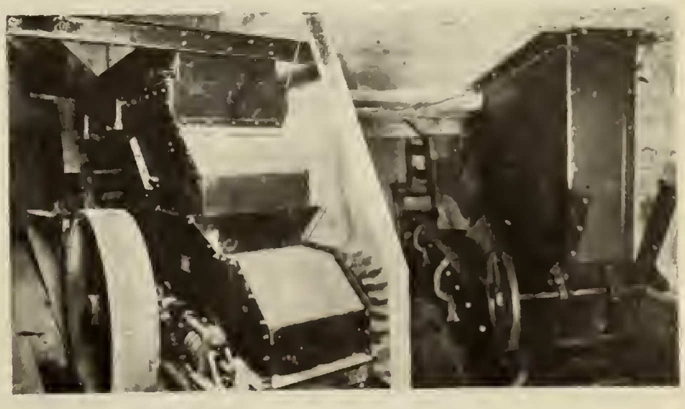


Motor Generator Sets.

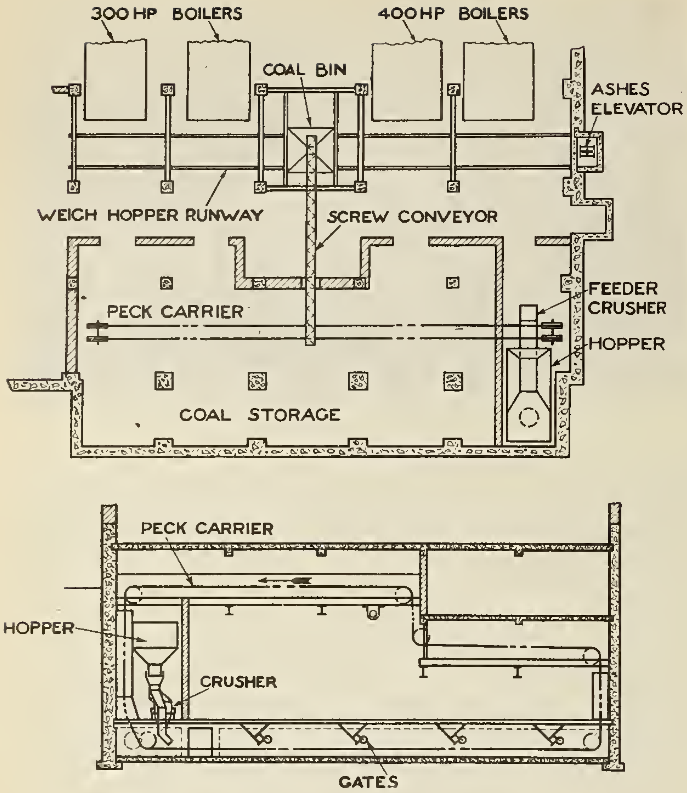
Coal is elevated about 25 feet from the coal-tunnel where it is discharged into a cross-conveyor of the helicoid or "screw type," which empties into an elevated steel bunker of 6-ton capacity, made by the Dominion Bridge Company. The coal from this bunker is discharged into a travelling (combined hopper and weigher) "larry" of 1,000 lbs. capacity, with scales made by the Standard Supply Co. of Pittsburg, Pa., through the Canadian Link Belt Company. The "larry" illustrated here is moved along from one boiler to another by hand and the

VISION — THEN AND NOW

INDOMITABLE faith and wonderful vision are terms that have been frequently used in descriptions of the New Mount Royal Hotel. It may be interesting to recall that faith and vision had much to do with the founding of Ville Marie de Montreal in 1641—1642. The romantic story had its beginning in Old France where one, Jerome de la Dauversiere, desirous of launching some plan whereby the red men of Canada might be won over to Christianity, claimed to have been told by an angel that the first step toward this object would be the setting up of a mission on the Island of Montreal. From this inspiration developed the expedition of Maisonneuve who, with a company of fifty, landed on the site of the future metropolis some two hundred and eighty years ago. The spot had been visited by Cartier one hundred years before, but there had been no subsequent settlement. Not long did the Iroquois permit the newcomers to remain unmolested and the story of Maisonneuve's heroic defence is one of the finest epics of early days in this country. His memory has been perpetuated in graceful form by the statue in Place d'Armes Square. It is from this spot that the eastern metropolis has radiated with characteristic faith, courage, perseverance. Maisonneuve and his little company might easily lose themselves in the splendid structure that has just been completed. It is not the only instance in Canadian history where the visit of a missioner has formed the foundation for modern perspective and enterprise.



Coal Crusher and Loading Chutes.



Plan and elevation of coal bunkers and conveyor.

coal is discharged or unloaded, as required, into the different stoker hoppers—the coal being automatically fed from the hopper to the stoker. Plan view of the coal conveying and ash handling system is shown herewith.

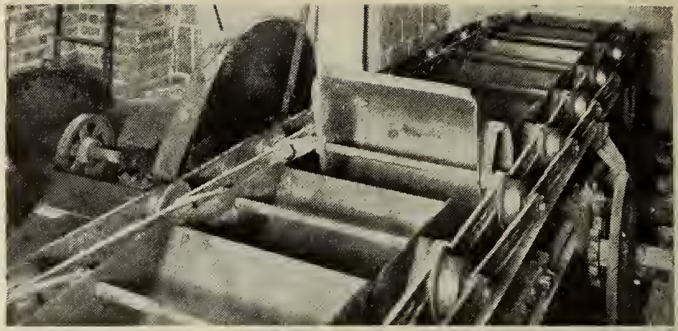
The power plant proper consists of 4 Robb water tube boilers, 2 steam-driven generators, 2 steam-driven feed pumps, 2 steam-driven vacuum pumps, 2 steam-driven supply pumps, 2 air compressors (one steam-driven and one motor driven); 2 steam-driven refrigerating machines, 2 motor generator sets and large motor-driven ventilating fans, motor-driven elevator hoists and numerous smaller electric driven circulating and sump pumps. The boiler and engine room floors are approximately 30 feet below the street level and the main portion of the power plant is located in the north-east portion of the sub-basement or near the corner of Burnside and Medcalf Streets.

About 10 feet below the boiler room floor is the smoke tunnel, ash pit tunnel and coal conveyor tunnel. The bottom horizontal section of the coal conveyor is about 100 feet long.

Boiler Room Equipment

There are installed in the boiler room 4 Robb water tube boilers. Two of the boilers are of 400 h.p. capacity each and two others are of 300 h.p. each, making a total of 1,400 h.p. installed. The boilers are of the double cross-drum type and designed to carry 160 lbs. pressure.

They are not equipped with regular super-heater units, although there has been provided a special superheating feature, the top rows of tubes being so designed that the equalizing steam passing through them is exposed to the hot combustion gasses in the first stage or pass. The boiler ratings are based on the usual formula of 10 sq. ft. of heating surface per h.p. The boilers are supported upon steel columns, made by the Dominion Bridge Co., and erected by the Engineering Sales & Service Company, Montreal. The boilers are equipped with Turner baffles, which together with the brick settings, and furnace linings, were installed by Mander & Lucas. The furnaces are lined with Glenboig fire brick and the back passes with Lumber City fire brick. The boilers are all equipped with stokers, furnished by the Taylor Stoker Company of Canada, Limited. Two of the stokers have 3 retorts each and the two others 4 retorts each, there being one retort per 100 h.p. demand. Each retort is provided with 17 tuyeres. The stokers are driven by 4 12½ h.p. vertical steam engines. The stokers are intended to burn either anthracite screenings or slack (bituminous) coal or a mixture of both. The overload capacity of these stokers is 200% of rating.

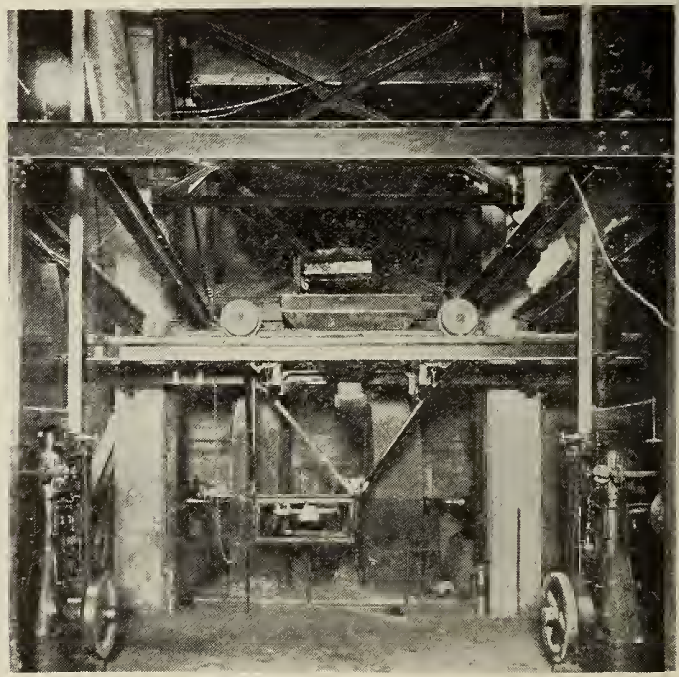


Coal Conveyor.

The compressor plant is described as comprising an Ingersoll-Rand class ER-1 single stage straight line short belt motor driven air compressor equipped with the latest type of I-R plate valves, permitting higher overall efficiency than any similar equipment yet produced. This unit is used for regular operation, and for standby purposes, an Ingersoll-Rand class FR-1 I-R single stage straight line steam driven compressor is installed. This machine is also equipped with the latest type of plate valves and I-R balanced piston steam valve. An unique feature of the compressor or plant, which is strictly up-to-date in all respects, is that special precautions were made to prevent the noise of operation from travelling throughout the building.

The advantages of this plant are extreme simplicity and reliability, large capacity, limited only by the source of supply, low maintenance cost and great flexibility. A further advantage is that the water is very thoroughly aerated by the amalgamation of the air and water passing through the discharge pipe. The extensive aeration to which the water is subjected and the natural filtration due to the subterranean sources of supply produce a pure undefiled water which is particularly adapted to hotels, breweries, bottling works and municipalities.

The advantages of the particular type of pump installed are: Realization in the most efficient manner of all of the advantages to be gained by use of an air lift pump. In practice the air in the Type "VA" Pump is divided into fine streams



Coal Bunker and "Larry" in Boiler Room.

which is an essential requirement in air lift pump efficiency.

A proper amount of back pressure is held in the pump and prevents sudden rush of air due to the coalescence of bubbles and lightening of the discharge column. There are no moving parts whatever. The foot piece offers a smooth, unobstructed entrance and discharge chamber. There are no nozzles or obstructions.

It is impossible to prevent scale and dirt passing down the air lines into the pumps, consequently provision must be made to eliminate any such trouble with certainty. In the class "VA" pump any foreign material which may come down the air pipe falls through the unobstructed openings between the outside casing and the inner tube.

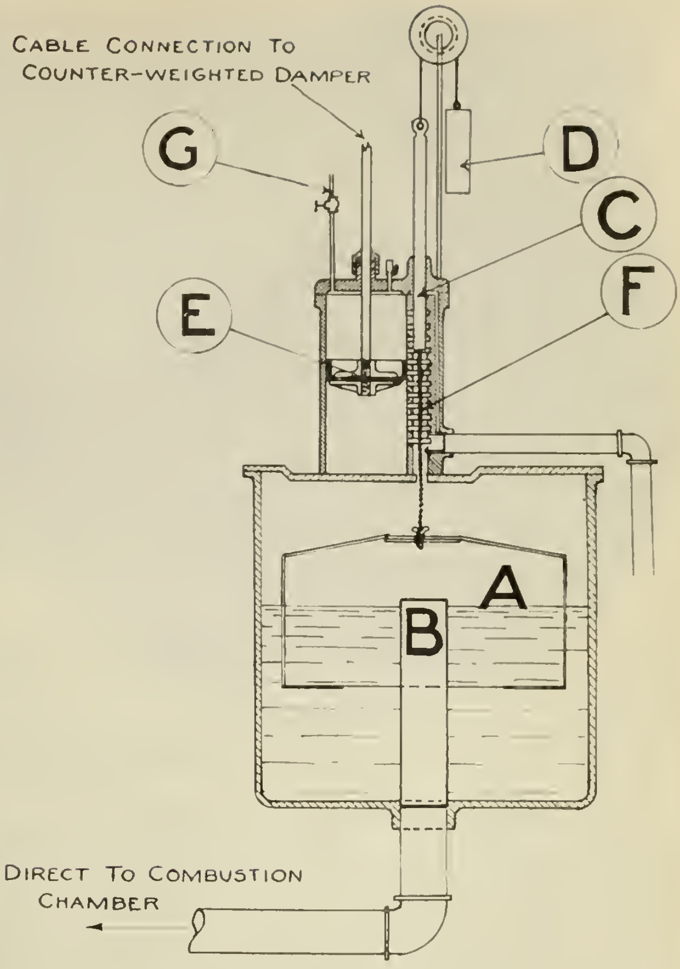
This regulator made by the Craig Regulator Company of Canada is a very simple device, and its control of the damper is actuated by fluctuation in the draft over the fire, with the result that if the draft becomes excessive beyond the point for which the regulator is set, the damper is closed sufficiently to bring it back to normal, and vice versa.

A glance at the line drawing will make the following description very clear. The 2 in. pipe B opens directly into the combustion chamber at one end, and as shown under the gasometer float A in the regulator itself, the gasometer float is connected through a chain F to a plunger C which moves vertically in a multi-port valve opening and closing the ports with the movement of A. The piston E is in a cylinder off which the multi-ports of the valve just mentioned open. This cylinder is fed by water from a pipe G from city water supply, which is controlled by a needle valve. The counterweight D balances the plunger C, chain F, and gasometer float A, and any extra weight in this counterweight takes care of the position of the damper to give the required draft.

The action, briefly, is as follows: Any extra suction at D exerts a downward pull on A, and consequent downward movement of C, closing off the ports in the multi-port valve. Immediately the pressure in the piston chamber above E is built up through the inflow of water at G, causing a downward movement of the piston and a closing of the damper which will reduce the suction. It should be noted that the piston E by the closing action of the damper, will be comparatively slow, as the inflow of water through G is cut down to a minimum by the needle valve. On the other hand, when the reverse action takes place, the plunger C rises and opens as many ports in the valve as the decreased draft condition dictates, allowing a quick rise of the piston E, and the consequent quick opening of the damper.

Coal "Larry" Supplying Stoker.

Steam Engine Driving Stoker.



Damper Regulator.

Forced (Balanced) Draft System

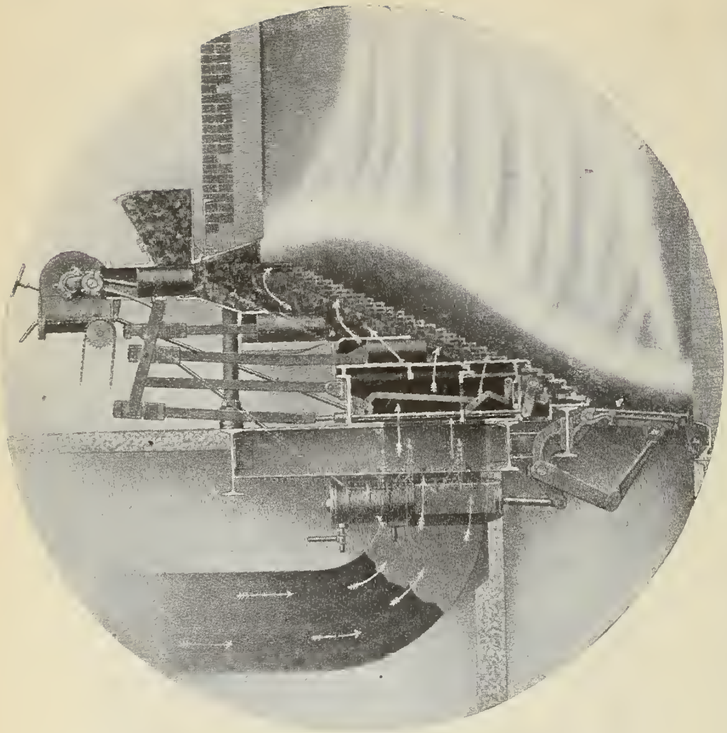
The forced draft equipment consists of 2 (Keith) Sheldon's, Ltd., fans supplied by Ross G. Greig, of Montreal. The fans are driven by two 25 h.p. vertical steam engines, by the Troy Engine Foundry & Machinery Company, of Troy, Pa. The forced draft fans and engines are set in an offset directly in front of the boilers. These fans are used in combination with a Craig damper regulator attached to each boiler which results in a balanced draft being maintained automatically.

An unusual feature encountered here is the "down-draft" direction of the gasses or products of combustion from the last pass to a smoke tunnel below and thence up to a round (brick-lined) steel stack or chimney.

The smoke stack is 7 ft. 6 in. in diameter and 182 feet high above the boiler room floor. It was built and erected by the Dominion Bridge Company. It extends 30 feet above the main roof and this is the only portion of the stack which has not been lined.

Soot blowers or cleaners—Each boiler is equipped with six units of Diamond soot blowers, valve-in-head type, supplied by the Cleaton Company, Montreal.

The water columns are all equipped with high and low water alarms. The safety valves consist of two 4" "Pop" or



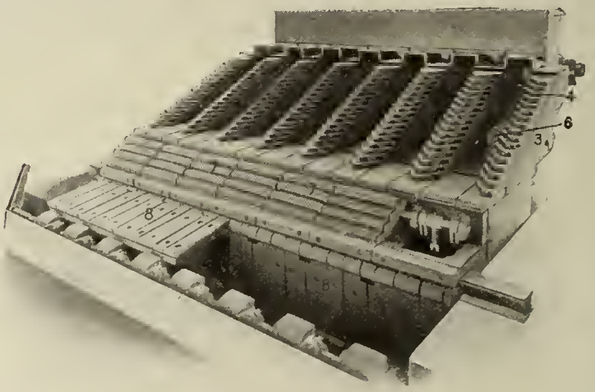
Sectional view of stoker, showing series of coal feeding plungers.

spring leaded type of valve supplied by T. McAvity & Sons.

Feed water regulators—Each boiler is equipped with Copes feed water regulators, made by the Northern Equipment Company, and supplied by Peacock Bros., Montreal. They automatically regulate the flow of feed water to meet requirements.

Main stop and non-return valves—There are four 6 "D" main stop non-return Lunkenheimer steam valves, supplied by the Garth Company, Montreal; also Lunkenheimer stop and check valves in the feed water lines.

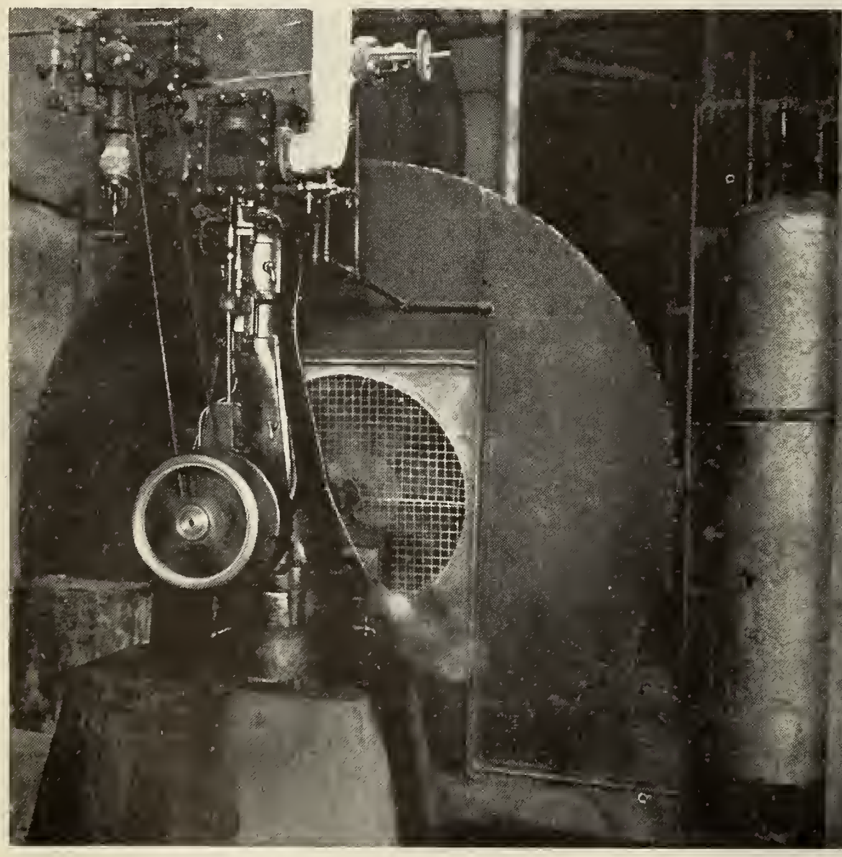
Blow-down valves—There are two sets of blow-down valves to each boiler, one is of the type of everlasting B. O. valve; and the other consists of Lunkenheimer gate valves. The blow-down discharges into a large B. O. or expansion tank, made by Darling Bros., Montreal. The drains from the above tank are led into a sump-pit or tank below the boiler room floor, and a set of ejector pumps remove the waste water to the main sump-pit. The steam gauges, made by the Foxboro Company, Foxboro, Mass., and were supplied by Peacock Bros., of Montreal.



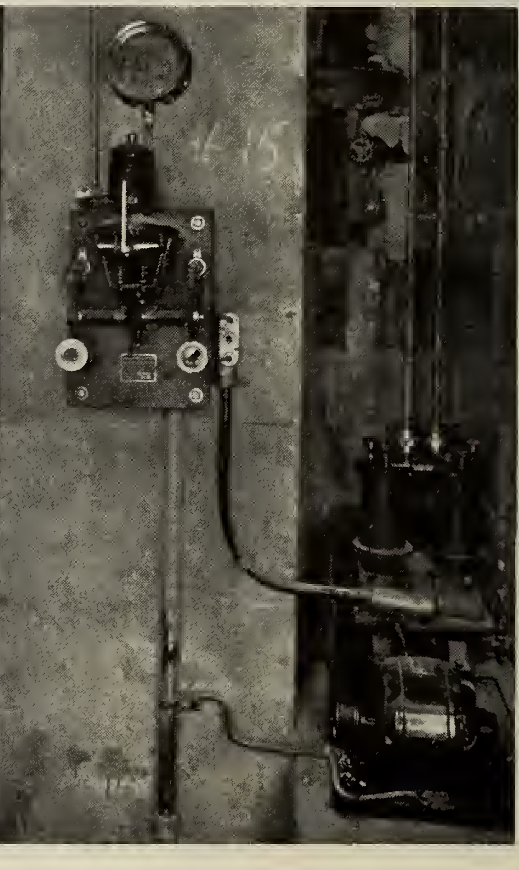
Inside view of furnace showing multiple retorts of stoker.

Boiler meters.—Each boiler is equipped with a Bailey boiler meter type 26, class 56, which indicates and records the air flow, steam flow and the flue gas temperature, also the draft in the fire box; in addition to the above there is an integrating feature which totalizes the flow of steam for any desired period.

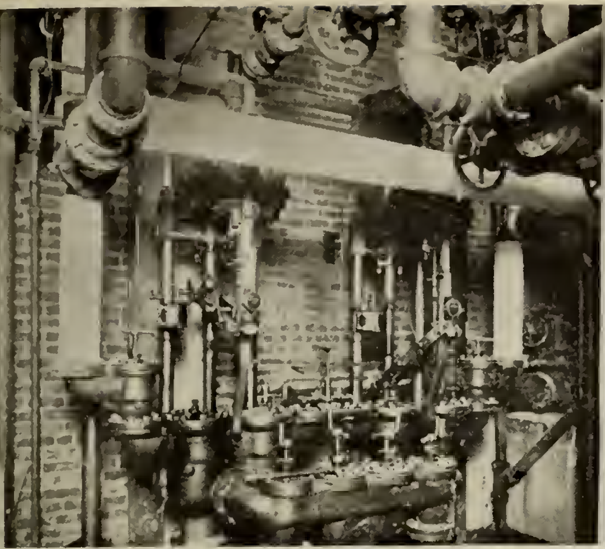
Steam flow meters.—There are two Bailey steam flow meters, type C6, class 1, which indicate and record the flow



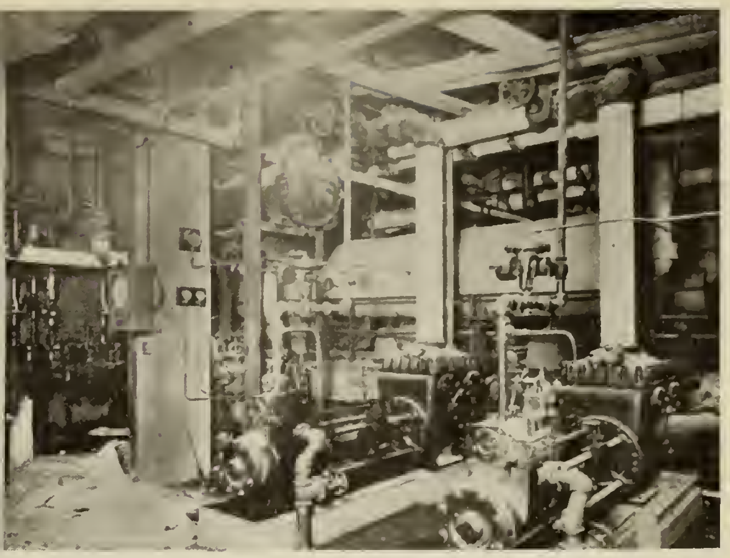
Engine and Fan For Forced Draft.



Johnson Regulator and Air Compressor.

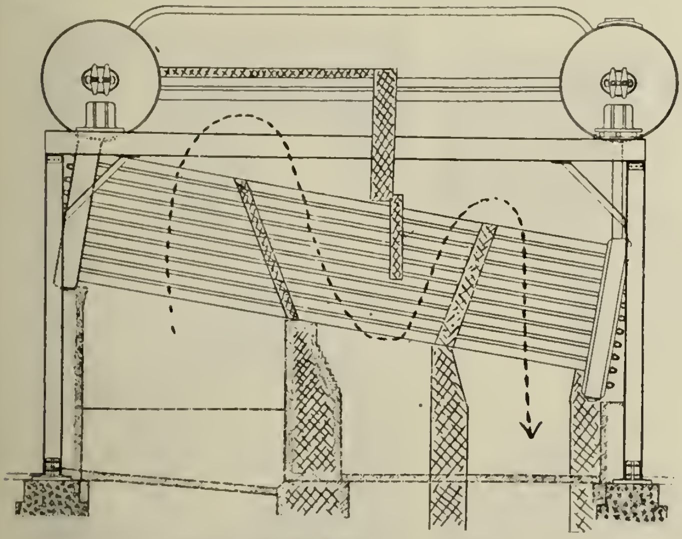


Twin Feed Pumps.



Corner of Pump Room.

of steam other than that used for power and heating purposes. They are also equipped with an integrating feature for totalizing the amount used for any desired period. One of them is used to meter the steam used in the kitchen, and the other to meter the steam used in the laundry. It is quite important that the steam used for power in summer and that used for heating in winter should be determined by similar instruments. In this way the amount of condensate going to the sewer could be determined and in such a large plant the corrective value of such information would prove valuable and result in a direct economy.



Special Baffling and Down Draft.

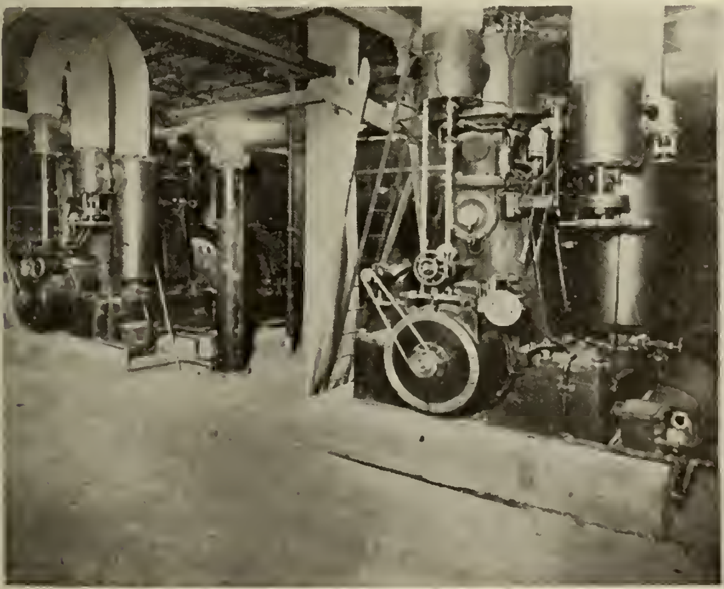
Steam and Hot Water Distribution

Steam branches from the boilers are all connected into a 10 in. main steam header or "log" from which an 8 in. loop provided steam for all the auxiliary steam pumps and engines located in the engine and fan room.

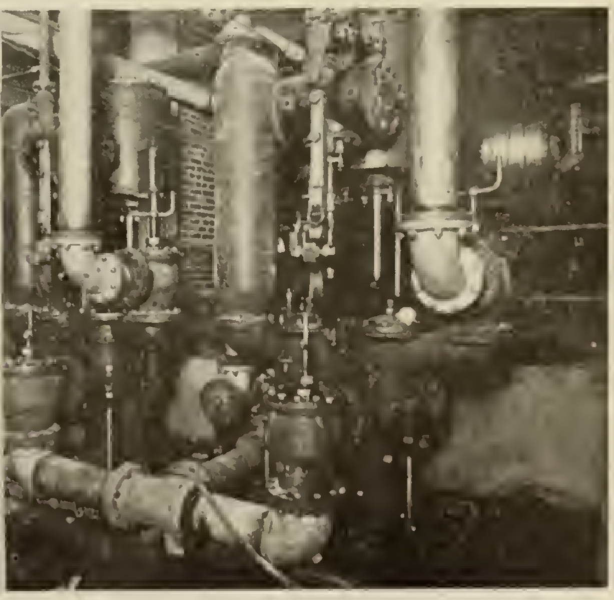
The steam is distributed first at 160 lbs. as above described, another line known as the high intermediate carries 80 lbs., another known as the low intermediate carries 40 lbs. and the low pressure from 2 to 3 lbs. is used for heating purposes entirely. All the steam piping from 5" up to 10" as well as all brass and iron pipe is of the Crane make, and all high pressure steam valves are of the Lunkenheimer make; Crane valves are used for low pressure steam heating.

Philip Carey—85 per cent. magnesia pipe covering was used by Wm. Rutherford & Sons for all tanks and steam pipes. The feed water control and check valves are Lunkenheimer make supplied by Garth & Co.

A Bailey feed water meter, type C2, class A, is used to indicate and record the flow of feed water to the boilers; the



Steam Driven Generator Sets.



Service and Fire Pumps.

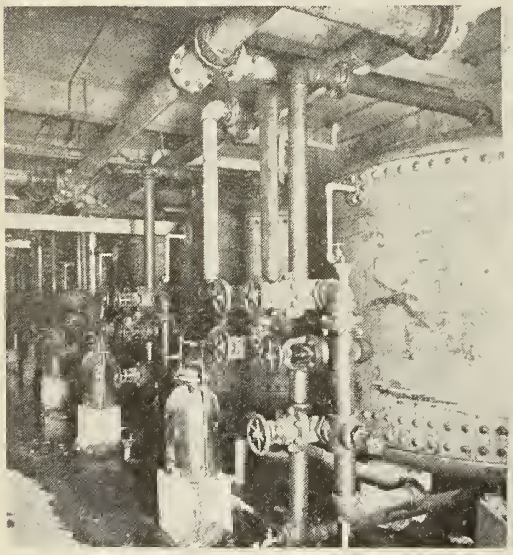
temperature of the feed water is also indicated and recorded; also this meter is equipped with a special integrating feature which totalizes the amount of feed water used for any desired period.

Feed water pumps.—The two 10½x8x24" steam driven, vertical direct acting, Weir feed water pumps, through Peacock Bros., are the latest design of the G. & J. Weir Pump Company. Their capacity is, in excess of that required, (200 lbs. head at a speed of 12 double strokes per minute), 5,930 imp. gallons each per hour. These pumps are equipped with Copes feed water pump regulators. There are two size 5 Blackburn & Smith Corp. feed water filters.

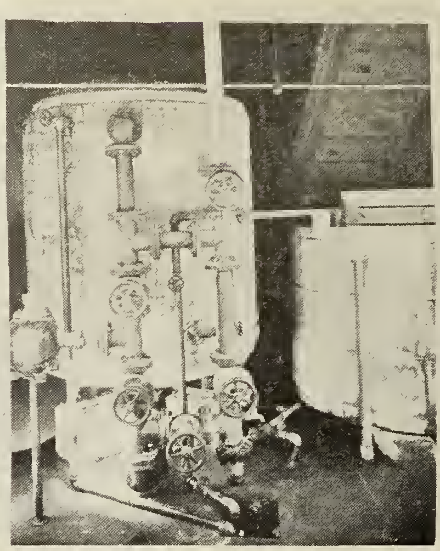
The feed water heater, illustrated here, has a capacity of 3,950 gallons per hour and is of the closed type. It is heated generally by exhaust steam and is equipped with a Powers automatic temperature regulator.

In the winter time there will be a large amount of condensate from the heating system returned to the hot well or feed water supply tank; and the make-up water is taken from the two large storage tanks upon the roof. Each storage tank has a capacity of 10,000 gallons of filtered water. Further provision has been made for supplying the boilers direct from the two city water service connections. There are in all five sources of feed water supply.

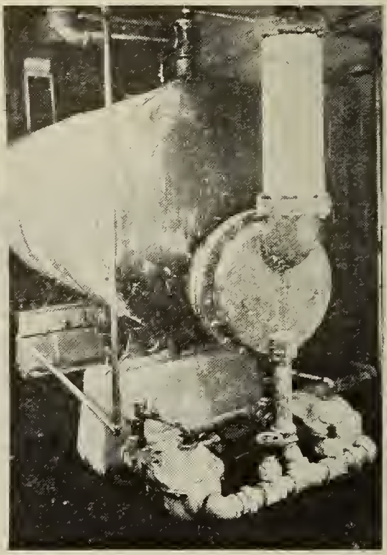
(1) High pressure city water direct to boilers at 135 lb.



Pressure Filters.



Water Softener.



H. W. Supply Tank.

(2) Filtered water from the service supply pumps at 150 lbs.

(3) Low pressure city water (60 lbs.) by feed pumps at 175 lbs.

(4) Hot water returns from the heating system by feed pumps at 175 lbs.

(5) Water from the artesian well, should an emergency require at 15 to 175 lbs.

City water connections—Provision has been made for two water connections, one from the high pressure service (Peel St.) at 135 lbs., and another from the low pressure (Burnside) at 60 lb. One very objectionable feature, an engineer will note here, is the use by the city of Montreal of left-handed stop valves. Such a practice should be discontinued at the earliest possible moment.

Pressure water filters—The 6-78" Refinite pressure filters shown here have a capacity each of 6,000 Imperial gals. on a basis of three gallons per square foot per minute. The hot water supply for wash basins, baths and shower baths, also kitchen and laundry, is provided for by five large cylindrical tanks, heated by exhaust steam. One of them is used exclusively for the laundry. They have a combined capacity of 19,000 gallons per hour.

Water softener and brine tank—The 60 inch water softener and brine tank by Refinite Co. of Canada has a guaranteed capacity of 46,000 Imperial gals. in 10 hours. The softened water is provided for use in the laundry.

General supply and fire pumps—The general water supply for the building, also emergency for fire purposes, is provided for by two steam driven 17x12x21 direct acting vertical Weir pumps. They were supplied by Peacock Bros., and have a capacity each of 24,000 Imperial gals. per hour at 170 lbs., (speed 26 double strokes per minute). Although the building is thoroughly fireproof, there will be at times considerable combustible material stored in it, so that arrangements were made that either one or both of these pumps could be used for fire purposes.

Vacuum pumps—The condensate from the heating system is handled by means of four Darling Bros. steam-driven vacuum pumps.

Condensate from the laundry during the summer is handled by Crane lifting traps.

An air compressor in a modern power plant is now considered indispensable. The Mount Royal is provided with two 12x10, made by the Canadian Ingersoll-Rand Company, Sherbrooke, Que. One is a steam driven unit and the other is motor driven by a Westinghouse electric motor.

Elaborate Electrical Installation

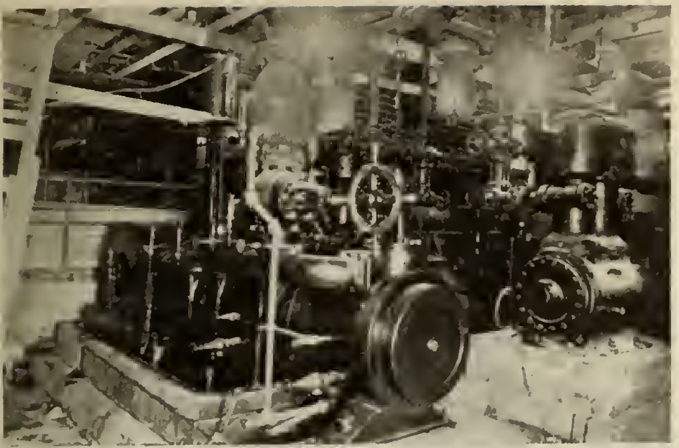
The electrical equipment consists of the following:

(a) 3-150 K.V.A. 2440 volt 60 cy. A.C. oil cooled transformers, by the Canadian Crocker Wheeler Company, St. Catharines, Ont.

(b) 2 sets of air-cooled transformers, by the Canadian Westinghouse Company, Hamilton, Ont.; one set of two is used to start the larger of the motor generator sets; the other set of two is used to start the smaller of the motor generator sets.

(c) Motor-generator sets, manufactured by the Canadian Westinghouse Co. The larger set consists of a synchronous-motor 435 h.p. 98.0 amps. at 2300 volts (a.c.) driving a 300 k.w. generator, 1305 amps. 230/115 volts at 630 r.p.m. The other set consists of a 2300 volts (a.c.) synchronous motor (290 h.p. 65.3 amps.) driving a 200 k.w. (D.C.) generator, 230/115 volts, at 630 r.p.m.

(d) 2 steam-driven electrical generators. The Bellis & Morcom steam engines have a capacity of 430 B.h.p. each normal load, and 25 per cent. overload when operating at 125 pounds pressure and exhaust against 3 pounds back pressure. They are direct connected to Canadian Westinghouse generator, 300 k.w., direct current three wire 125-250 volts. The generators are of Westinghouse make, each of 300 k.w. capacity 1305 amps. 230/115 volts (D.C.) at 375 r.p.m.



Frick Uniflow Engine and Ammonia Compressors.

(e) Electrical motors of various makes, which are described under the following headings:

Coal-conveying, ash-conveying, ventilating, exhaust and supply fans; elevators, passenger and freight; air compressors; refrigeration and brine circulation; sump pumps; laundry machinery; kitchen and service; elevator signal and safety; telephone system; pneumatic tube blower, miscellaneous electric fans, etc. All motors used generally are 60 cycle A.C. 230 volts. The motor load is approximately 300 h.p. The lighting load is 450 K.V.A.

The electrical distribution system was designed and installed by the Canadian Comstock Company, of Montreal and Toronto, under the supervision of Mr. McCrom. In general, alternating current 60 cy. 110 volts is used for lighting purposes, and direct current at 230 volts is used for all electric motors.

The main switchboard consists of 18 panels installed in the sub-basement just west of the engine and pump room. These control motor lighting and 2300 v. circuits.

The principal pieces of equipment by the Metropolitan Electric Co. on the front of the main switch board are: D.P.-D.T., D.P.-S.T., T.P.-D.T. and T.P.-S.T. knife switches; volt and ampere meters, by Weston Instrument Co.; 9 General Electric and 9 Westinghouse circuit breakers; 2 D.C. and 2 A.C. G. E. watt meters.

On the back of the main switch board are mounted the following: Westinghouse rheostats and 3 control levers for the Westinghouse type B 1 oil switches and 6 control levers for the F 11 oil switches and a bank of fuse blocks and cartridge fuses by the Metropolitan Electric Company, Long Island, N.Y. The fuses protect both lighting and motor circuits leaving the board.

Back in the transformer room are the high tension bus bars and supporting frames. On this rack is mounted additional equipment consisting of disconnecting switches and 4 G.E. and 14 Westinghouse current transformers. In addition there is an auxiliary 3 panel switchboard erected in the "Pent House" above the main roof, to control the power for the 6 passenger and 4 service elevators, also the lighting and ventilating fans used to supply the two large convention halls and ball rooms on the 10th floor.

Vacuum Pumps and Return Traps.

The equipment of the auxiliary switch board in the "Pent House" is as follows: 3 large panels, two of them having 5 circuit breakers on each, which control the current to 10 elevators and the third panel controls the circuits to the exhaust and supply fans used in connection with the direct heating; also a circuit to the automatic, electrically-operated refrigeration system. On the back of the third panel is mounted a bank of Metropolitan fuse blocks and cartridge fuses.

The board for controlling elevator signals, Norton door closers and interlocking door switches, designed and erected by H. Voss, superintendent for the Canadian Electric Equipment Company, Toronto, has proved of special interest. It is also located in the "Pent House."

Besides the main and auxiliary switch boards mentioned previously, there are many power and lighting distribution boxes located at different convenient places throughout the building. Some of them are equipped with the Hart magnetic control switches by the Devoe Electric Switch Company, Montreal. The wires for both lighting and motor circuits are all run in approved conduit and the 5,000 outlets made with approved outlet boxes, by Canadian General Electric Co. Five carloads of ½" to 4" Beaverduct were used.

Main Sump-Pumps and Fan Room.

Passenger and Freight Elevators

The purposes, sizes and capacities of the elevators (Otis-Fensom) vary as follows:

6 passenger of 2 to 1 traction type, cap. 2,500 lbs., speed 450 p.m.

1 employee's of 2 to 1 traction type, cap. 2,000 lbs., speed 200 p.m.

3 service of worm gear type, cap. 2,500 lbs., speed 400 p.m.

1 freight and service of worm gear type, cap. 3,500 lbs., speed 100 p.m.

1 freight of worm gear type, cap. 3.500 lbs., speed 350 p.m.

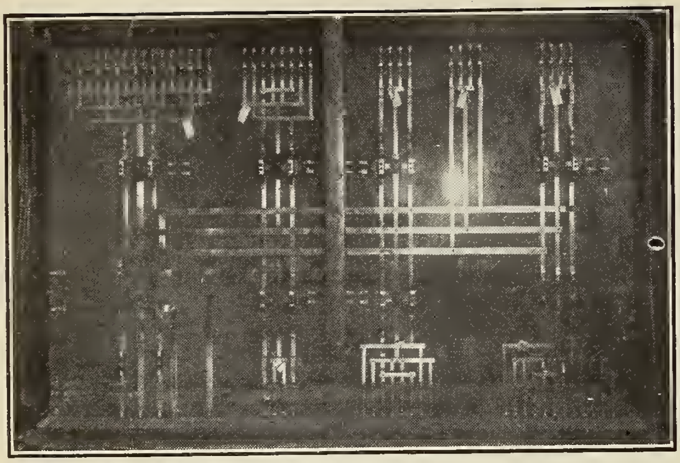
1 service of worm gear type, cap., 1,500 lbs., speed 50 p.m.

3 dumb waiters.

There are many small electric motors used in the kitchen, storerooms and service departments, which supply power to numerous new or up-to-date devices for increasing efficiency and economy.

Direct and Indirect Heating

Direct Heating—Some idea of the amount of radiation required may be gained from the fact that there is approximately 8,000,000 cubic feet of space to be heated, with a very large glass and outside wall exposure. There are installed 2,500 units of varying sizes of steam radiators by the Dominion Radiator Co. in the various bed, bath, reception, dining and special rooms, and the heating of them is controlled as required by modulation valves and thermostatic traps. It is estimated that from 60,000 to 63,000 square feet of radiation



Lighting Panel With Hart Magnetic Control.

was required to heat the building, including both the direct and indirect systems.

Indirect Heating—In connection with each fresh air supply fan, is a heating unit consisting of a bank of steam-heated pipe coils and in combination with it is an air washing or spraying system which controls and regulates the humidity or proper amount of moisture which the air should contain for health and comfort. The indirect radiation installed is approximately 11,000 square feet.

The heating equipment, the Kieley & Mueller steam pressure reducing valves, as well as Lunkenheimer valves constitute a Garth Co. installation. Low pressure steam valves were by Crane Company. All steam and water pressure gauges used, both indicating and recording, were of Foxboro make through Peacock Bros., Montreal. The condensate or hot water returns are handled in winter time by four Darling vacuum pumps. During the summer time the hot water returns are handled by Crane tilting and lifting traps.

WALTER T. ARMSTRONG,
Chief Designer, Ross & MacDonald.

Ventilation and Air Exhaust

There are a number of screened openings from which a fresh air supply is taken in at different parts of the building; however, there has been provided a cold air shaft direct from the roof which supplies fresh air to the main fan room situated in the sub-basement.

The fresh air supply to the main indirect heating is washed and carries the proper amount of moisture introduced before it is delivered to the lobby, main dining and special rooms. There are installed 10 fresh air supply fans and 14 air exhaust fans, all of which are of the Keith pattern, by Sheldons, Ltd., of Galt, Ont. They are driven by Westinghouse motors, which vary in capacity from 3 to 30 h.p. Auxiliary ventilation in the "Pent House" on roof is provided to take care of the grand ball or banquet room and convention halls on the 9th floor.

R. Miller, Superintendent of Building Construction, Thompson Starritt.

The hot air supplied to the various rooms passes through a "diagonal grill" or lattice-like face plate, by Tuttle & Bailey, Bridgeburg, Ont. The galvanized air-boxes or duct through which the hot air is supplied to the rooms and the used air is changed frequently or exhausted, are by Baxter & Webber, Montreal. Two hundred tons of Keystone galvanized iron was used to complete the amount of air duct required, and an average of 30 men have been employed constantly for several months making and erecting the work right on the job.

Ice-Making and Refrigeration

The main refrigerating and ice-making machines consist of what is said to be the first steam uniflow engines with poppet valves for both intake and exhaust, driving ammonia gas compressors. The complete outfit was manufactured and installed by the Frick Ice and Refrigerating Machine Company, Montreal. The engines are fly-wheel-governed and designed to operate at high speeds, ranging from 150 r.p.m. normal to 325 r.p.m. maximum. The vertical enclosed type of ammonia compressors are designed to compress the gas to 125 lbs. normal and 175 lbs. maximum. They have a capacity. each of 40 tons normal and 60 tons maximum. They were installed with a guaranteed capacity of 75 tons of ice per day.

The ammonia gas, after being compressed, is passed through a bank of condenser coils, where the temperature of the compressed gas is further reduced at least to 52 F., after which some of it passes either to a low temperature refrigerator or

Brine and Fresh Water Pumps.

the ice making room, where expansion takes place and the gas absorbs the heat from the substances to be frozen. Another portion of the compressed gas is expanded in coils about which the brine is circulated. The brine, after imparting its heat to the ammonia gas while it is expanding, becomes reduced in temperature and is circulated to the various tanks and refrigerators where only a moderately low temperature is desired. The drinking water supply for the guests is cooled by passing through a brine-cooled tank. The ammonia gas after expansion and absorption is drawn back into the compressors by the suction effect of the receding compressor pistons, and there compressed as previously described, thus completing the cycle.

In the ice-making room, which is about 30 feet square, there are about 500 large cans (8" x 16" x 32"), immersed in a tank full of a brine solution. The brine is circulated around and in between the immersed cans by means of two special brine agitators, driven by two 54 h.p. Reliance electric motors. The cans are filled with 100 lbs. of filtered water and when frozen are removed from the tank to the unloading and ice storage room; the cans are later returned to the tank filled with water and immersed again in the brine circulation. The brine in circulating comes into contact with submerged coils, where ammonia gas is continuously expanding and passing back to the compressor to be compressed again. The ice-making plant has a capacity of 250 blocks of ice every 24 hours, or 25,000 lbs. of ice. Adjoining the ice-making room is a large ice storage room commonly called the "ice house," which consists of a large room where the ice is piled up in tiers. This room is completely lined with 2" slabs of cork insulation, made by the Armstrong Cork and Insulation Company, Toronto and Montreal.

MOUNT ROYAL HOTEL MECHANICAL STAFF.

Front Row, left to right—W. J. Carmichael. Wm. Raeburn, senior shift engineers; S. J. Heenan, chief electrician; J. A. Clarkson, chief engineer; Thos. Kynman, assistant chief engineer; Thos. O. Cubett, senior shift engineer. Other members of the staff. some of whom are included in the above group are—Henry Jackson, Jr.; Frank Pitts; G. W. Holmes, senior shift engineers; Wm. Heath, general mechanic; A. Hostwell, assistant general mechanic; W. Whelan, head plumber; A. Ventres, and J. Williams, assistant plumbers; F. A. Russell, steam fitter; G. Ba'n, F. Murphy, and J. Cook, stoker operators; W. Harris, Jos. Scrodo, Dan. Simpson, coal trimmers; A. Matthews, cleaner and oiler; S. W. Cliff and Jas. B. Fisher, ice-making; P. Stapleton and H. H. Sloane, electric wiring; J. P. Doyle, H. O. Glennie, electric lamps and fuses; O. Leggie, G. Wilson. motors and elevators; J. P. O'Meare, office clerk, J. Wilkinson. storekeeper; Geo. White, general labor.

Just outside of the ice storage room is located three ice breaking machines which are used to reduce the ice blocks to the various sizes required for general use in the building.

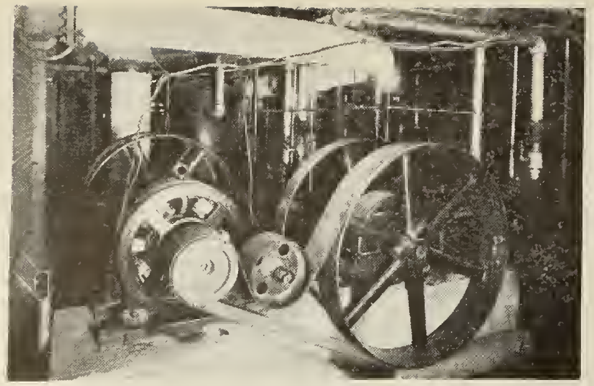
Besides the brine circulation for ice-making there are high and low temperature brine systems. The high temperature system is circulated by two circulating pumps, driven by two 10 h.p. Reliance motors, while the low temperature brine is circulated by two circulating pumps driven by two 5 h.p. Reliance motors. All the circulating pumps are Darling Bros. make. The brine circulation and compressed ammonia pipes used for direct expansion are all covered where exposed to atmosphere with cork insulation, manufactured by the Armstrong Cork and Insulation Company.

The electric motors used are controlled by square D switches made by the Cutter Hammer Co., Milwaukee, Wis.

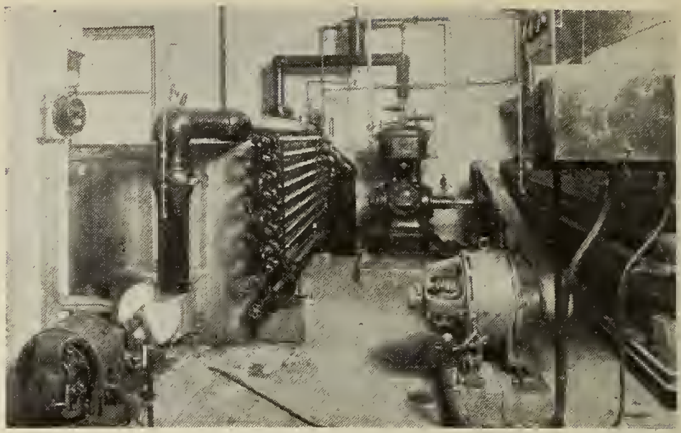
Automatic Refrigerating Unit

There is a complete automatic refrigerating unit located in the Pent House above the roof. It is intended to take care of the cold storage, refrigerators, etc., requirements of the banquet and convention halls. It consists of a Frick vertical enclosed type of compressor, 7½ tons capacity, belt-driven by a 10 h.p. Reliance motor, 220 volts, 800 r.p.m., also condenser coils and brine circulation to the refrigerators on the 9th and 10th floors. The brine is circulated by a circulating pump, made by Darling Bros., Montreal, driven by a 3 h.p. shunt wound Reliance motor, 11.4 amp. at 800 r.p.m. The automatic temperature control and all instruments used are made by the Foxboro Company, of Foxboro, Mass.

There has been provided an ammonia line from the main plant in the basement to the banquet hall for direct expansion and cold storage purposes, in addition to the refrigeration supplied from the Pent House.



Air Compressor Outfits.



Refrigerating Machine.

The principal sub contractors, for the power plant equipment and materials were as follows:

Armstrong Cork & Insulation Co.—(Cork) pipe covering.
Canadian Allis-Chalmers—Ornamental iron work.
Canadian Comstock.—Design and construction, electrical distribution.
Canadian General Electric Co.—Electric supplies and beaver duct.
Canada Cement Co.—50,000 bbls. of cement.
Canadian Fairbanks-Morse Co.—Platform scales.
Canadian Ingersoll Rand Co.—Air compressors.
Canadian Link Belt Co.—Coal and ash conveyors.
Canadian Westinghouse Co.—Generators, motors, transformers, etc.
Carmichael Waterproofing Co.—Roofing.
Crane, Limited—All steam and water pipes, also all valves used in low pressure steam work.
Cutler Hammer Co.—Circuit breakers on main switchboard.
Darling Bros., Ltd.—Circulating, vacuum pumps, etc.
Devoe Electric Switch Co.—Light and power panels.
Dominion Bridge Co.—Smoke stack and structural iron work.
Dominion Radiator Co.—Steam radiators.
Engineering Sales & Service Co.—Boiler erection.
Frick Ice Machinery Co.—Refrigeration equipment.
Giddings, A. A. & Co., Ltd.,—Transformers.
Johnston Regulator Co.—Temperature regulators.
Laurie & Lamb—Steam engines.
Mander & Lucas—Boiler settings and turner baffles.
Northern Electric Co.—Electrical supplies.
Otis Fensom Elevator Co.—Electric passenger and freight elevators.
Peacock Bros.—Steam pumps, meters, etc.
Robb Engineering Works—Water tube boilers, etc.
Sheldon's, Ltd., (Galt)—Keith fans, forced draft, etc.
Taylor-Forbes Co., Ltd.—Three ejector (sump) plants.
Taylor Stoker Co.—Underfeed stokers and engines.
The Cleaton Co.—Diamond soot cleaners.
The Garth Co.—Steam heating work.
Thos. J. Dyer Co.—Plumbing work.
Wm. Rutherford & Co.—Pipe covering (Philip Carey's).

EMERGENCY FUEL

As an emergency fuel, a mixture of fuel oil with fine coal in as large proportions as the coal will absorb and hold is suggested by the United States Bureau of Mines to steam coal users and gas manufacturers to augment their fuel supply during the present shortage.

Slack coal that has a high percentage through an 8-mesh screen, or which may be crushed to sizes of one-eighth inch or less, will take up in oil from 30 to 40 per cent. of its own weight and make a fuel high in calorific value. Coarse slack coal, however, as judged by a representative sample from the Pittsburgh market, will absorb oil to only 3 to 10 per cent. of its own weight, which would give a fuel having only about 4 to 15 per cent. increased heating value. The finer the size of the coal, therefore, the larger is the amount of oil which will be held. Tests made by the Bureau of Mines at its Pittsburgh experiment station indicate that the mixture can be made with either bituminous slack or anthracite culm.

This method bears a relationship to the Trent process of purifying coal by fine grinding and amalgamation with oil, now in operation at a plant at Alexandria, Va., which has demonstrated the success of a combination of oil and coal for steam-making, gas manufacturing and other fuel purposes. The present emergency proposal does not contemplate the cleaning process, but involves merely the simple mixing by shovel or concrete mixer. The Trent Corporation has volunteered to assist the Government in advising in the use or application of oil-coal mixtures, and to waive during this emergency any claim of infringement of its process which may or may not be involved by the simple mixing of fuel oil and coal, without reference to cleaning.

Chain grates and certain other automatic stokers are probably well adapted to handle the oil-fuel mixture if the bin and feeding devices are suitable. Oil-fuel mixtures will not fire spontaneously, but undoubtedly care should be exercised to ventilate bins where external heat may tend to drive off lighter gases, although the fuel oil which is on the market has had the lighter oils distilled from it.

This simple mixture of fuel oil and coal is proposed by the Bureau of Mines merely as a temporary measure. While under conditions of normal fuel supply such a mixture probably would not prove satisfactory unless it involved the cleaning feature embraced in the Trent process, in places where fuel oil is available it can be used to piece out a poor coal supply without the changes in equipment necessary to convert boilers to oil burning.

BRITISH PUMPS FOR SUDAN

A great deal of important irrigation work is in hand in the Sudan; and British firms are playing a prominent part in the manufacture and installation of the powerful pumps required for such purposes. Recently a British firm secured a contract for three 45 inch pumps driven by oil engines of nearly one thousand horsepower each. Each of these pumps is capable of delivering two cubic metres of water per second against a maximum head of close on 26 metres when running at 150 revolutions per minute; both engines are of the centrifugal twin series type. The contract included all the piping and auxiliary machinery, the latter consisting of two 50 horsepower oil engines for driving dynamos, motor driven circulating water pumps, charging pumps, and compressors.

Development of electrical power in South Africa is creating an active market for electrical equipment there.

In operating at about 75% of the present capacity, the U. S. steel industry is running at more than 100% of pre-war production.

Electricity in Its Infancy

By T. J. PACE

WE ARE only on the threshold of the Electrical Age. People who see the progress made in electrical applications, who now see trolley cars going where once the horse-drawn vehicle went; who are accustomed to having their houses lighted at the turn of a button; who have electric lights to make their streets as bright at night as in the day; who find their factories run by electricity; and who see the thousand and one ways in which electricity is saving time and labor—these people may think we are in a completely electrified world.

Nothing could be farther from the truth. As a matter of fact the work of the electrical industry has just begun. Business is good and is going to continue to be good for the next year. One of the reasons for this good business outlook is the vast amount of building, both of office buildings and homes. All this activity helps industry. The effects of this building increase are being felt in all kinds of industries, and particularly the electrical industry, for it will have its wiring and the installation of appliances, illumination, convenience outlets, etc., to do.

These new building projects are practically all to be electrified and perhaps this may seem to the laymen that we are living in a completely electrified world. But it is a fact that of all the homes in the country, only about 30 per cent. are wired for electricity and of the number which are wired, only about 20 per cent. are adequately wired. Right here is some business for the electrical fraternity.

This wiring proposition is not all of it, however. One of the biggest problems of the electrical industry is to supply homes with enough convenience outlets to take care of the increasing number of electrical appliances now being placed on the market.

Those who think that the world is completely electrified should know that the farmers throughout the country are now awakening to the advantages of electricity and that thousands of light and power units are now being installed where it is inconvenient for the central station to run power lines. The farmer is finding that electricity is a great saver of time and labor.

Of all the railroad mileage in the country, there is only about two per cent. electrified. This statement sounds as though there might be something the matter with railroad electrification. But the fact that there is not a large railroad in the country that is not now investigating the application of electricity to its lines only further bears out my first statement that electrical development is only in its infancy.

(Continued on page 40)

New Equipment in Chateau Frontenac; Large Tower Increases Cap.

Quebec.—Chateau Frontenac is destined to be one of the wonders of hotel construction when the new additions are completed, and this famous hostelry thrown open for the reception of guests in the spring of 1923. There is no need to describe the original chateau built on the promontory of Quebec, overlooking the St. Lawrence and with unrivalled scenic prospect. The object of referring to the Canadian Pacific hotel is not to describe the architecture, founded on the lines of a French chateau, but to speak of the steel concrete and fireproof tower and of the machinery and electrical fittings that are being installed on a scale of such magnitude as to be worth a featured description.

The enlargements and improvements to the Chateau Frontenac were undertaken in 1919, when the foundation of the twenty-story steel and concrete tower in the former hotel court yard was commenced. This tower, which has absorbed 2,800 tons of fabricated steel, has just been completed by the Dominion Bridge Co. and the roof is now being applied. The height of the tower is 500 feet above the level of the river and 300 feet above the solid rock foundation upon which it has been built. Besides the main offices, on the first floor, the tower will have three hundred additional bedrooms. The basement of the new chateau covers a large area. Here the boiler and engine rooms are located and the installation of the machinery practically completed.

There are three Goldie & McCulloch semi-marine water-tube boilers equipped with Jones underfeed stokers, Diamond soot blowers and all the latest instruments, such as Cambridge CO_2 recorders Craig damper regulators. Venturi feed water and steam flow meters are installed. Ashes are moved by steam jet. The boiler capacity is 325 and 260 horsepower, and with the type of stoker, 100 per cent. over-rating.

Engine Room Equipment

There are in the engine room two Belliss & Morcom (Birmingham, Eng.) engines, sizes 16 and 24 x 12, and 275 horsepower, Thomson motors and two motor generators. The large engine connects with a Westinghouse D. C. generator, 2,200 k.w., 220 volts, speed of 380 revolutions per minute. A small steam set engine, General Electric Co., connects with the D. C. generator, 150 k.w., 220 volts, and has 420 r.p.m. The large motor generator set is 200 k.w., 220 volts, which revolves at 900 revolutions per minute. A small motor generator set is 150 k.w. capacity, at 220 volts, 900 r.p.m. There is in addition one Crocker-Wheeler wheel balancer of 15½ k.w. capacity, and one Westinghouse balancer of 30 k.w capacity.

The Scotch switchboard embraces 15 panels. The first two are for strong synchronous motors, the next four generator panels, both motors and generators, D. C. The seventh and eighth sections are for two balance sets, the ninth panel for current heating, which will supply approximately 225 k.w., to supply kitchen ranges with heat at 110 volts. The tenth and eleventh section of panels connected with the switchboard are direct power feeders, supplying power for the six elevators, three passenger and three freight, and motors. The remaining four panels are for lighting and are capable of operating all machines in parallel, with a total capacity of 700 k.w. at 220 volts. For lighting, there is a three-wire system, 110 and 220 volts, and there are ammeter and power factor panels, double-throw aid switches and rheostats. The double current generator panels are equipped with circuit breakers of the reverse current type. The pole sight throws switches and rheostats and each panel has its own volt meter and ammeter. The balance of panels are equipped with three pole sight circuit breakers for starting the balancer sets, each equipped with double reaching volt meters and ammeters.

The A. C. heating panels are equipped with ammeter arc plugs so that the current in each phase may be determined. The two power distributing panels are equipped with signal throw switches. The lighting panels have pole signal-throw switches. The installation includes an electrical (Cambridge) CO_2 recorder, showing the percentage of carbon-dioxide in the flue gas. It gives readings each minute. There is a six-inch cushion of sand under the base of each machine to eliminate vibration, and the effect is wonderful, not the least vibration being felt, even in the engine room.

The entire machinery and electrical plant is being installed by the Canadian Pacific Railway building department, under the supervision of the company's chief mechanical and electrical engineer.

D. H. Mappes and his assistants are also to install 650 new radiators in the addition now in course of construction, besides miles of piping and electrical wiring, all insulated and enclosed in piping. The entire heating, lighting, etc., will be carried out in connection with the hotel machinery and electrical installation. Cold and hot air will be supplied throughout the building, as well as a system of ventilation from the engine room. The refrigerator service in all of the various storerooms, is fitted with the latest system in steel-concrete air block piping.

The roof will be of copper, and although the structure is every inch fireproof, a large steam pump will be installed which will pump water to every section of the building. The refrigerating installation comprises a ten compartment General Electric refrigerator with two

(Continued on page 52)

Practical Application of Mechanical Oscilloscope

Tuning Down High Speed Mechanisms so That Same Are Visible to Naked Eye—High Tension Current Employed for the Lamps—Use of the "Creeper" Gear

Minute visual examination of mechanisms operating at high speed is made practical by the use of a recently developed instrument known as the oscilloscope. A simple mechanical principle underlies the action of the Elverson oscilloscope, and its operation has been perfected after considerable experimenting on the part of the makers, Herbert Kennedy & Co., of London, Eng. Actually the oscilloscope is a commercial and workable application of the effect obtained when moving machinery is viewed in an intermittent artificial light. In such cases, however, the synchronism of moving parts with the frequency of the light flashes is purely accidental, whereas in the case of the instrument here described the results obtained are subject to delicate and accurate control.

Simple Method of Operation

Possibly the best estimate of the wide range of practical applications covered by this instrument will be obtained by first describing the method adopted for obtaining the desired result, and this is in reality remarkably simple. In the first place it must be remembered that the human organs of vision, including the eye, optical nerves, and the area of the brain concerned, require a definite time for operation, so that an impression, however transient, will, if sufficiently intense, occupy a definite period so far as the human capacity for vision is concerned. This period varies in normal cases between 1-10 and 1-5 of a second. In the second place it will be obvious that on account of the above considerations, all except slowly-moving parts of machinery will be invisible to the naked eye, or, at the best, visible only as a confused blur, on account of the multitude of different impressions which are received by the eye within a very short space of time.

If, however, the mechanism is rendered visible for a very minute period of time, after which comparative darkness supervenes, a definite image will be registered by the brain, whilst if several repetitions of this image occur within a fraction of a second, the effect will be correspondingly intensified as far as human vision is concerned. This briefly is the principle upon which the oscilloscope operates.

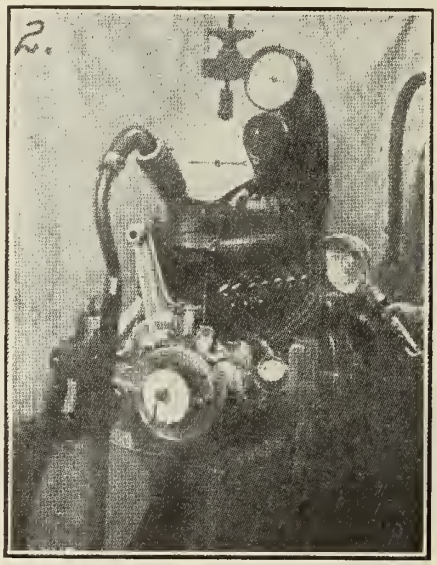


Fig. 2—Oscilloscope applied to automobile engine.

Essentially it consists of a special type of electric lamp which may be made to give a definite number of flashes of light per minute, the exact number depending upon the cyclic period of the mechanism which it is desired to examine. Thus the complete instrument comprises the lamp with an accumulator and induction coil and means for interrupting the current and controlling the number of flashes per minute. Considerable experiment was, however, necessary before these requirements could be embodied in practical form, and the equipment finally evolved is shown in Fig. 1.

This shows two lamps provided with shades and suitable holders and an accurately-made gear box, these units being connected up with an accumulator, induction coil, and condenser enclosed in a wooden case. It should be mentioned that the connections are so made that the equipment can be operated only when the lid is in position on the case, thus ensuring protection of the apparatus and of the operator against the high-tension current employed for the lamps.

Gas-Filled Lamps

The lamps are of a special gas-filled type, in which an electric discharge takes place between a point and plate electrode in an atmosphere of neon, these lamps having been evolved as the result of considerable experiment to give flashes of light of great brilliance and of exceedingly short duration. One of the lamps shown is a master unit upon which a control switch is fitted in the form of a spark gap which is rendered necessary by the intermittent nature of the current. This spark gap nullifies the effect of inductance in the lamp circuit, confining reactionary currents to the bulb, so that for a given current the maximum discharge is obtained between the electrodes. Consequently, since one or more lamps may be connected in parallel with the master unit, the maximum amount of light may be obtained from a given current.

Action of Gear Train

On the right in Fig. 1 is shown the gear box, which consists of a graduated circular casing in which two accurately-made gear trains are enclosed. Each of these trains receives its motion from a primary pinion on the central shaft, which is coupled directly to the mechanism to be tested, and each of them drives a contact breaker, which may be switched into the lamp circuit. In the case of one gear train, the speed is so arranged that the flashes of the lamp

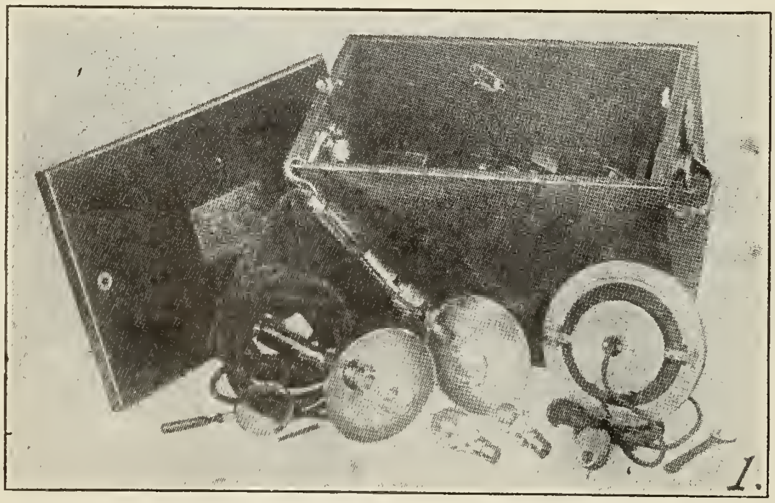


Fig. 11—Elverson oscilloscope and accessories.

synchronize exactly with the revolutions of the primary pinion, whilst in standard sets the other gear train gives 100 flashes of the lamp in 99 revolutions of the pinion. A switch working about the centre of the gear box brings either circuit into operation as desired, or, if required for special purposes, radial slides may be moved by hand to give one, two, or four flashes per revolution with either current.

In the case of the gear train where the number of flashes coincides with the number of revolutions of the primary pinion, it will be obvious that each flash occurs at a particular point in the revolution of the pinion. Thus the revolving member of the mechanism to be tested is illuminated in exactly the same position at successive revolutions, with the result that, if external light is sufficiently reduced, the mechanism appears to be stationary, although in reality it may be moving at a high speed. Similarly all parts mechanically coupled to the revolving shaft will be illuminated at definite points in the cycle of movements, so that any mechanism may be subjected to minute visual examination under actual working conditions irrespective of the speed employed.

Apparent Speed Reduction

On the other hand, if the alternative circuit or "creeper" gear is brought into action, successive flashes of the lamp will illuminate the mechanism in positions removed from one another by 1-100 of the cycle, despite the fact that actually the mechanism has passed through 101-100 of a complete cycle during the space of time between successive flashes. This, in effect, means that the apparent speed at which the mechanism is functioning is reduced to 1-100th of the actual speed, so that parts revolving at, say, 1,000 r.p.m. appear to be moving at the low speed of 10 r.p.m., at which speed, of course, visual examination is not only possible, but exceedingly useful, since the actual working movements of the parts are reproduced for inspection.

Typical Examination

If the primary shaft of the gear box be coupled directly to the cam-shaft of an internal-combustion engine, the action of the valve and rocker mechanism may be analysed minutely. Actual tests with the instrument have, in fact, already revealed a number of interesting points in connection with valve gear. Thus in many cases the lag which takes place in the closing of the valve when the valve stem is heated up may be distinctly observed, whilst failures of the roller to follow exactly the cam profile are equally noticeable. In the last-named case the roller may be seen to bounce on the cam and to be accompanied by a corresponding movement of the valve on the seating.

Testing Gear Action

Another important application of the device is in connection with gear testing, since errors in the interaction of two gears are rendered readily apparent. It should, of course, be pointed out that gears which apparently mesh correctly when running at 10 r.p.m. may exhibit several serious defects if the speed be increased to 1,000 r.p.m. or more. When using the oscilloscope, however, the majority of the defects remain apparent, whilst the speed at which the gears are revolving appears to be reduced, in this case by 100 to 1.

Actual tests show that periodic errors due to inaccuracies in circular pitch or lack of concentricity are visible as a slow oscillation of the various members of a gear train, whilst in cases where variable stresses are encountered in the drive the presence of backlash in the gears gives rise to the same visual phenomenon.

Studying Moving Mechanisms

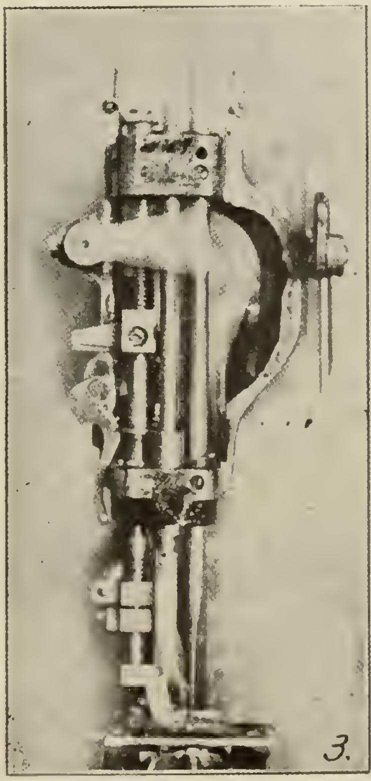
Another important point is the fact that moving machinery may be made to appear stationary at any desired point in the cycle of operations. This is effected by moving the switch on the gear box to the stationary position, after which the complete unit, i.e., the gear box and contact breaker, may be rotated about its axis until the mechanism is observed to be in the desired position. This fact suggests several interesting possibilities in connection with the study of vibration and torsional stresses.

Thus in the case of machinery where an undesirable degree of vibration is apparent it will be found in the majority of cases that the vibration is periodic and synchronous with the movement of one of the main components. Whether this is the case or not may readily be determined by coupling the primary shaft of the gear box to the main revolving members in turn. If then the contact breaker is set so that two or four flashes per revolution are made, periodic vibration synchronising with the movement of the shaft will result in two or more images of the various parts being visible. Further, the planes or points where the amplitude of the vibration is at a maximum may readily be determined by setting the instrument to give two flashes per revolution and then rotating the gear box about its axis until the maximum distance is obtained between the two images. Thus it is possible actually to measure the extent of the vibration, and, in addition, to determine the direction and period of the movement, a factor which should be of great importance when testing high-class mechanisms with a view to improvements in design.

Examining Shaft Stresses

With regard to torsional vibration and torsional stresses in shafts, the method of application is equally simple, and in this case the protractor scale on the rim of the gear box housing is utilized. In the first place, the gear box is mounted in a suitable support, whilst two lines are scribed near opposite ends of the shaft to be tested, the lines being parallel to the axis of the shaft and in line one with the other. The primary shaft of the gear box is then coupled to the member under test, and both are rotated, whilst the contact breaker is switched to the stationary position so that the test lines become visible. The simplicity of this suggests developments in the direction of improved meth-

(Continued on page 40)



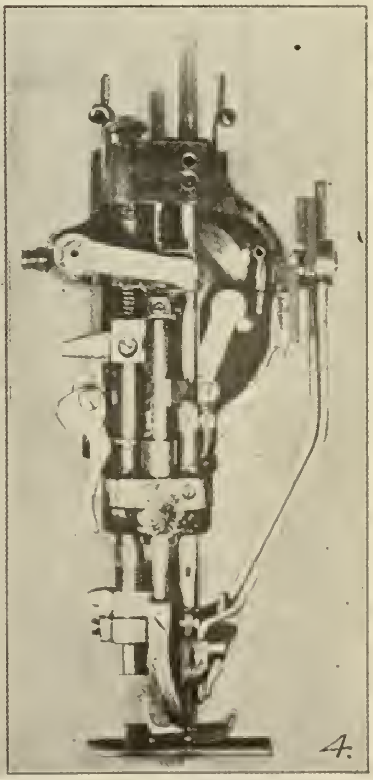
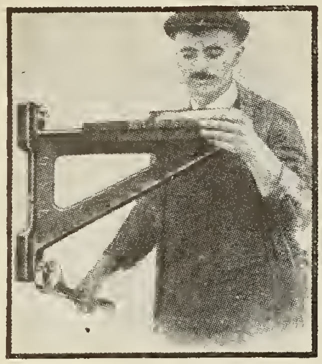


Fig. 3—Headstock of sewing machine running at 1,500 r.p.m. Fig. 4—Machine still running, photographed by light from oscilloscope.

Some Factors in Power Transmission



Care Required When Installing Shafting—Figuring the Size of Shaft—Joints Should be Properly Made to Ensure Efficiency—Reducing Friction by Means of Ball Bearings

OPINIONS of engineers differ as to the best method of power transmission when a number of machines are to be operated in the one plant or department. Some advocate the individual, while others stick to the older method of grouping the machines and operating from one main shaft. Experience has shown that no fixed rule could be made as to the best method to adopt, and each individual case must be solved on its own merits, the solution being based on existing conditions.

Installing Line Shaft Supports

The fundamental consideration in the problem of power transmission is the erection of the line shafting that is to carry the numerous pulleys for driving the various machines. Where individual drives are used long lengths of overhead shafting are seldom necessary, but it is only in comparatively few plants that one will not see a line shaft of some description. It must be obvious that in order to obtain an installation of high efficiency great care must be given to the erection of the various brackets or hangers used for supporting the shaft. The practice followed when erecting a line shaft cannot be clearly defined, as the methods adopted by individual millwrights and mechanics will vary according to their own personal ideas and experience, as well as the local conditions governing each specific case. However, a brief outline may assist those who may have such a duty to perform. Each individual instance must be solved on its own merits, but the summary here given will be the practice recommended when erecting a line carried on ball bearings.

Placing the Hangers in Position

When the approximate location of the shaft has been determined, the hangers or brackets are arranged and secured in their respective positions and aligned by means of a spirit level and a taut string. During the process of securing the bracket or hanger to the wall or ceiling supports, a steel square is used to assure proper alignment of the machined surfaces that carry the boxes or ball bearing housings. It is advisable also to check the erection both horizontally and vertically by means of plumb lines. In the case of S.K.F. bearings the housings are thoroughly cleaned, the felt washers saturated with grease, and placed in the grooves in the housing. The lower sections of the housings are placed in their respective positions and the bearing seatings painted with cylinder oil to prevent the outer ring of the bearing from becoming firmly attached to the housing through the action of rust. Before placing the ball bearing on the shaft the latter should be wiped thoroughly to remove all grit and dirt.

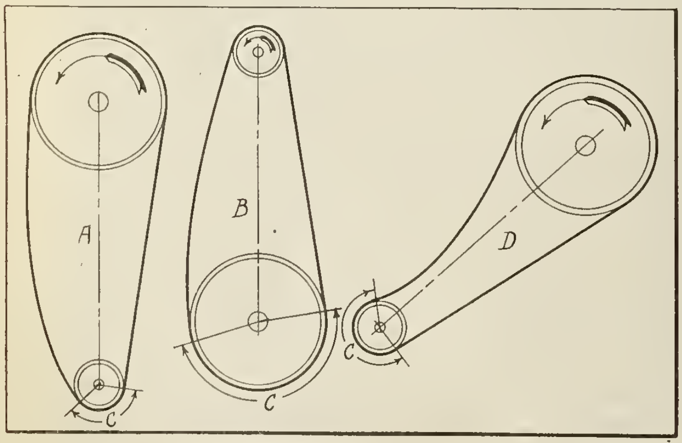


Fig. 1—Points to watch in vertical drives.

Placing and Aligning the Shaft

The shaft is then raised and placed in the lower sections of the plummer blocks, after which a spirit level is used to make final horizontal alignment of the shaft. The bearings are then fixed in their respective positions in the housings, by means of the locking nut. In the case of free bearings, care should be taken to make sure that the ball bearing fits into its seating in such a manner that the bearing as well as the shaft can move sideways with perfect freedom. When fixed in the desired position the sleeve nuts are firmly locked by the safety grub-screws. Before fitting on the upper sections of the plummer blocks the bearings are well lubricated. When bearings are supported in hangers, care should be taken to avoid excessive tightening of the top locking screw. Final alignment in a vertical plane is then made by means of a plumb line. Examination should not show the shaft rubbing at any point on the bearing housing.

Figuring the Size of the Shaft

When making calculations for size of shafting, it is well to use shafts of ample dimensions to take care of unexpected overloads and subsequent additions to plant equipment to be driven by that particular shaft. For the usual run of line shaft service, where supports are provided every eight feet or less, and where average loads and speeds are used, the shaft rating as given below may be considered good practice:

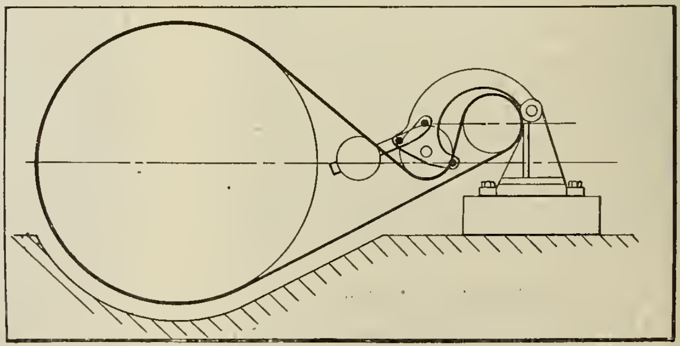


Fig. 2—General outline of Tenix short drive.

H. P. Transmitted by Steel Line Shafting

Dia. of Shaft	Number of Revolutions per Minute					
	100	150	200	250	300	350
1 1-16	6	8.9	11.9	14.9	17.9	20.9
1 15-16	8.9	13.3	17.7	22.2	26.6	31
2 3-16	12.6	19	25	31	38	44
2 7-16	17	26	34	43	52	60
2 11-16	23	34	46	58	69	81
2 15-16	30	45	60	75	90	105
3 3-16	38	57	76	95	114	133
3 7-16	47	71	95	119	143	167
3 11-16	58	88	117	146	176	205
3 15-16	71	107	142	178	213	249

A formula for above table would be:

$$H.\,P. = \frac{D^3 \times R}{83.7}$$

Shafts Subjected to Heavy Loads

When severe service is required, such as shafts carrying gear drives, large pulleys with wide belts, and where heavy loads and shocks are delivered at intervals or suddenly, a greater factor of safety should be taken. This is necessary to take care of the variations in the stresses on the shaft. A reasonably safe formula in such cases would be the following:

$$H.\,P. = \frac{D^3 \times R}{125}$$

where D = dia. of shaft in inches.
R = rev. per min.
H.P. = horsepower.

It will be understood that the table and formula given are only approximations. More accurate results may be obtained from the charts shown in Figs. 5 and 6. To use the chart it is necessary to calculate the twisting and bending moments of the shaft, based on the load, distance between supports and other factors. The figures between the heavy black lines indicate the h. p. at the point of intersection of the bending and torsional moments. The charts are based on the formula:

$$D = \frac{\sqrt[3]{5.1 \times (M + \sqrt{M^2 + T^2})}}{S}$$

when:
d = Shaft diameter in inches.
M = Bending moment in inch-pounds.
T = Twisting moment in inch-pounds.
S = Fibre stress in pounds per sq. in.

Stress and Tension in Belts

When a belt is stretched over a pair of pulleys, is cut to the proper length and laced together to form an endless band, it is obvious that uniform tension will exist throughout all portions of the belt, as long as the same is at rest, due to the tightening exerted by the lacing. If the distance between the respective shafts is considerable, the weight of the belt itself will increase the tension in that section of the belt near the pulleys. This increase of tension due to the weight of the belt would make but little difference in the unit-stress of the material, so it is safe to assume that the tension is equal at all points when not exerting a pull.

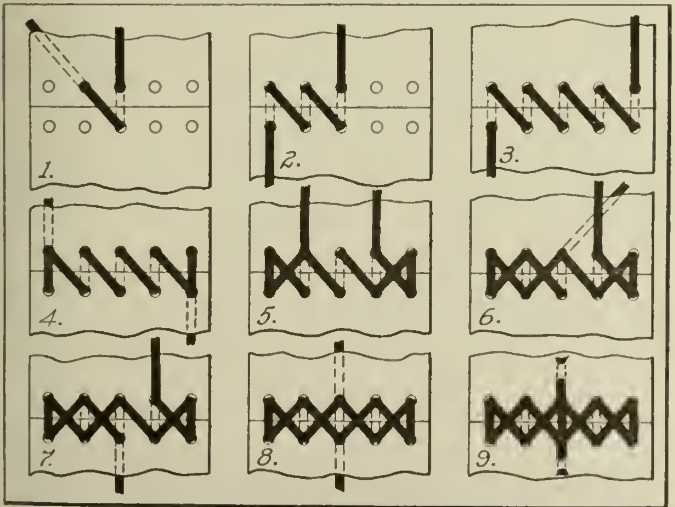


Fig. 3—Showing sequence of lacing belt.

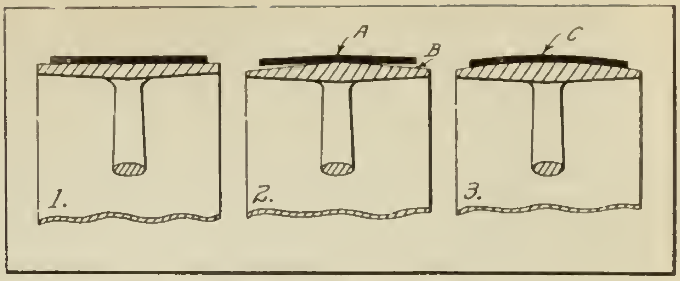


Fig. 4—Flat and crowned pulleys.

In the process of transmitting power, however, the condition of stress in the belt is materially changed. Owing to the flexibility of the belt it is only by pulling that power can be transmitted to the other shaft, so that increased tension is evident in the power side of the belt, the opposite side developing a sag or slackness caused by the stretch due to load resistance. The sum total of the tight and slack side tensions is approximately the same as the uniform stress when belt is at rest. The amount of pull that can be applied to a belt is limited by the tension at which the belt slips around the pulley. Since the force of friction between belt and pulley is dependent upon the normal force with which the belt is pressed against the pulley, and the coefficient of friction between the two, it is obvious that the tighter the belt is laced, and the rougher the contact surfaces, the greater is the power that can be delivered by the belt. From this it would appear that it is possible to transmit any amount of power through any size belt, if such belt were only laced tight enough.

While theory might lead us to this conclusion, the same would be impossible in practice, as no belt would stand the strain. Other practical conditions are likewise involved which fix the limit of power transmitted at a point far below the breaking strength of the material.

Effect of Centrifugal Action

When the belt, as it passes around the pulley, changes its straight-line direction to circular motion, each particle of the belt — like a body whirling at the end of a cord about a centre of rotation — tends by centrifugal force to fly away from the surface of the pulley, thereby decreasing the normal pressure, and hence the friction. This centrifugal action also changes the tension in the belt between the pulleys. As the centrifugal force increases in proportion to the square of the linear velocity, it is evident that the effect is greater at high speeds than at moderate or low speeds.

A further circumstance that affects the driving power of a belt is the stiffness of the leather or other material of which the belt is made. When passing around a pulley, the belt is bent to conform to the circumference, and is again straightened out as it leaves the pulley. It is evident then that the theoretically perfect action is modified somewhat according to the nature of the bending and the thickness or flexibility of the belt, so that a small pulley carrying a thick belt would be the worst case for successful theoretical calculations.

Joints Should be Properly Made

A very important factor in power transmission by belt is that of the laced joints. This, naturally, is the weakest portion of a belt and therefore special care should be exercised in seeing that the connection is properly made. The first thing to consider is the cutting of the belt ends. This must be carefully done. The ends should be cut perfectly square with the run of the belt and the holes in each end properly aligned with each other. An effective method of lacing is shown in Fig. 3. In all cases it is advisable to have the laces on the pulley side of belt running parallel, the crossing being made on the back. Knots should not be used. The best practice is to lock the lace by passing it through an extra hole and pulling it tight. A cut is then made in the lace just

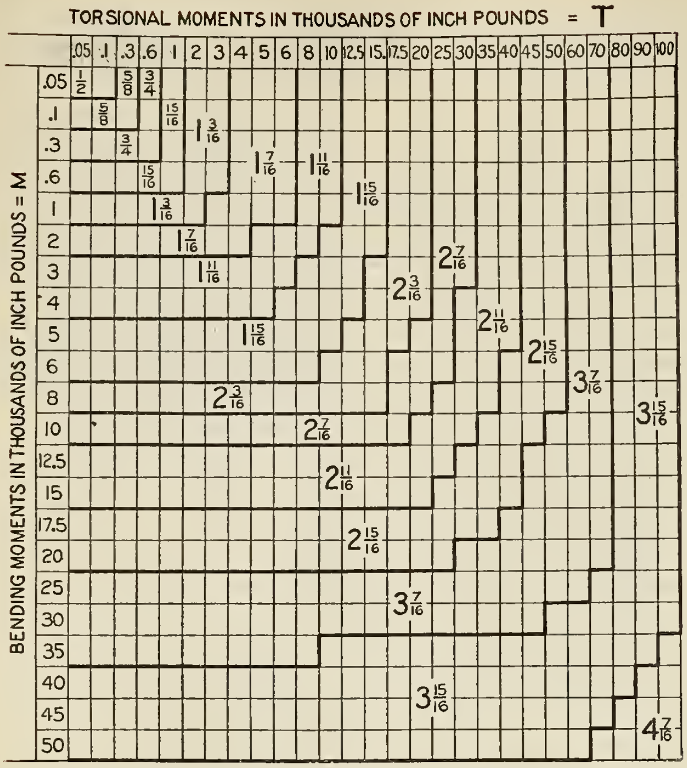


Fig. 5—Chart for finding the h. p. of shafts of small diameter.

clear of the hole, and about half way through, at an angle to prevent lacing pulling back. The lace is then cut off about ¼ in. back of lock.

Crowning the Pulley Face

The crowning of pulleys is a very important feature. A flat faced pulley would give the highest frictional value, but unless conditions are ideal, it is difficult to keep the belt on the pulley. It is general practice to crown pulleys on which the belts are permanently running. There are two methods in use, the flat conical crown and the spherical crown. In the former the apex of the crown is a pronounced point as shown in Fig. 4, and the tendency is to make a poor contact with face of pulley. The method shown at Fig. 3, where the face is rounding, is the better way as it permits a more uniform bending of belt fibres.

Different Systems of Rope Drive

Properly designed rope drives are highly economical and efficient in many situations, for transmitting power between long centres, at angles, around obstructions and particularly where larger units of power are to be carried. The flexibility of manila rope, its positive operation, relatively low cost and long life give it many advantages.

There are two systems of rope transmission. What is known as the English system is made up of individual ropes, separately spliced and running constantly in the same groove of the driving sheave and of the driven sheave. Due to more or less unequal stretch, it is almost impossible even to approximate uniform tension on all the ropes. Consequently it is usual to employ ropes of larger diameter and load them heavily. English system drives are practicable only when the ropes run horizontally or nearly so and in some such situations they are very satisfactory.

The fundamental principle of the so called American system of manila rope transmission is that one continuous rope is used (with only one splice), which travels consecutively through all the grooves of the sheaves and which runs continuously around a winder and tension carriage arrangement, that keeps the rope adjusted at a uniform tension throughout its entire length at all times, for ordinary variations in load. The American system is far better adapted and more efficient for most service.

Efficiency of Rope Drive

The successful operation of any rope drive is dependent primarily upon the design and the proper adaption of those principles which have been demonstrated by experience to govern efficient rope drive practice. The diameters of the sheaves in relation to the diameter of the rope and the speed are important. The location of the tension outfit and how the rope leads to and from it also are vital factors.

The diameter of rope to select, the number of wraps, the form of the sheave grooves, the general arrangement and location of the sheaves, the "wind" of the rope and other questions are individual problems with each drive. They can be answered only from an extensive experience with rope drives for all kinds of service.

To plan a rope drive, complete and definite information is required about the conditions of service. This data should be accompanied by a rough sketch showing the layout of buildings and equipment. The information required to enable engineers to prepare plans and estimates for rope drives is specified below:

The approximate amount of horsepower to be transmitted.

The type of unit that supplies power to the driving shaft and the class of equipment that power is to be delivered to.

Direction of rotation and speed of the driving shaft; also that of the driven shaft.

The diameters of both shafts.

The location of both shafts and their position in relation to adjacent floors, ceilings, walls, posts and other obstructions. This is necessary to properly determine the sizes of sheaves and the location of tension equipment.

How close bearings can be placed on each side of both driving and driven sheaves.

The centre distance of the shafts and whether they are parallel and on what level.

It should also be stated whether the ropes have to clear any obstruction.

Considering the Friction Loss

Present-day factory operation demands that every possible source of leakage be eliminated, or at least minimized. A frequent, and very often inestimable, cause of leakage is the power loss caused by inefficient or faulty transmission installations. Owing to the variable stresses that hangers, shafting and bearings are constantly subjected to, it is imperative that great care be exercised when erecting all classes of shafting that is to transmit power. Friction in bearings is one of the chief sources of lost power. With modern ring-oiled bearings the frictional loss may be reduced considerably, but even with this type of bearing the best results are only obtained after the bearing has been well "worn in," and in attaining this objective, constant care and attention is requir-

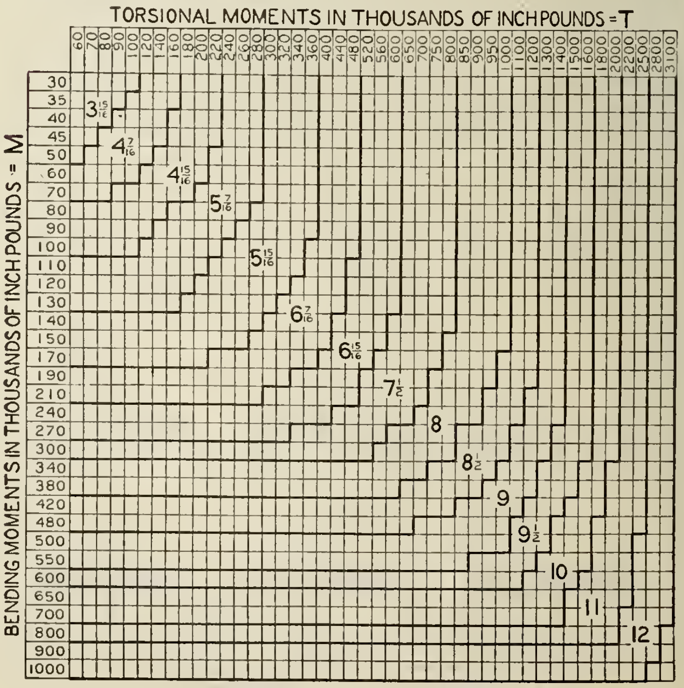


Fig. 6—Chart for finding the h. p. of shafts of large diameter.

ed to see that the oil supply is adequate and shafting kept in perfect alignment.

Allowance for Shaft Deflection

By equipping line and counter-shafts with ball bearings, the cost of lubrication and attention is reduced to a minimum; there is no necessity for "wearing in," and the starting effort is almost negligible. It is essential, however, to avoid bearings of a rigid construction, and provision should be made to counteract shaft deflection, a condition that is invariably present in some form or other when long lengths of shafting are subjected to a number of varying and opposing stresses. Some bearings are designed with swivel housings, but considerable unnecessary strain is often placed on the balls when the bearing is under heavy load. In self-aligning bearings any deflection of the shaft is taken care of by the special arrangement of the housing that permits the balls to roll sideways in the spherical ball race. This instantaneous response to shaft deflection minimizes loss through friction.

The problem of friction loss in transmission equipment must be faced by the engineer sooner or later. It is generally conceded that well designed ball bearings have a lower co-efficient of friction than the plain bronze or babbitted bearing. Few of the plain bearings will register an efficiency greater than 80 per cent. and when poorly installed may show a loss through friction of 30 per cent. or even greater. By the installation of ball bearings this loss has been reduced by upwards of 70 per cent.

Typical Example of Power Saved

As a typical example of the saving possible through the use of ball bearings we will assume that 40 ft. of 3 in. shafting is carried on five plain bearings, the power delivered being 60 h.p. at 250 r.p.m., the total load on the five bearings, including pulleys, belt pull, etc., being about 18,000 lbs. Placing the co-efficient of friction for a plain journal bearing at 0.04, the friction load will be:

$$18{,}000 \times .04 = 720 \text{ lbs.}$$

This gives the ft. lbs. per minute, as:

$$\frac{720 \times 3.1416 \times 3 \times 250}{12}$$

and the h. p. absorbed by friction in the plain bearing of:

$$\frac{720 \times 3.1416 \times 3 \times 250}{12 \times 33{,}000} = 4.28 \text{ h. p.}$$

For well designed ball bearings the co-efficient of friction will seldom exceed .002, so that the loss in such cases would figure out at:

$$\frac{36 \times 3.1416 \times 3 \times 250}{12 \times 33{,}000} = .214 \text{ h. p.}$$

This indicates an approximate saving in power of:

$$4.28 - .214 = 4.06 \text{ h. p.}$$

Aside from the actual power saved, a feature of economic advantage is the low starting effort required for shafts equipped with ball bearings, as the initial pull is relatively the same as when running.

In making calculations for and the selection of suitable bearings, it should be borne in mind that tables generally give the sizes for steady loads and speeds, so that where bearings are subjected to shocks, ample margin should be allowed in excess of the load stated. For this reason it is recommended that a reasonable factor of safety be used when figuring.

Rules to Follow When Installing

When fitting a line shaft with ball bearings it is advisable to adhere to certain conditions. These might be stated briefly as follows: One bearing only should be fixed axially on each independent line of shafting; it is advisable to locate this fixed bearing as near the centre of shaft length as possible; bearings on either side of fixed unit must be located centrally in the housing and be free to move laterally in either direction; where sleeve nuts are used for tightening or adjusting, they should be screwed on in the direction opposite to shaft rotation; be sure and tighten grub screw that locks the sleeve nut; see that ball race is well lubricated with the necessary grease.

The Lenix Short Drive

Lack of sufficient space frequently restricts the length of drive that can be used. In such instances it is generally the practice to fit up an idler to make up for the loss of centre distance. This is especially true when there is a great difference between the diameter of driver and driven pulleys. Fig. 2 illustrates the application of the Lenix flexible idler as used on equipment such as ice machines, air compressors, etc., where the shaft centres are necessarily close together. It is important, however, in obtaining effective service from a drive of this character that a belt be selected with a high degree of pliability and one that will not break down readily under the constant changing positions of belt fibre.

Tension and Power Transmitted

When a belt is working at its full efficiency the pull on the tight side will range from 60 lbs. to 120 lbs. per inch of width for single belts, this stress varying according to the thickness of the leather from which the belt is made. A fair working average is about 90 lbs. per inch of width. For double belts this is increased to approximately 150 lbs., the average between the range of 135 lbs. for light and 160 lbs. for heavy leather. In order that the belt shall do its maximum work the strain in lbs. on the slack side of the belt must bear a certain ratio to the pull tension that slippage does not take place. In practice this ratio will be about 1 to 3, dependent on the condition of the belt and pulley surfaces, and on the percentage of belt contact. Safe practice places the ratio at 1 to 2, so that a fair average for stress would be 45 lbs. for single and 75 lbs. for double belts.

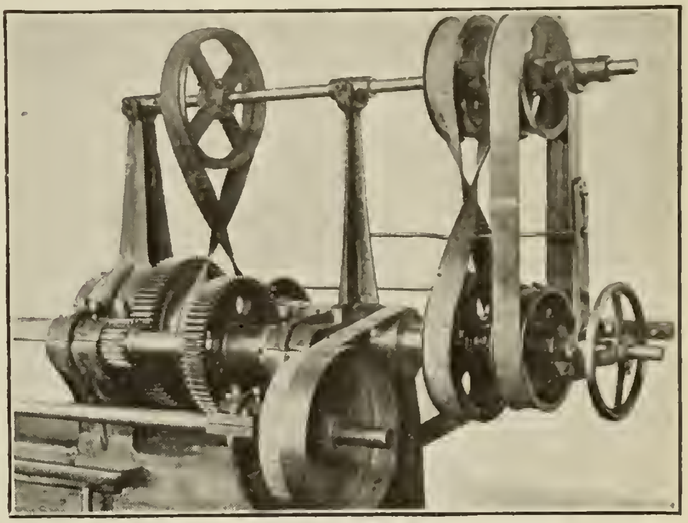


Fig. 7—Interesting arrangement of belt drive.

The following rule will be suitable for determining the power capacity of any given belt: multiply the belt width in inches by 45 for single and 75 by double belts, and by the speed in feet per minute, dividing the product by 33,000. The result will give the h. p. delivered by the belt. Suppose a 4 in. single belt is running at 1,200 ft. per min., the result will be found by the rule given, using it in the form of a formula:

$$H = \frac{w \times t \times v}{33{,}000} \text{ where}$$

H=horsepower; w=belt width; t=tension; v=velocity.

$$H = \frac{4 \times 45 \times 1{,}200}{33{,}000} = 6\tfrac{1}{2} \text{ h.p.}$$

For a 10 in. double belt running at 1,500 ft. uer min., the h. p. transmitted would be:

$$\frac{10 \times 75 \times 1{,}500}{33{,}000} = 34 \text{ h.p.}$$

It is always advisable to use pulleys as large as possible, as the action of the belt in passing over small pulleys creates stresses in the belt that add greatly in shortening its life. The percentage of the pulley circumference in contact with the belt has a vital effect on the friction between the two elements. It is obvious if the belt contact exceeds 180 deg. the friction will be greater than when less than half the circumference is covered. At the same time it will be understood that what is gained on one pulley of a connected pair is lost on the other. However, when the slack side is on top any sag in the belt when operating under load will add to the power factor. If an idler is used it is best located near the smaller pulley and on the sagging side of belt. A glance at Fig. 1 will show the advantages of proper installation of vertical or oblique drives. The ideal belt drive is the horizontal, but this condition is not always possible so that some alternative must be resorted to. In Fig. 1 the drive shown at A would be very inefficient as the contact on the small pulley is reduced as the speed increases. That shown at B is better as the effect is not so pronounced when the large pulley is the driven and at the bottom. Vertical drives should not be encouraged and some modification between it and the horizontal will give better satisfaction. A serviceable drive is shown at D, where the sag of the belt due to load causes the belt to increase its wrap around the small pulley and thus add to power transmitted. The efficiency of a belt when running horizontally will be reduced about 30 per cent. when operated at an angle of 70 degrees.

ELECTRICITY IN ITS INFANCY

(Continued from page 33)

The same thing is true of the inland waterways and ocean steamship companies. Nearly all of them, to-day, are working on the application of electrical propulsion to their own particular problems.

It is true, also, of the industries. The steel, coal, mining, in fact, all the fundamental industries of the country, are working on their own electrification problems.

The world, to-day, is not electrified. It is just becoming electrified. Within the next few years there will be a thousand-fold increase in electrification, which means, of course, that the life of every citizen in Canada is going to be affected indirectly, perhaps, but directly for the most part. Electricity and the electrical industry is just in its infancy.

The total cost of the bridge to be constructed at Ile Perrot, Que., for the Dominion and provincial governments will be approximately $260,000. Work on the superstructure will be carried out by the Dominion Bridge Co. at a cost of about $125,000, the remainder of the work being awarded to the Dufresne Construction Co.

Reasons Why Belts Slip on Pulleys

IN NEARLY every plant there are some drives in use on which more or less trouble is experienced because of the belts slipping on the pulleys, and it has become quite a common practice to endeavor to overcome this by lagging the pulleys with some special covering or by use of applications which tend to hold the belts and pulleys together when they are in contact.

The results obtained by the use of these expedients can be satisfactory only to a degree for while in many cases they apparently correct the difficulty it is quite probable that a really careful investigation will bring out that the trouble which manifested itself in belt slippage has been transformed into another form which is not so evident as was the slippage and consequently is overlooked altogether. Increase in friction in bearings is one common form which this transformation takes, and the result is a decrease in the efficiency of the power unit, which not only backs up directly to the coal pile and the money box, but is a steady boarder.

It is much like trying to cure a surface manifestation of an infection by putting on a salve. You may drive it away from some particular spot, but it will show up somewhere else and will continue to do so until you remove the cause of the infection.

There are two factors which fundamentally influence slippage—one is the resistance to slip exerted between the two surfaces which are in contact, and commonly referred to as the co-efficient of friction, and the other is the pull in the belt which is the cause of the tendency to slip. Therefore, when a belt slips on a pulley, assuming that the belt is pliable and conforms readily to the face of the pulley, it may be either because the co-efficient of friction between the belt and the pulley is too low, or because the belt pull is too great.

In probably nine hundred and ninety-nine cases out of a thousand, it is because the belt pull is too great, and manifestly the logical and rational thing to do is to decrease the belt pull, not only because it constitutes the removal of the cause of the trouble, but because it decreases the wear on the belt and decreases the friction in the bearings, and as a consequence reduces the demand on the coal pile and the drain on the money box, while increasing the co-efficient of friction accomplishes none of these advantages.

The amount of power a belt transmits is calculated by multiplying the belt pull by the belt speed, so it will be seen that if the belt speed is increased the belt pull can be decreased, and the same power will result. For instance: If the belt pull is 800 lbs. and the speed 3,000 ft. per minute, the same amount of power is being transmitted as if the pull were 600 lbs. and the speed 4,000 ft. per minute, and when you stop to figure that in the transmission of power there is a tension in the belt on both the pulling and slack side when the drive is standing still, which throws a side pull on the bearings of pretty close to twice the working pull, it will be seen that cutting down the belt pull means a great deal.

In this particular illustration the total reduction in the side pull on the bearings is something like 600 lbs., while the pull tending to cause slip on the pulleys is cut down by 200 lbs., and it is all accomplished by increasing the diameters of the pulleys. The real cure for belt slippage and at the same time a profitable dividend paying investment is:

1st. See that the belts are pliable so that they conform to the faces of the pulleys, and then

2nd. Increase the pulley diameters so that efficient belt speeds are obtained, and the belt strains are brought down to within reasonable limits.

PRACTICAL APPLICATION

(Continued from page 35)

od of measuring horsepower under actual running conditions, since with a shaft of given dimensions and material the angular displacement of torsional strain bears a constant relationship to the load applied.

As indicating the practical applications of the oscilloscope, the accompanying illustrations may be of interest. Thus in Fig. 2 the equipment is shown attached to the half-time shaft of one of the latest types of engines, the object in this case being to examine the working of the valve gear. To attach the primary shaft of the gear box to the desired part, a simple form of adapter is supplied. Some difficulty may, of course, be experienced in the examination of parts which must necessarily remain enclosed, but in this connection it may be mentioned that a considerable amount may be seen through a very small aperture, since the light may be projected in any desired direction, whilst the images formed are perfectly clear and definite.

The last-named point will be appreciated on referring to Figs. 3 and 4, which are reproductions from actual photographs of the headstock of a sewing machine running at approximately 1,500 r. p. m. In the case of Fig. 3 it will be seen that the moving parts present the usual blurred appearance which precludes the possibility of visual examination of the majority of the components. In Fig. 4, however, every part is distinctly visible, although during the time of the exposure necessary to secure the original photograph the machine made upwards of 2,000 revolutions.

Incidentally it may be mentioned as a curious fact that in general the clearest images are obtained when the mechanism is running at the highest speed.

Canadian Coal Output Affected by Strikes

Eleven Disputes Between Employers and Employees—Production Slightly Less Than Last Year—Four Million Tons in Interprovincial Trade—Large Quantities Imported From England

By S. J. COOK
Chief of Mining, Metallurgical and Chemical Branch, Dominion Bureau of Statistics

OUTPUT of coal from Canadian mines during the twelve months of the calendar year 1922 was approximately 14,210,000 tons as compared with 15,057,493 tons in 1921; 16,946,764 tons in 1920; and 13,919,096 tons in 1919. The great strike which tied up the United States coal mines for several months was reflected in Canada and resulted in a loss of 1,199,427 working days. Eleven disputes between employees and employers occurred in the coal mining industry in Canada during the eleven months ending November, nine of which were in Alberta and South-eastern British Columbia, and the other two in Nova Scotia. In all 23,901 men were affected, and of the time lost, 931,960 days were lost in the strike which began on April 1st, and 260,034 days' time was lost in the short strikes originating in August. Having in mind the fact that over one million working days' time was lost by the employees of the coal-mining industry during the year the output of fourteen and one-quarter million tons may be considered quite satisfactory. Alberta coal mine output amounted to 5,387,000 tons, a little more than half of which was lignite and nearly all the balance bituminous. Nova Scotia contributed 5,349,000 tons and occupied second place among the coal-producing provinces. British Columbia accounted for 2,936,000 tons, and New Brunswick and Saskatchewan followed with 289,000 tons and 250,000 tons respectively.

Interprovincial Coal Shipments

Four million tons of Canadian coal moved in interprovincial trade during the year, and of this amount about 2,443,000 tons was bituminous coal, the balance being mostly lignite. Shipments of Nova Scotia coal to other Canadian provinces, principally New Brunswick, Prince Edward Island and Quebec, amounted to 1,982,000 tons. The Province of Quebec received about 1,600,000 tons of Canadian coal during the year, an increase of nearly 700,000 tons above the receipts of Canadian coal in the preceding year and fully six times as much as reached this province in 1920.

The restoration of the St. Lawrence trade to the normal pre-war figure of 2,000,000 tons per season was therefore almost overtaken during the twelve months just closed. Shipments of Canadian coal into the province of New Brunswick totalled 360,000 tons, while the shipments from that province to other points in Canada amounted to 63,000 tons. Only about 10,000 tons of Canadian coal was shipped into Central Ontario during the year. Manitoba and the section of Ontario lying west of Fort William and Port Arthur received approximately 600,000 tons. Saskatchewan's receipts of Canadian coal were about 1,267,000 tons, while the shipments from that province for domestic trade were slightly under 100,000 tons. Alberta coal to the extent of 1,829,000 tons found its way to other Canadian provinces and 85,000 tons of British Columbia coal was also shipped for consumption in other parts of Canada.

Coal Imports and Exports

Exported Canadian coal amounted to 1,821,000 tons for the year comprising about 1,000,000 tons from the western provinces and the balance from the Maritime Provinces. In spite of the strike the amount of Canadian coal exported during the twelve months ending December, 1922, was only about 160,000 tons less than in the preceding year. The exports during 1920 were 2,558,000 tons, and in 1919 amounted to about 2,000,000 tons.

For the first time in many years quantities of coal were imported from Great Britain and in all about 874,000 tons was received, 710,000 tons of which was bituminous and 164,000 tons of which was entered as anthracite. The receipts at customs ports in Quebec of this coal from Great Britain amounted to 812,000 tons during the year, while New Brunswick received 47,000 tons and the balance was equally divided between Ontario and Nova Scotia. Imports of coal from the United States amounted in all to 13,937,000 tons, comprising 11,254,000 tons of bituminous coal and 2,683,000 tons of anthracite coal. As compared with the records for the preceding year the imports of bituminous coal were 2,300,000 tons lower, and the imports of anthracite were 1,885,000 tons less. Comparison with 1920 figures would indicate an even greater shortage as the imports of United States bituminous coal in that year were close to 16,000,000 tons and the anthracite imports came very near 5,000,000 tons.

Statistics have been prepared showing for each of the past three years the output, interprovincial movements, exports for foreign trade and imports for domestic consumption of anthracite, bituminous and lignite coal for each province in Canada and from the data given there has been deducted the amount of coal made available for consumption in each provincial division. For the whole of Canada the apparent consumption, or more properly, the coal made available for consumption in 1922 amounted to 27,200,000 tons and included 21,228,000 tons of bituminous coal; 3,083,000 tons of lignite; and 2,888,000 tons of anthracite coal. The principal coal-consuming province, as indicated in the table, was Central Ontario in which 9,849,000 tons was made available, including 1,716,000 tons of anthracite coal. In 1921 the same area was supplied with 11,543,000 tons and in 1920 with 13,331,000 tons. For Quebec the data given show that 4,450,000 tons of coal was made available in 1922 as compared with 4,898,000 tons in 1921, and 5,327,000 tons in 1920.

Coal mined in one province is sometimes shown as exported from another province, a notable instance being that the bulk of coal exported from the Province of Alberta is shipped through the customs ports of Fernie and Cranbrook, in British Columbia, while some Nova Scotia coal is exported through the port of St. John, New Brunswick.

Statistics show that in 1920 Canada produced 16.9 millions tons, exported 2.5 million tons, imported 20.8 million tons, and thus apparently consumed 35.2 million tons. In 1921 when the output was 15 million tons, the quantity exported amounted to 1.9 million tons, imports to 18.1 million tons, and the apparent consumption was 31.1 million tons. The decline in the consumption of coal in 1921 was in conformity with the prevalent depression in the industrial world. For 1922 the output was 14.2 million tons, the exports 1.8 million tons, the imports 13.9 million tons from the United States and 0.8 million tons from Great Britain, so that the apparent consumption was 27.2 million tons. The decrease in every item was due to the strikes prevailing during the year, although the apparent consumption of 27.2 million tons was also partly due to depressed industrial conditions. The output towards the close of the year was decidedly improved.

Motor vehicles registered in Canada during the year 1922 numbered 470,000, as compared with 402,029 cars in 1920 and 2,100 cars in 1907, according to the latest government figures. During the past four years the car registration in Canada has almost doubled, and the Dominion now holds second place in per capita possession of automobiles—about one car to every eighteen people.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

S. S. MOORE - - - Managing Editor
W. B. ROBERTS - - - - - - Editor
B. G. NEWTON - - - - - Manager
H. D. TRESIDDER - Advertising Manager

SUBSCRIPTION RATE
Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year, other countries, $3.00. Single copies, 25c. Advertising rates on request.
THE MACLEAN PUBLISHING COMPANY, LIMITED
143 UNIVERSITY AVENUE, TORONTO, CANADA
JOHN BAYNE MACLEAN, President
H. T. Hunter, Vice-President. H. V. Tyrrell, General Manager.

Mount Royal Hotel

HOW VERY soon we adapt ourselves! The travelling man who for weeks and months has been travelling through the more sparsely populated districts of our country, accepting the poor conveniences and homely accommodation of smaller hotels, which in many cases are mean in the extreme, has the good fortune to eventually blow into one of our larger towns. He casually walks into one of the largest hotels and with little or no thought, quickly accommodates himself to the modern conveniences and luxury that are afforded him without even considering the cause of this wonderful transformation. If he should happen to be of an inquisitive turn of mind, he will slowly retrace in his mind the source from which these benefits are derived. In so doing, he will ultimately find himself in a labyrinth of pumps, boilers, engines, dynamos, refrigerating apparatus, etc., in the basement, and last but not least, confronted by a competent staff of engineers whose duty it is to see that every portion of this apparatus is functioning correctly. It is this apparatus that we have briefly described in this issue, but which gives but only a slight conception of the enormous equipment that a hotel of this proportion requires. Needless to say, it would be a presumption to attempt to describe many of the interesting features of the mechanism in the space we have taken, but we can leave that for some future date when we can treat with each machine or apparatus separately and in a more complete and exhaustive manner.

Our large hotel companies are realizing the necessity of keeping abreast with the times. In their endeavour they are utilizing all the ingenuity that brains and science can produce to promote greater comfort for their guests and are sparing no expense in their effort. We can therefore see that we have a condition that is conducive to growth from which has crystalized a monument of architectural and engineering perfection and embodied in the new Mount Royal Hotel of Montreal.

Canada's National Resources

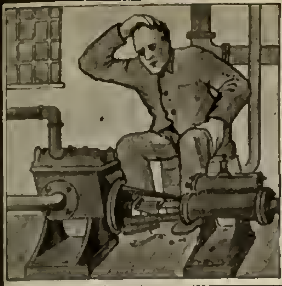
WHILST we are looking around and bemoaning the fact that there is comparatively little or no hard coal coming over the border from the States, our minds naturally turn to the resources of Canada and wonder to what extent we are self supporting. It is most refreshing whilst we are in this state of mind to hear it announced that Canada has an extensive natural product in the form of Helium gas, which is peculiar to one district in Alberta alone, where the natural gas contains 36 per cent. We are also informed that Professor J. C. McLellan, of Toronto University, can now produce this gas in commercial quantities at a very cheap rate.

The history of this gas is one of the romances of science. It was recognized and its spectrum identified more than 50 years ago, but it was not until 1895 that Sir William Ramsay, discovered and actually isolated a portion of it. The cost of producing even a very small amount of gas at this time was so high that the gas could not be utilized for any commercial purpose. It was, however, during the war that Prof. McLellan was sought out by the British Admiralty and appointed scientific adviser, in which capacity he performed a very valuable war service.

He was successful in generating this gas sufficiently cheap to bring it into the domain of ordinary usefulness, when it was used instead of hydrogen for inflating war balloons. Its value was of the highest importance on account of it being non-inflammable, whereas hydrogen was known to be dangerous from many standpoints. And now after two years' industrious research helium gas has been liquefied at 484° F to below the freezing point of water, and through which process the gas can now be produced at an extremely cheap rate.

From a scientific standpoint it now makes it possible to undertake research of a varied character in the interests of physics, refrigeration and chemistry, and before long it may possibly be introduced as a commercial proposition on account of the peculiar properties of the gas at this low temperature. Some of the peculiar properties of the gas in its liquified state, are that materials brought in contact with it, modify their physical peculiarities and characteristics in a most pronounced manner. For instance lead and rubber, which at ordinary temperatures are most pliable, can be made to become most brittle, and the magnetic properties of many of the elements become intensified. At this early stage it is hardly possible to suggest for what purpose this gas may be ultimately used, and what further avenues of science may be opened for research due to its discovery.

It may not be generally known, but during the war Prof. McLellan distinguished himself most brilliantly with the Admiralty Dept. It was during the gloomiest days of the German submarine campaign, he succeeded in perfecting the hydrophone, which very materially helped to combat this awful menace. And now in further view of his recent discovery, we feel proud that Canada can produce such a scientist, and in view of him refusing exceptional offers from abroad, he has proved himself to be a Canadian through and through, and a Canadian for Canada.



OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Question:—Would you kindly inform me through your paper the working pressure we could allow on our hydraulic press the accumulator being 4 in. bore and 2¾ in. thick; the cylinder 14 in. inside diameter, and 4 in. thick and the piping ½ in. bore and ⅜ in. thick—all cast iron?

H. H. Orillia.

Answer:—We are presuming, in answering the above questions that everything else about the plant is proportionate to the sizes given to us. We could give you a working pressure from the above particulars, but if the bolts and flanges of any of the covers or joints are relatively weak, then it would be the size of the bolts and flanges that would determine the safe working pressure and not the thickness and diameter of the cylinder or pipes. Do not forget that "The strength of a chain is its weakest link." We are therefore just answering the questions given to us and nothing must be taken for granted beyond this.

It will be understood, that in working out the strength of a cast iron cylinder, the same formula is used as that of working out the strength of a boiler shell, except that we have no seam to consider, and in the case of cast iron, the strength of material and factor of safety is different. There are quite a large number of authorities on the subject and we, therefore, think it would be a good plan to work out the strength from first principles and compare our results with the formula of some standard authority:

The formula for the strength of any cylindrical vessel is:

$$P = \frac{2t \times S}{D \times f}$$

where P = Pressure t = thickness.
S = tensile strength of material.
D = inside diameter.
f = factor of safety.

The tensile strength of cast iron is from 5 to 7 tons and since we do not know the class of material we are dealing with, for the sake of safety we had better take the least strength given. The "Practical Engineer" handbook informs us that where the load is constant, we can use a factor of 4 but if there is a variable load 8 must be used. With the above formula, using a tensile strength of 5 tons and a factor of safety of 8, we will determine the pressures.

Accumulator 4 in. dia. (inside), 2¼ in. thick:

$$P = \frac{2t \times S}{D \times f}$$

$$= \frac{2 \times 2.25 \times 5 \times 2240}{4 \times 8} = 1{,}575 \text{ lbs.}$$

Cylinder 14in. dia. (inside) 4 in. thick:

$$P = \frac{2t \times S}{D \times f}$$

$$= \frac{2 \times 4 \times 5 \times 2240}{14 \times 8} = 800 \text{ lbs.}$$

Piping .5 dia. (Bore) ⅜ in. thick:

$$P = \frac{2t \times S}{D \times f}$$

$$= \frac{2 \times .375 \times 5 \times 2240}{.5 \times 8} = 2100 \text{ lbs.}$$

It will be seen that the lowest pressure obtained from the above calculation is that of 800 lbs. for the cylinder. We will therefore check this with a formula much used in American practice, and given in Kempe's Engineer's Hand Book:

$$D = d\left(\frac{P}{f} + 1\right)$$

D = External diameter.
d = Internal diameter
P = Pressure in lbs. per sq. in.
f = 1200 for cast iron.

$$D = d\left(\frac{P}{f} + 1\right)$$

$$22 = 14\left(\frac{P}{1200} + 1\right)$$

$$\frac{22}{14} = \frac{P}{1200} + 1$$

$$P = 1200\left(\frac{22}{14} - 1\right)$$

P = 685 lbs. approx.

In this formula, however, the factor of safety has been embodied in the constant 1200 given to us, in which the factor of safety must have been a little higher than the one of 8 we used earlier. Since, however, the difference we obtain in our answers is only a matter of a difference in factors of safety used, we can take either answer to be correct, and we could think that 700 lbs. would be a reasonable pressure to operate at.—Ed.

Question:—In what proportion are dished and bumped heads on a boiler as compared to their diameter? Give a worked-out example of the formula used where no stays are required.

G. E. P.—Edmonton.

Answer:—Bumped or dished convex heads do not require staying if they are dished to a radius equal to, or less than, the diameter of the shell or drum to which they are attached.

The formula for dished heads for the province of Alberta is:

$$B = \frac{(t - 1) \times TS}{R \times 56}$$

When B = Boiler Pressure, t = thickness of the plate in sixteenths of an inch, TS = Tensile Strength of the plate per square inch, R = Radius to which head is bumped in inches, h = Camber or height of bump measured from chord in inches, C = diameter of spherical portion of head, exclusive of radius at flange in inches.

Let us suppose that the steam drum of a boiler is 36 inches dia., and the heads are made of 7/16 inch steel plate having a tensile strength of 55.000 lbs. and conform to all requirements, then

$$B = \frac{(t - 1) \times TS}{R \times 56} \quad \frac{(7 - 1) \times 55000}{36 \times 56}$$

$$= 163 \text{ lbs.}$$

Question:—In a horizontal engine running in such a direction that the crank pin is receding from the cylinder during the upper half of the revolution, which parts of the following are most affected by wear and in what manner:—Cylinder cross-head pins, guide-bars, crank-pin and eccentric sheave?

Answer:—A horizontal engine running as described would be a right-handed engine and the parts would wear as follows:—The cylinder would wear on the bottom due primarily to the weight of the piston, also to the spring in the rings. The cross-head pins would wear on the front and back sides, that is, the face nearest the cylinder cover and the one nearest the crank shaft. In each case perhaps one third of the surface of the pin would be affected or possibly less.

All the strain and wear comes on the bottom guide-bars, both on the outward and inward portion of a revolution.

If the engine was reversed, the wear would come on the upper guides. The wear on the crank-pin is usually fairly

(Continued on page 49)

Progress in New Equipment

NEW MERCURY PUMP

A new high-vacuum automatic mercury pump is described as being based on a modified Sprengel action. It works automatically, the mercury being removed from the lower to the upper reservoir, mixed with a current of dry air which is sucked through a side tube by a filter pump. The defects of design of former types of pump are discussed, their inefficiency at low pressures explained, and suitable simple remedies suggested. The introduction of an intermediate reservoir in the middle of the fall tube, kept automatically exhausted by the Sprengel action in the lower fall, allows the upper half to exert a positive exhaustion for every pellet of mercury falling down, even at the lowest obtainable pressure. The absence of compression in the first fall enables the maximum bore to be used for the fall tube; and hence speeds and efficiencies of exhaustion comparable to those of a Gaede pump are obtainable, though less than a pound of mercury is required to operate the pump.

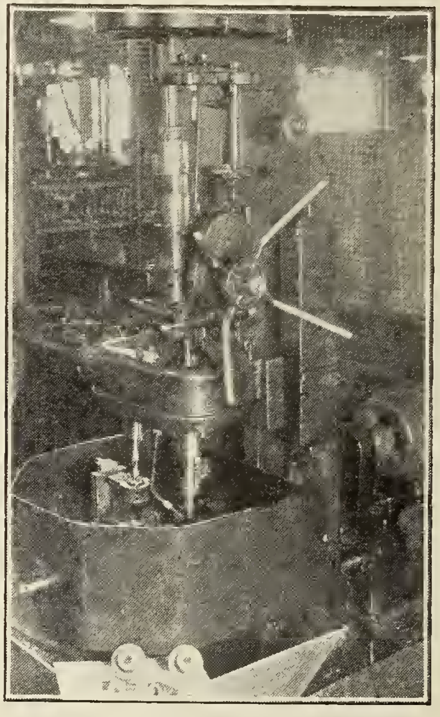
A VALVELESS PUMP

Every user of a reciprocating pump knows the endless trouble which arises in connection with the valves. However carefully these are designed and however well they are manufactured, they sooner or later require replacing or repairing owing to the heavy strain which is placed on them. With these difficulties in view countless inventors have tried to make a reciprocating pump without valves; but complete success seems to have been reserved for a British engineer. His pump has no valves and is so constructed that its cylinders fill and discharge completely on every stroke thus giving the highest possible efficiency. The only parts liable to repair of replacement are those employed in the driving head and they are all easily accessible and are standardized so that they can be rapidly interchanged at slight cost. The materials used are specially selected to ensure the maximum of wear. During a test recently carried out on a six-inch pump driven by a one horse-power motor 5,000 gallons of water were pumped per hour against a head of about six feet.

L'Air Liquide Society announce that, in future, their products will be sold by the Canadian Liquid Air Co., who will retain the sales offices and staff of the former and assume all contracts.

DRILL ADAPTED TO SPECIAL OPERATION

An interesting drilling and reaming operation on a regular Rockford 20 in. box column drilling machine is shown in the accompanying illustration and described herewith. The drill is regularly rated as having a capacity to drive a 2 in. high speed drill in solid steel. The drive is direct by silent chain from electric motor through interchangeable pick-off gears for speed changes. Four speed changes are regularly provided in a simple feed box.



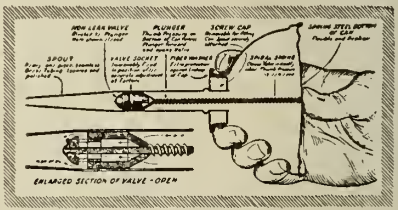
Interesting drilling and reaming operation.

A four station rotary table, with index plunger worked by foot treadle, is applied to the regular table. The rotary table is indexed by hand after the locating plunger is pulled. The table is provided with four two-jaw chucks, with formed jaws to suit the work. An extended wrench is provided so that the work of tightening the chuck screws takes place outside of the chip guard. These chucks are under work spindles with operation going on while the fourth is being loaded. A finished piece is removed at each index. A three spindle drive head equipped with a "V" gibbed slide, is mounted on the table ways. The spindle drives and feeds this head. The head is fully-counter weighted. A positive micrometer adjustment stop on the quill is provided for a depth gauge. An adjustment for height and diameter of drill; drill bushings support is provided under the left hand spindle.

The sequence of operations is given as follows: first spindle, rough drill; second spindle, rough taper ream and face; third spindle, finish taper ream. The work consists of yoke and flange members of a new oil lubricator universal joint, and production is maintained at the rate of 250 pieces a day. Diameter of rough drilled hole, ¾ in., length 2⅝ in.

NON-LEAK OIL CAN

An oil can that is constructed to prevent the dripping of oil from the spout except when pressure is applied to the spring bottom has recently been placed on the market. The valve socket is located in the spout of the can and rigidly fixed in a definite position after accurate adjustment at the factory. The valve that regulates the flow of oil from the can is riveted to the plunger that extends from the valve to the spring bottom of the can. Pressure on the can bottom forces the plunger outwards and opens the valve in the spout. A small spiral spring surrounding the plunger causes the valve to close instantly when thumb pressure is removed. The spout is drawn from the best quality brass and will not bend, turn or split. The can is made of rolled steel, copperized inside and out. The screw cap is particularly large and a fibre washer provides extra protection against leakage. All cans are tested at 110 lbs. air pressure. They are known as the "O-NO-DRIP" and are made by Arthur S. Harding Co., Boston, Mass.



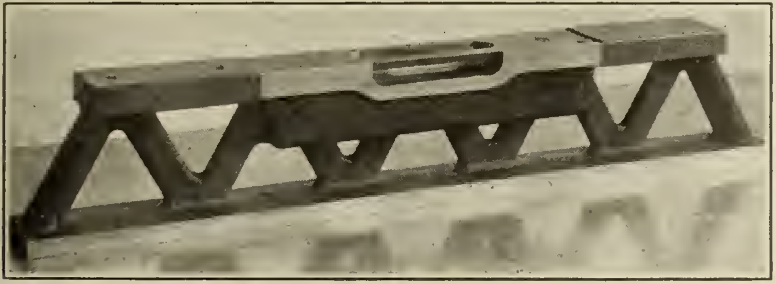
O-No-Drip Oil Can.

AN IMPROVED GAS PRODUCER

When power has to be produced at an isolated point where a waterfall is not available, one of the most economical sources is the gas producer. This appliance practically distils coal by a continuous process of air suction through the burning fuel, but most of the forms hitherto designed are open to serious objections in practice. The main difficulty is to produce a steady flow of gas of uniform quality from a producer which has to be fed intermittently. A recent type of producer developed in Great Britain obviates this drawback by arranging that the feeding of coal shall be continuous and that the fire-bed itself will be agitated so as to keep the process of distillation going ahead continuously. These improvements have now been combined with an ash extractor of novel and ingenious design. It is essential that the ashes shall be removed evenly from all parts of the ash bed continuously; and in the new producer this effect is obtained by means of a beam which revolves steadily and is provided with teeth which project upwards and forwards through the ashes. At each end there are six scoops arranged on a rotating ring, and each scoop as it revolves removes a certain quantity of the ashes forced out by the teeth already mentioned. Tests show greatly improved results over the usual type of gas producer.

TRUSSED FRAME PRECISION LEVEL

A precision level of extreme accuracy has recently been developed and placed on the market. These levels can be made with different degrees of sensitiveness but the one generally used is the 10-second instrument. With this level each division (1/10in.) that the bubble runs indicates a variation from the horizontal of .0005in. in one foot. From this reading the necessary adjustment can be readily made. A 10-second level has a vial ground to a radius of curvature of about 170 feet and is as sensitive as is found practicable for setting up fine machine tools and similar work. A 3-second level having a proportionately larger radius of curvature is more sensitive but requires several minutes for the bubble to come to rest. Levels more sensitive than 10-seconds are too sluggish for shop use.



Trussed frame precision level.

The inside of the vials used in these levels is ground with extreme accuracy to a uniform curvature and they are carefully inspected to make certain that each division indicates the same angle of inclination. This assures the accuracy of the instrument and is also particularly important in its adjustment. The frame is 15 in. long, experience having shown that a frame of this length, used with a straight edge when necessary, is more convenient and reliable than a longer one. The trussed construction not only makes the frame light, rigid and convenient to handle but also renders it comparatively insensitive to temperature changes. Insulating grips make it unnecessary to touch the frame when handling, thus eliminating possible errors due to expansion from the heat of the hands. These levels are made by the Pratt and Whitney Co., Hartford, Conn.

NEW RECIPROCATING PUMP

The Pulsometer Engineering Company, Reading, Eng., have just placed on the market a new model of a pump of the reciprocating type, which is stated to combine high efficiency with silence, compactness, and light weight. The pump is of the single-acting plunger type, fitted with patent rubber ring valves both for suction and delivery. The driving drum is arranged for connection with any convenient source of power to run the pump at 300-500 revolutions per minute. As the valves are made of rubber, and only a slight movement of this material is necessary, the pump is said to work absolutely silently. Automatic lubrication makes it possible to run the pump for long periods without skilled attention and, the moving parts being entirely enclosed, it is possible for the pump to be placed in a private house without it being a nuisance to the inhabitants either from its noise or uncleanliness. This pump is made in four sizes, ranging in capacity from 250-2,000 Imperial gallons per hour to work against heads of up to 100 feet.

Magnetic chucks are very efficient for holding small pieces for grinding, as the entire face of the chuck can be covered with such parts, thereby supporting each other firmly, so that a large number can be machined at one time, resulting in a much larger production than would be possible by handling the pieces separately.

ELECTRIC CHAIN HOIST

An electrically operated material handling hoist intended for service in places where the travelling crane or the hand hoist would not be convenient or economical, has been placed on the market recently. The hoist may be transported to any desired location and easily erected for temporary services. The apparatus consists of a standard chain hoist modified in design to be operated by a small heavy-duty motor, which drives the chain block by means of reduction gearing and a slip friction clutch; all this mechanism is mounted on a malleable iron supporting bracket. While the electric-driven hoists are regularly furnished as complete units, the motor attachment is so designed as to be readily fitted to existing chain hoists. In the event of stoppage of electric power the hoist can be operated by hand in the usual manner. The devices are made in sizes to be applied to hoists ranging from 1-4 to 10 tons capacity. The armature shaft and driving worm are supported in heavy-duty ball bearings and ample provision is made for adequate automatic lubrication. Only one hand is required to operate the pendant controller, the other one being free to steady and guide the load. Strength and lightness are features of construction. The weight of a one-ton hoist will be approximately 148 lbs. These electric chain blocks are made by the Motorbloc Corporation, Summerdale, Philadelphia, Pa.

IMPROVED FORM OF PULLEY

No kind of equipment is more familiar to the engineer than a shaft carrying pulleys; and in most cases it retains a primitive simplicity which makes it adaptable to a wide range of conditions. There are, however, cases where a departure from the traditional form is likely to be advantageous. For example, the development of ball bearings, to which keen attention is being given in Great Britain, is regarded as an important source of economy in running. Another feature is the use of a split pulley where it is necessary to add pulleys to a line of shafting. Quite a new form of split pulley, claiming many advantages, has been introduced by a British firm, and it is so simple in construction that one person can easily mount it on a pulley within a minute. The pulley is made in two parts, one forming more than three-quarters of the circle and carrying two projections against which the other piece is fitted. The adjustment of one screw tightens up the pulley and keeps it in straight alignment. No side-holding screws are employed, so that the pulley can be fitted close up to another pulley. This and its other advantages make it peculiarly well suited for experimental work where pulleys have to be put on and taken off with the least possible interruption of other work.

Electrical Section

TO PERMIT a dynamo to generate electricity, it is necessary that a magnetic field be supplied, also that a conductor consisting of a loop of wire should move across this magnetic field in such a manner that the number of magnetic lines of force due to this magnetic field, passing through this loop should be changed. It is in this act of changing the number of lines of force through the loop which results in the dynamo generating electricity.

Strictly speaking, the dynamo does not generate or create an electric current. The action of the dynamo is really similar to that of a pump connected to a well. The water is already in the well, the pump does not create the water, it simply produces the water at the location required, by lifting it out of the well.

The dynamo simply disturbs the balance which exists between Nature's supply of positive and negative potential existing in all space. The dynamo therefore simply creates this difference of potential by virtue of which a flow of current is enabled to take place.

It was found by experiment that the most convenient method by which to achieve this changing of the number of lines of force passing through a loop of wire, was to arrange such loops of wire in such a manner that they could be rotated between the poles of a magnet. This when completed was known as an armature. Such an armature may be made of any material sufficiently rigid to withstand the centrifugal force when given a rotary motion. It is merely a form upon, which to mount the necessary loops of wire. In practice, however, the armature core is always made of metal and should be made from the finest charcoal iron. The reason why it is made of iron instead of wood or some fibrous material, is entirely due to the fact that the magnetic field is intensified by the iron, in a similar manner to the effect of inserting a piece of iron into a solenoid (as explained in one of the earlier articles).

When dynamos were first made, the armature cores were made in one solid piece, and slots cut into the core to accommodate the turns of wire round the core. It was found however that all such armatures rapidly became hot, when placed in operation.

This phenomenon was due to what is termed eddy-currents. Upon devoting a little thought to this matter we soon realize how these eddy currents are generated. We wind our loop of wire along the length of the armature (so that it will face the full width of the pole piece face) and it has induced into it, a current of electricity. Therefore it is only a logical conclusion that the larger mass of metal forming the armature core, should also have a current induced in it. Furthermore, on account of its relatively large mass, its resistance will be less than that of a small conductor resting on its surface, therefore in accordance with Ohms Law, quite a small electro-motive force will be capable of circulating quite a large current through this mass and as the heating effect of a current of electricity is proportional to the current squared multiplied by the resistance, it will be apparent how soon this may reach rather large proportions.

The heating effect was also found to be very detrimental, since not only was the effect on the core to be considered, but there was the effect on the insulation of the wire forming the winding of the armature, and furthermore, there was the waste of energy in driving power. As we cannot get something for nothing, this heat energy was naturally only derived from some form of energy supplied to the mass, and this was the energy applied in causing the rotation.

The solution naturally was in reducing the mass through which these eddy-currents flowed. This could be readily effected by dividing the armature core into several sections, and insulating each section from its neighbour. The eddy-current loss is proportional to the thickness of the armature core. Obviously therefore if we make the core entirely out of very thin discs, we will reduce the eddy-current loss to a minimum. To achieve this object laminated armatures were introduced. The lamination of an armature is always carried out in a plane at right-angles to the direction in which the eddy-currents would have a tendency to flow.

The armature is built up of thin laminations or core discs not more than 1/32 of an inch in thickness, the best quality of iron only being employed for this purpose. These laminations being stamped out in the form of the finished section of the armature, they are then bolted together or keyed on the armature shaft. Generally the oxidised surfaces of the thin discs are sufficient to introduce a high electrical resistance, and so cut down the flow of current to a minimum. Frequently, however, they are given a coating of varnish, whilst in special cases, very thin sheets of paper are pasted on the surface of the discs. The resistance so built up, will be sufficient to successfully oppose the small potential difference which arises between one disc and the next, and thereby prevent any serious flow of eddy-currents.

The designs of these armatures vary considerably as will be seen from the list of the following types here given: "Siemens," tripolar, quadripolar, plain ring, slotted ring, plain drums, slotted drum, tunnel, and multipolar.

The Siemens or H armature, is now obsolete, so far as large modern construction is concerned, but is still used for toy dynamos and motors and also ignition, and telephone magnetoes. Upon considering this type it will be apparent that the conductors are spaced a full 180 degrees apart. This will mean in the case of a dynamo possessing only two pole pieces, that there will be a very great fluctuation in voltage each revolution.

The tripolar armature is an improvement on the H type on account of the conductors being spaced 120 degrees, with a consequent steadying of the voltage. By increasing the number of slots

TYPES OF ARMATURE LAMINATIONS

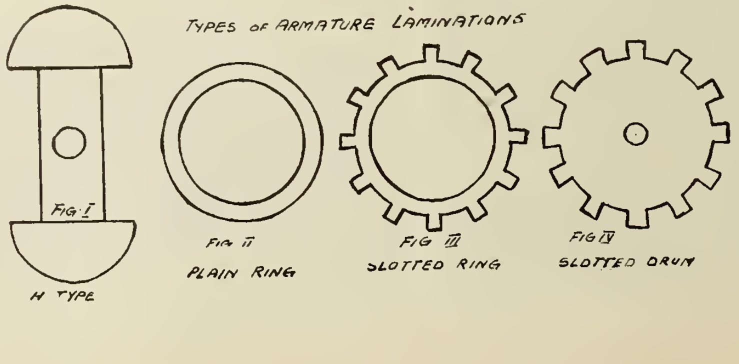


FIG I — H TYPE

FIG II — PLAIN RING

FIG III — SLOTTED RING

FIG IV — SLOTTED DRUM

round the disc, we obtain a spacing for the conductors, which permits a greater number of series conductors, and as one conductor leaves the densest part of the magnet field another so quickly takes its place, that the momentary fluctuation of the voltage becomes less and less perceptible.

The plain-ring armature is perhaps the easiest of all types to wind, the slotted-ring being only a modification of the plain-ring type, therefore the same remarks apply. It has certain special characteristics which are somewhat of an advantage, the principal one being its entire absence from local vibrations due to the magnetic lines which gather in tufts on all armatures that have a number of tooth like projections. However, its other faults weigh seriously against it, so it is no longer employed.

The slotted-drum is the type most frequently employed, and is the one most frequently to be met with in actual practice.

We are now in a position to consider the methods employed in winding the conductors, or inductors on to the armature core. It is important at this stage to fully consider again a few of the calculations concerning series and parallel circuits, dealt with in articles that appeared in this paper in February and March 1922. By once again reading the articles referred to the subject will be refreshed in the reader's mind. The necessity for the reconsideration of this subject is due to the fact that on all armatures in practical application, there are certain conductors that are in series throughout the winding, whilst others are in parallel, and it is the combination of these parallel windings which has to be taken into consideration when arriving at the fundamental equation for the generation of the voltage of the dynamo. Furthermore, the capacity of the dynamo in amperes is governed by the sectional area of the conductors and the number of conductors in parallel.

For some strange reason or other, this subject of armature winding has become shrouded with an atmosphere of mystery, and plant engineers have permitted themselves to become scared at the thoughts of any attempt at winding an armature which has broken down. All modern armatures have a closed circuit system of windings, which means that the current after circulating through the whole of the windings; comes back to the starting point again. The simplest way to approach this subject is to consider the armature to be cut open and spread out flat, which gives what is known as the developed system. It is possible then to see just where each loop of wire goes to, and where it takes its bend at the back end of the armature.

To avoid the complications of having too great a number of lines on the sketch it is much simpler to follow, if each slot in the armature is only supposed to contain one conductor. It will be observed that a certain length of wire is required to make the connection to the commutator, and that length of wire is outside the face of the pole pieces. This does not affect the electrical continuity of the circuit, as the current has already been induced in the coil and will flow round it and down on to the commutator, and from there be picked up by the brushes. In fact the commutator forms an excellent medium for making a good joint, as it should always be so arranged that there are no joints along the loop of wire forming the inductor.

By following the arrows round each circuit shown on the armatures in Fig. 5 and Fig. 6 it will readily be seen how the current circulates through the whole set of windings, coming back to the place from whence it started. In the sketches, only one coil in each winding has been shown to permit of the subject being more readily understood. In actual practice, however, several coils would be included in each sector of the armature but this makes no difference to the pathway of the current, since it would merely go round and round in that particular sector, the number of times that there were number of turns. It would then pass on to the next coil in series and again round and round as before, but there would only be two ends to each coil, no matter how many turns comprised the coil, one end would start the coil and the other would terminate it.

In Fig. 7 there is shown a sketch of a 12 slot-drum-armature, and a 12 segment-commutator. It is easy to see at a glance in this figure the active conductors as represented for an armature to revolve within a 2 pole field. It will also be noticed that the span of the armature coil is just one half of the circle, or in other words, covers 180 degrees. This is because each coil must be so spaced that it covers the face of the pole-piece when it is present to the pole. In other words, as one side of the coil is under the one edge of the pole piece, the other side of the coil should just be under the other edge of the opposite pole piece. Opposite sides of the same armature coil must always lie under poles of opposite polarity. This is the reason why a 2-pole armature will not work if placed in a dynamo which possesses a 4-pole field.

In the case of the armature shown in Fig. 7, if we wished to make this suitable for running in a 4-pole field instead of a 2-pole, we would have to strip the armature and arrange the span of the coils to meet the new conditions. Since opposite sides of the coils must be under opposite pole pieces, and as we have now 4 pole pieces spaced 90 degrees apart, we need to divide the armature into 4 sectors of 90 degrees each, and relay the coils in the slots falling within each of these sectors. See Fig. 8.

It will be obvious that each coil performs its own little function in having a current induced into it as it passes under the influence of each magnetic pole. Such a current will be of a certain voltage, but the voltages now called for are higher than can be commercially obtained by several coils in one slot of the armature, therefore we need to connect a certain number of the coils together in series, and so augment their voltages until for a given speed we can obtain voltages in the nature of 250 to 500 as is now generally demanded.

Both ends of the coil on the armature must be connected to the commutator, and for convenience the segment on the commutator nearest to the free end of the coil may be used for the first connection, but the other end of that particular coil must have sufficient length to reach back to the segment of commutator next to the segment to which the beginning of the coil is connected. This is known as the "step" of the commutator.

There are two distinct methods of applying the winding to the armature core, one is by hand winding, and the other is former winding. The hand-wound armature is now only used in the case of very small machines, in all other cases former winding is generally used.

Former winding is much more symmetrical in appearance, and is far easier to ensure good insulations between the coils, as the coils are wound on wooden shapes or "formers." These are then varnished, taped and snugly fitted and shaped to their final position without the forcing and crushing of the insulation which frequently results from trying to wind the coil smoothly and tightly in the case of hand winding. Furthermore, portions which are at the maximum potential difference are brought close together, and there is apt to be difference in respective lengths of the coils, leading to unequal resistance. This would cause a difference in current values, with a resulting difference in armature reaction, which again results in troubles in obtaining sparkless commutation. However, as they are much

(Continued on page 52)

TYPES OF ARMATURE LAMINATIONS

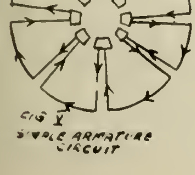


FIG V
SIMPLE ARMATURE CIRCUIT

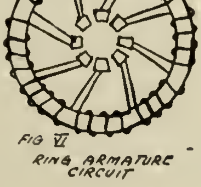


FIG VI
RING ARMATURE CIRCUIT

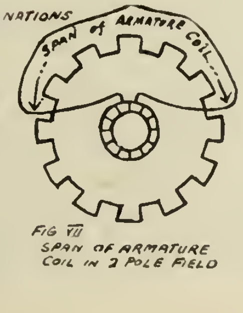


FIG VII
SPAN OF ARMATURE COIL IN 2 POLE FIELD

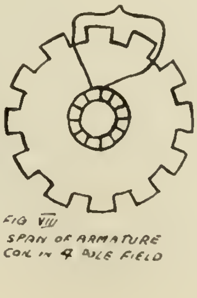


FIG VIII
SPAN OF ARMATURE COIL IN 4 POLE FIELD

Operators' Point of View

OIL VERSUS COAL

R. M. McLaren

Being slightly interested in the relative values of oil and coal as fuel, I collected some data based on the experience of several users of oil. In one plant I was told that an evaporation of 14 lbs. of water was obtained with oil. The evaporation with coal was not given, but Chas. C. Moore & Co. credit oil with an efficiency on an evaporation basis of 4 per cent. better than coal. This is undoubtedly on the assumption that both coal and oil plants are good. The comparison of a good oil plant with a poor coal plant would be unfair and the comparison of a good coal plant with a poor oil plant would also be unfair. We may also assume that they have taken a stoker-fired plant as the basis for their comparison and that a stoker plant will have 5 per cent. better efficiency than hand firing. As I wished to compare oil-burning with hand-firing we will have to allow an advantage of 9 per cent. to oil.

The evaporation of 14 lbs. of water would require 14 x 970=13,580 B.t.u. (Marks gives 970.4 as the latent heat of steam). This gives an efficiency of

$$\frac{13580}{19000}=71.5$$

almost, assuming that the oil has a B. t.u. value of 19,000. The specific gravity of fuel, or reduced oil is about .9 and at 9 cts. per gal. the price per lb. would be 1 ct. The efficiency of the coal plant would be 71.5—9=62.5 per cent. and assuming that the coal has a heating value of 13,000 B.t.u. there would be transmitted to the water

$$\frac{13,000 \times 62.5}{100}=8,125 \text{ B.t.u.}$$

Coal at $9. per ton=9/20 cts. so that for one cent we would get 20/9x8,125=18,055 B.t.u.'s transmitted to the water.

We all see that in buying coal we get

$$\frac{18,055 \times 100}{13,580}-100=$$

33 per cent. more for our money on the basis of evaporation than we do when we buy oil. There are charges to be added to the cost of coal for handling, storage, etc., but there are charges to be added to the cost of oil also for boiler room attendance, atomizing (when steam is used), etc., so that I don't see how it is possible to add 1/3 to the cost of coal. The saving in labor depends on the size of the plant and unless the plant has at least ten boilers in operation it is impossible to realize the best possible saving in labor.

In another plant the evaporation was given as 13.7 lbs. This was another win for coal.

In another plant an evaporation of 15.2 lbs. under test conditions was claimed. This is a little more than 8 per cent. better than 14 lbs. and the owners of the plant admitted that they were not using oil because it was cheaper. (They admitted that it cost more to use coal and for other reasons.)

In some plants it was not known what the evaporation was, so they made the comparison on the basis of the annual fuel bills, a rather crude and common basis, or perhaps they liked oil. The annual fuel bill basis is crude because the climate affects the demand for heat, although some will say that it takes just as much fuel in mild weather as it does in cold. I wonder if such people run their heating plants in summer and if they don't, why not?

In one plant it was claimed that 85 gals. of oil was equivalent to 1 ton of coal, and this the best anthracite. This looked good, so some figuring was done. Now 85 gallons of oil would contain 85 x 9 x 19,000=14,535,000 B.t.u. and allowing an efficiency of 75 per cent. for oil, there would be

$$\frac{14,535,000 \times 75}{100}=10,901,250$$

B.t.u. transmitted to the water. This is also the amount of heat transmitted from a ton of coal to the water. Assuming that the heating value of the best anthracite is 13,200 B.t.u., there would be in 1 ton of coal 13,200 x 2,000=26,400,000 B.t.u. As 10,901,250 B.t.u.'s are transmitted to the water the efficiency of the coal plant must have been

$$\frac{1,901,250}{26,400,000}\times100=41.3$$

per cent. or nearly. This is efficiency that very few of us would be proud of. But there may be another reason why 85 gallons of oil is the equivalent of one ton of coal and it may be the high price of the coal. It will be seen that 10,901,250 B.t.u.'s are transmitted to the water. This must also be the amount of heat in the coal transmitted to the water. The coal plant was assumed to be 66 per cent. efficient, so the total heat in the coal must have been

$$\frac{100}{66}\times10,901,250=16,517,000$$

B.t.u.'s, about. This amount of coal cost the same as 85 gallons of oil, or $7.65, so 264,000,000 B.t.u.'s, or one ton of coal must have cost

$$\frac{26,400,000}{16,517,000}\times765=\$12.23.$$

It doesn't look quite fair to ask us to believe that 85 gallons of oil is the equivalent of a ton of coal without telling us why. "Caveat Emptor" may be good law but it is not good justice. However there are places where law is in the ascendancy over justice. The problem may be clearer to some when it is explained that 16,517,000 B.t.u. is the heat value of 1,251 lbs. of coal, that is

$$\frac{16,517,000}{13,200}$$

A claim that is frequently made for oil is, that the efficiency may be or is maintained at a higher level than it is with coal. While it is possible to do so, no doubt, it was found that it was not always done. I found this out when I discovered that in a plant that got an evaporation of over 15 lbs. under test conditions, it slumped to about 10.5 lbs. for a week's run. This is not very complimentary to oil. Coal could hardly do worse.

In conclusion I would like to call the attention of a gentleman named Shovel to a slip he made in Power House, Nov. 20. Mr. Shovel bases his calculation on oil weighing 10 lbs. per gallon. This is hardly correct. Mr. Shovel also gives 7 cts. per gallon as the price of oil. This looks rather low, but perhaps Mr. Shovel lives in an oil country.

BENEFIT FROM POWER HOUSE

Editor, Power House:—

As a reader of Power House I desire to express a word of appreciation for the way in which our late editor, T. H. Fenner has labored to assist the stationary engineer in his struggle to mount the ladder of progress.

I myself have derived much benefit from his teachings, having gained considerable knowledge on engineering subjects both through P. H. and his teachings elsewhere. Great credit must be given Mr. Fenner for the able and practical manner in which he conducted the "Question Box," for this department could not have been other than of great assistance to all readers of Power House. I for one am guilty of taking considerable time of our late editor through that department.

There may be others at present writing in the same tone as I, but if not, I am sure that there are hundreds who are thinking the same and are appreciative for the knowledge they have gained through P. H. during Mr. Fenner's editorship.

I am glad to learn that he is not leaving our midst but that we shall see him occasionally.

The least that we can do is to wish him every success in his new sphere of endeavor.

E. G., Toronto.

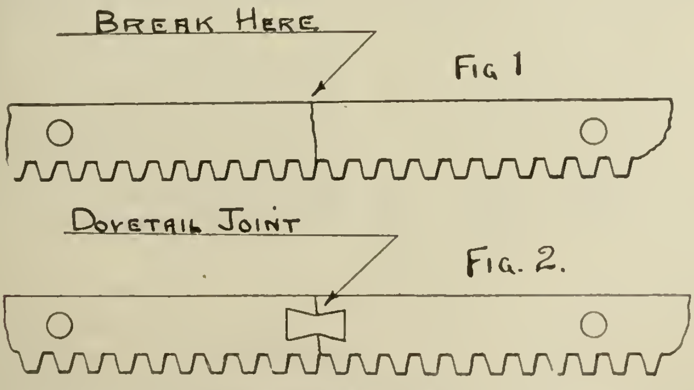
MARINE BOILERS FOR LAND STATIONS

During the war many important advances were made in the design of the boilers fitted to British men-of-war. The exraordinarily severe service demanded from naval boilers stimulated invention in many directions. The reduction since the war in naval programmes of all nations has accordingly restricted the demand for such boilers, and the makers are turning their attention to other fields. They have found a very promising one in the electric pump station. The marine type of boiler has the advantage of taking up comparatively little space and of being able to give a very rapid increase in steaming power, when, for example, a sudden load comes on the station. In one large British electrical station two of these boilers are being fitted with oil burners, and excellent results are expected to follow.

"REPAIRING A BROKEN RACK"

By G. Blake

This was a small mild steel rack, which had broken as shown in Fig. 1. As it was not possible to cut another, the writer repaired the broken one as shown in Fig. 2. Two dovetail slots were cut, one in each of the broken ends, and a dovetail wedge piece was snugly fitted. The slots were given a slight taper or bevel so that when the rack was brazed the molten metal would flow into the bevelled slots and make a solid joint. Regarding the brazing, it may be mentioned that to ensure the rack being straight, and to prevent any warping it was supported on a cast iron slab on two thin parallels near to the joint and held in that position by two small clamps during the brazing operation. This repair turned out entirely successful, and much time was thereby saved by repairing the broken rack, as to get another from the makers would have taken nearly a week.

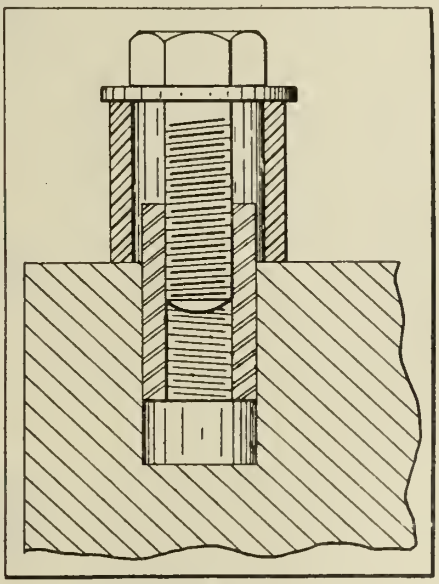


Repairs to Machine Rack.

REMOVING BUSHINGS

By A. Le Marshall

A method which the writer has used for a number of years in removing bushings from blind holes, and one that has given good satisfaction, is to run a tap of the nearest size into the hole of the bush so that a shallow thread will result. By placing a sleeve, a little larger than the bush, over the opening and using a washer and cap screw as shown in the sketch, the bush can be drawn out quite easily. This method will be found useful in automobile work, where the through hole is a trifle larger than the inside diameter of the bush. The writer has used this method in removing hardened bushings from air hammers. First plug the hole with fire clay to keep flame out of cylinder then heat and anneal bush, after which tap and draw out as stated.



Removing tight bushings.

QUESTION BOX

(Continued from page 43)

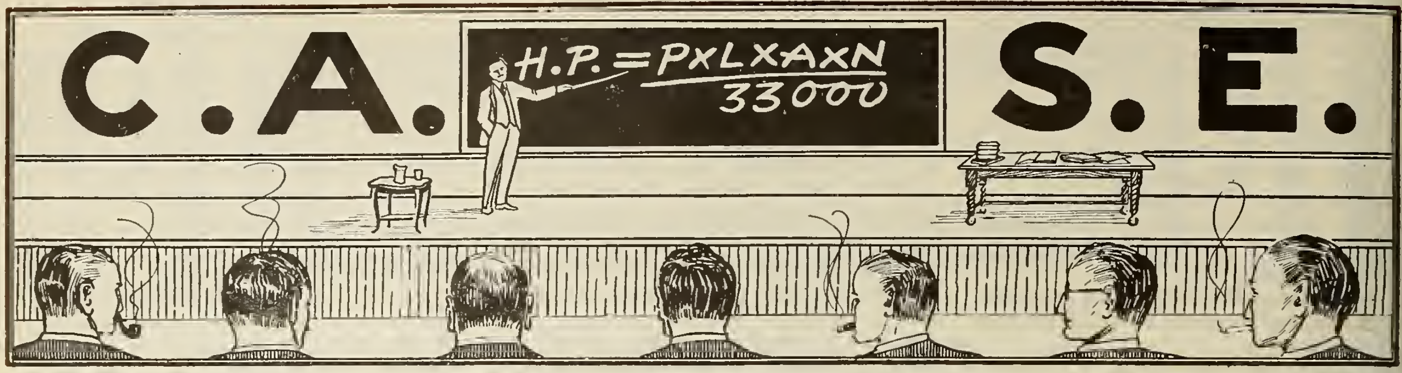
uniform, although if great accuracy was needed, it would be found that it wears slightly more at the point of greatest effort, that is, when the crank in nearly on the top and bottom of its path, or the cross-head is about mid-position. On account of the pressure being greatest at this point, the friction of the brass has the greatest wearing effect upon the pin. This last remark would also apply to the action of the strap and sheave of the eccentric, although the point of greatest effort, in this case would be when there was the greatest resistance due to friction on the valve face. The thrust or wear on the guide of the valve spindle would be directly opposite to that of the cross-head guides. An article will shortly appear in Power House dealing with the question you raise in respect to the length of connection rods and valve spindles.—Ed.

Question:—In a battery containing four boilers having the feed water pipes connected to one common header, it is found that whilst the boilers are in operation, the water gets too high in some boilers and too low in others, even when all the feed regulating valves are fully opened. It is also noticed that the same boilers are differently affected at different times. State the probable causes and methods of remedying this.

J. K.—Fernie.

Answer:—We are afraid J. K. is having a trouble that is very often experienced in a boiler room, especially where there are a large number of boilers and the boiler house is on an exposed position. There is, however, no mystery about such a condition. It simply means, that if the feed water is actually being pumped into the boiler, and the water level is falling, if there are no holes in the bottom of your boiler, the water is actually being evaporated. I have seen the same condition on numereous occasions, and in some cases it has been found that a change in the direction of the wind has had some effect upon it. It would be a good idea to keep a record of weather conditions the next time this occurs and by careful observation, you may possibly trace the origin to some such cause. It would be advisable to examine your brickwork dampers and baffles (if boilers are of the W. T. type) first and make sure everything is in good condition and tight.—Ed.

Winnipeg.—A terminal elevator with a capacity of 1,500,000 bushels will, it is reported, be erected at Port Arthur by James Stewart, president of the Maple Leaf Flour Mills, according to authoritative information obtained here. The cost will approximate $850,000 and construction will be commenced during the forthcoming winter. The site selected is near Thunder Bay elevator.



THE program for 1923 is herewith produced for the benefit of new subscribers to Power House. The complete program was dealt with in Power House issue of Aug. 20, 1922.

1923 Educational Program

January—First meeting: Boiler Room Appliances. Second meeting: Makes and Types of Feed Water Pumps.

February—First meeting: Miscellaneous Auxiliary Appliances for Boiler and Engine Room. Second meeting: Types and Makes of Steam Engines in Use.

March—First meeting: Indicating and Recording Meters—Their Types and Make. Second meeting: Indicating and Recording Instruments For Pressure and Vacuum.

April—First meeting: Boiler Room Efficiencies and How Determined. Second meeting: Engine Room Efficiencies and How Determined.

May—First meeting: Report Forms and Records. Second meeting: Useful Formula and Data.

The general education committee of the C. A. S. E. have entered the second section of their program for the season of 1922-1923. During the 1921-1922 season there was but one subject scheduled for each month, but this present season has seen a more intensive program arranged, there being two subjects, one for each meeting during the month. The different branches of the C. A. S. E. have been doing good work in connection with educational lines and no doubt more engineers will avail themselves of this splendid opportunity for education in the future.

Montreal.—There has been a rumor for some time that the Montreal branch of the C. A. S. E. are considering the formation of a separate organization, to be known as the Montreal and Quebec Province Educational Association. This is unfortunate, both for the C. A. S. E. and the Montreal branch. In view of the fact that the honors of grand president are now held by one of their illustrious members, they should hesitate to do anything that would tend to arrest the good work done by him in the past.

Although he was not one of the original incorporators, Henry Wright, chief engineer of the Hochelaga power plant of the Montreal Tramways, has done more than any other engineer to steer the C. A. S. E. "barque" in the right course. In fact, the splendid and unselfish work done by him both personally and by arduous correspondence with all the various provinces in the interest of the C. A. S. E. makes him well deserving of all the honors which could be given him not only by the C. A. S. E. but by all operating engineers. Mr. Wright is himself an honor and a credit to the association, being a member of both the American and Canadian associations of mechanical engineers. Besides encouraging the C. A. S. E., he has been instructing classes in engineering both in the C. A. S. E. and Y. M. C. A. Mr. Wright was the pioneer and most enthusiastic supporter of the Dominion-wide certificate with a uniform and standard form of examination, and his ambition can best be accomplished through a national organization such as the C. A. S. E.

There may have been some dissatisfaction with last year's educational program, and possibly some feeling about the present rules of government. However, these can all be eliminated and a broader and better one substituted. If Montreal contemplates something better then the engineers from coast to coast should have the benefit of it. Stick by the old ship C. A. S. E.

Toronto.—No. 1 C. A. S. E. held their regular meeting from 8 to 11 p. m. Jan. 16. It was a very stormy night in more ways than one. However, in spite of it being the coldest night of the year, quite a few remained to attend the educational program which was put on by R. McLaren, the chief engineer of the Massey-Harris Co. The subject was Feed Pumps and Their Various Types and Makes. Mr. McLaren read a paper on the subject and also made graphic illustrations on a large blackboard in connection with his paper. The whole lecture was listened to with very great interest.

As a result of the intensive educational campaign put on by Toronto No. 1, also the special interest taken by the newer members, a large increase in membership is looked for in the near future.

The subject for discussion at the next meeting of the C. A. S. E. will be: Various Types and Makes of Circulating Pumps. Papers are invited from members and "adherents."

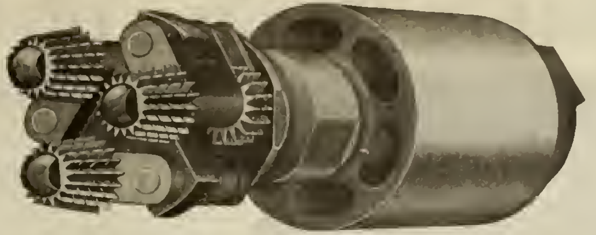
The friends of G. A. Brown, the recording secretary of Toronto No. 1, C. A. S. E., will be glad to know that he has fully recovered from his recent illness.

Split Bearings

Difficulty.—Small two-part split bearings made out of lead-base babbitt have a spongy surface on shaft bearing part. Heating of shells, mandrels and babbitt being correct. **Remedy.**—This is due to the fact that the shells have been poured with their mandrels on top, thus allowing a certain amount of dross to fill up the part of shell in contact with the revolving shaft; a lead-base alloy generally has more dross to it than a tin-base one. These small two-part bearings are best poured in a horizontal position, bottom upwards (which causes any dross to rise to the top and makes it stay next to the bottom of the shell when casting is done), the mandrel resting on a surface plate and the molten metal poured through holes in the bottom of shells. This method of working has the great advantage of making the bearing surface very clean and dense, the babbitt is compressed by the weight of metal on its top, which faces the bottom of shells, an impurities or dross thus remaining bottom part of the finished casting

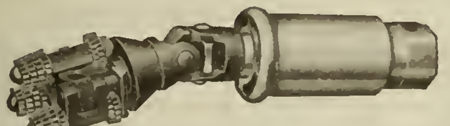
In the pouring of large 2-part bearings using the same quality lead-base alloy, as in the small bearings listed above, it is much better practice in order to get sound castings, to have the shell and mandrel in a vertical position, the front bearing surface facing downwards. This causes any dross that will form to rise to the back end of the casting part which faces toward a shaft's end so that there will be a thin layer of dross that can be cut off if proper allowance has been made for extra metal. These large bearings can also be cast bottom upwards like the small two-part ones, but, as a general rule, it will be found much more convenient to do this pouring with the shells in a vertical position.

Amherst, N.S:—A preliminary survey has been completed by the Nova Scotia Power Commission with reference to their projected power development scheme on the Economy River.



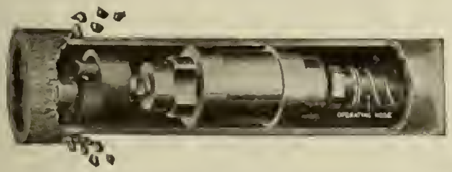
Standard Water Driven Tube Cleaner

KEEP YOUR BOILERS CLEAN



Lagonda Water Driven Cleaner for Curved Tubes

Lagonda Air Driven Cleaner for Straight Water Tubes



Cleaner Removing Scale from Outside of Fire Tube

All natural waters contain some impurities which, when introduced into a boiler, may appear as solids deposited on the heating surface. No matter what the substance consists of, it must be removed at frequent intervals or it will decrease the capacity and efficiency of the boiler and may cause it to be badly damaged by over-heating.

Some waters, notably well waters, deposit such quantities of scale that they should be purified before going into the boiler, thereby preventing an accumulation of incrustation and consequent damage to boiler parts, and at the same time effecting a large saving in fuel by keeping all parts of the heating surface in a clean and efficient condition. If you have bad feed water it is a case for the chemist, for the scale is probably composed of several substances which must be known before the exact treatments necessary to get rid of them can be determined upon. The use of treatment without technical advice is poor policy.

Stony and vegetable matter in suspension can be removed by FILTERS, which we supply in various sizes and designs to suit all requirements. In most Canadian plants, lake or river water is used for feed, and these waters seldom carry large quantities of scale-forming materials in solution. Scale can be allowed to form in boiler for a considerable period. Experience in each individual plant determines the limit at which tube difficulties will begin or a perceptible falling off in efficiency will take place. With such a limit of scale formation fixed, and the danger of allowing it to be exceeded, well understood, probably the most economical and efficient method of keeping the heating surfaces clean is by use of the LAGONDA TUBE CLEANERS.

The cleaners are designed and so constructed as to thoroughly remove all the scale, in the shortest possible time, at the lowest cost of operation, and they require a minimum amount of repairs, reducing both the waste boiler time and labor cost of cleaning.

They are made to operate by either water, air or steam. In every case a swing head is furnished so designed that three sets of cutters are thrown out by centrifugal force against the scale in such a manner that they make straight line contact with the tube and they do the work without damage to it.

You can be supplied with LAGONDA tools for cleaning Economizers, Condensers, Evaporators and other tubular plant.

We shall be very glad to furnish full particulars

BABCOCK & WILCOX, LIMITED

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE, BANK OF HAMILTON BUILDING

A Reasonable Saving of 5 to 10%

Should You Expect More?

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee St. PHONE G. 3660 Toronto, Ont.

ELECTRICAL SECTION

(Continued from page 47)

easier and quicker to manufacture, and since all coils in any given armature will have the same displacement, throw or pitch, one former would be sufficient upon which to form the shape of the desired coil. Furthermore, on account of each coil being quite symmetrical there is no tendency to unbalanced voltages due to the difference of self-induction. Therefore all the evidence is in favor of the coils being former wound, especially when we consider how they simplify the actual operation of winding. Again the coils built on a former have been made to the exact "pitch" of the armature and as the coils are bound to be correctly spaced they will fit snugly in the slot to which its "pitch" conforms. This should fit without much strain or forcing and the edge of the coil just be sufficiently short to make the fitting "friction tight."

Largest aluminum casting ever made in United States was cast at plant of Light Mfg. and Foundry Co., Pottstown, N. J. It weighs 1,275 pounds, five feet high and eight feet long and was cast for a printing press concern at Dunellen, N. J.

Montreal.—The new foundry of the G. & J. Weir Co., Ltd., at Ville St. Pierre, Montreal, built in 1922 at a cost of $400,000 is now being operated. In addition to pump castings a full line of grey iron, bronze and gun metal castings is being produced.

Toronto.—The British-American Oil Company is enlarging its Toronto refinery by adding a new process building which contains the latest machinery for the production of certain lubricating oils. This plant will enable it to manufacture oils at present in demand which heretofore it has not made in large quantities. The company has also established six new branches in Ontario and Quebec, each of which has large tank storage accommodation as well as warehouse and office facilities.

M. S. U. A. ANNUAL REPORT

We always expect to find something interesting and original in the annual report of Mr. Stromeyer, Chief Engineer to the above association, and the present report has proved to be no exception. The fatigue tests are very unique and give us food for much thought. The "Principles of Boiler Design" treat with this old subject in a very comprehensive way and the specific heat formula, evolved after a large number of trials, is further interesting material on a very important subject.

Plans by the T. Eaton Co., Toronto, propose the immediate conversion of the older portion of their store, built in 1883, three storeys high with a frontage of 120 feet on Yonge st., into a modern structure of eight storeys. It will contain 200,000 square feet of floor space, equipped with traction elevators and other equipment of the latest type. The work of alterations will proceed without interfering with the regular business.

INGLIS PLANT TO MAKE CONVEYING EQUIPMENT

CHICAGO.—Webster Mfg. Co., manufacturers of elevating, conveying and coal rehandling machinery, have entered into an agreement with the John Inglis Co., Toronto, Canada, whereby the latter will make certain of the Webster lines in Canada. It is understood that a Canadian sales company has been formed with William Inglis, head of the John Inglis Co., and the president and vice-president of the Webster Mfg. Co., as chief owners. Mr. Inglis will be president of the new sales company, and it is announced that R. L. Smallwood, formerly general sales manager for the Dodge Mfg. Co. of Canada, will be sales manager. This organization will in no way affect the identity of the John Inglis Co., but will have to do solely with the marketing of Webster equipment as produced in the Inglis plant.

The Webster Mfg. Co. have factories here and at Tiffin, Ohio.

NEW PUBLICATION

We have received a very interesting booklet from De Lavel Steam Turbine Co., Trenton, describing the installation of a geared turbine, driving a direct current 600 K. W. generator and 500 K. W. alternator in the plant of the Crown Williamette Paper Co., West Lain, Oregon. The interest of this installation is that the turbo-generator provides sectionalized speed control, also that the various sections of the paper machine are driven electrically by D. C. motors. The relative speeds of the several rolls, as required to take up the "draw" or stretch of the paper being maintained accurately by synchronous motors belted to the direct current motor shafts with adjustable cone pulleys.

NEW EQUIPMENT IN CHATEAU FRONTENAC

(Continued from page 33)

ventilators. Also wine room refrigerator, installed by the Canadian Jewett Company of Bridgeburg, Ont.

The refrigerating system comprises a ten-compartment general storage refrigerator with two vestibules, also wine room refrigerator installed by Canadian Jewett Co., of Bridgeburg, Ont.

Smiths Falls.—Northern Buttons, Limited, is a new industry which located here at the beginning of the new year. At present, twenty-six hands are employed and this is likely to be increased to fifty by Feb. 1st. Manufacturers' Chemical Co. have purchased a site here and when in operation will employ between fifty and one hundred hands. Frost & Wood, manufacturers of farm implements, are doing a very good business for this season of the year, and are employing four hundred hands. Wood Sawmills, owned and operated by the United Farmers, had a ten-thousand dollar loss by fire recently. Valuable woodworking machinery was destroyed. They intend to rebuild and equip a new plant immediately.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Member American Society of Mechanical Engineers

M. BARRY WATSON, M.E.
Consulting Mechanical Engineer

Designs Perfected. Inventions Developed, etc.

192 Arlington Ave., Toronto
Phone, Hill. 6976W

Sturtevant

The Sturtevant cindervane does away with cinders and speeds up production by maintaining greater draft.

Our sales-engineers will explain to you the economy of the installation. Ask for folder 609.

B. F. STURTEVANT CO.
of Canada, Ltd.

Montreal *Galt* *Toronto*

FOR SALE

SALESMAN WANTED FOR STEAM SPECIALties, power house and heating equipment. State age, education received ,and previous experience if any. Box 101, Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison, & Son, R. R. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

TAYLOR SAFES FOR SALE—RARE OPPORtunity to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

FOR SALE
Fuel Oil Storage Tank
10,000 GALS. CAPACITY.

This is a new tank. We have not yet taken delivery of it, and offer it at a very attractive price.

MR. VOGAN, The MacLean Publishing Co.,Ltd, 143 University Ave., TORONTO.

GEO. CALLARD
BUILDER & CONTRACTOR

Furnace and Boiler Work a Specialty

Highest References from All the Leading Engineers of the City

Phone: Uptown 1590

210 Quesnel Street
Montreal

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES **$1 A MONTH**
8754 ILLUSTRATIONS **$12 COMPLETE**

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you , 1 monthly until $12 is paid.

Signature ________________

Occupation ________________

Employed by ________________

Residence ________________

Reference ________________

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings ***Forgings***
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations. ***Write for our latest catalogue***
Patterns **Machine Work**

INVESTIGATE THE
ADVERTISEMENTS
APPEARING IN EVERY ISSUE
OF POWER HOUSE

YORK Ice Making & Refrigerating **MACHINERY**
For Every Practical Purpose
Consultation on any Refrigerating Problem invited.
CANADIAN ICE MACHINE CO., LIMITED
Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

OIL BURNING SYSTEMS
INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.
LAURIE ENGINE CO.
(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.

Man Either Progressive or on the Retrograde

By **G. M. EATON**

LET Y equal the burden of responsibility imposed by the job.

Let X equal the number of men competent to shoulder the load.

Analyzing the limits, we find when no burden of responsibility exists, anybody can fill the bill, and therefore when Y = zero, X = infinity.

When the burden is infinite, no man can stand the gaff, and therefore when Y = infinity, X = zero.

Analyzing the approaches to the limits, we see that a small increment of responsibility above zero eliminates a very great number of individuals. Each successive increment, however, eliminates a decreasing number.

We can, therefore, at once describe the general shape of the curve as referred to rectilinear co-ordinates. It is asymptotic to both axes and is concave up. It is obviously approximated by the hyperbola with the equation XY = a constant. See Fig. 1.

For purposes of discussion, we will neglect the possible detail discrepancies between this equation and the actual and proceed as if it were fundamentally true. true.

Stated in words:

The product of responsibility and the number of men competent to bear it, is a constant.

Life in the abstract is a hyperbola.

Life in the living is climbing the hyperbola.

We will first study a few of the phenomena encountered in ascending a single hyperbola, bringing out later that a third dimension is involved and that no real life exists in "Flatland."

Consider the case of a group of university graduates entering an industrial establishment as students. In the first analysis the curve covered the entire human race, but with Mr. Einstein's permission, we will change our measuring stick and the curve will at once represent the ability the employer expects to find in these men. They start at the right-hand end of the curve, but obviously their load-sustaining capacity covers a wide range. There is, therefore, an apparent discrepancy in our equation.

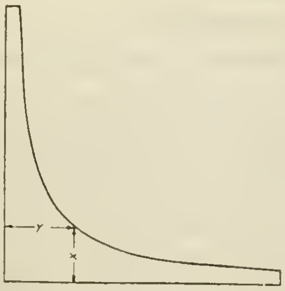


Fig 1

There was a time when it was considered up to the young man—and up to him alone—to show what stuff was in him. To-day the existence of a joint responsibilty is recognized. The mist must be penetrated by both the man and the establishment. The more thorough and effective the effort on both sides, the quicker will be the clearing of the atmosphere, and one head after another will appear above the fog, to start moving toward its logical position on the curve, till the group is strung out and each man moving at the speed dictated by his ability and effort. We will assume that even the least able man has made material advance.

Now take that part of the curve intercepted between the men of the highest and the lowest ability; again apply the principle of relativity, and Fig. 1, after a fashion, represents the group from a somewhat different angle. The lowest man has advanced in his actual capability to serve, but relatively he has slipped back. We have, therefore, a new slant on the adage that "A man goes up or down and cannot stand still."

Periods of depression like the one we have just experienced, drive home the lesson that the opportunity to serve goes hand in hand in the long run with relative ability to serve.

We can often learn much from analyzing the slope of a curve. The going at the right-hand end looks easy, with small chance to slipping. But every step up demands sticking to it harder to develop the requisite adhesion, and shortly, digging-in is essential to secure sound toe-holds, each successive hold requiring increased effort.

We have been analyzing what we believed to be a single plain curve, but we find on close scrutiny that we are dealing with a laminated structure, and incipient cleavage planes are found to exist. See Fig. 2. The hyperbola exists in each lamination, and the various men are beginning to segregate as directed by their several abilities and preferences. Some gravitate to salesmanship; some to engineering; etc.

After a little more time has elapsed, and as we look with a stronger glass, we find further latent cleavage as specialized leanings become defined.

Thus, we find the industrial life to be a hyperbolic prism with a detail structure built up of many laminations akin to a mica crystal. We have spoken of cleavage, and our analogy to mica may profitably be pushed a bit further. Each lamination is complete in itself, but the whole crystal is strong only as each lamination remains sound and in a state of close cohesion with its co-operating laminations. And as the lamination is to the crystal so the department is to the establishment, the establishment to the industry, and the industry to the college, and both to life in all its phases, nations and races.

The lamination that "sluffs" off its close relation to the whole ultimately disintegrates and vanishes, leaving perhaps a gap for a while, which is healed with the lapse of time, and life goes on, and jobs go on, and men go on.

The life prism has smooth perpendicular sides. The graduate student lamination stands at a dizzy height, measured with the yard-stick of the boy who cannot afford the luxury of a university training and in a lesser degree to him who earns his way through. The college man who early recognizes his course as a ladder that will reach to this level is fortunate, while often the man who has had to work his way finds that the very operation has served to sharpen the calks on his boots, so that they grip firmly on the steeper pitches of his chosen hyperbola.

Each individual—and we here revert to our original scale and include the human race—has his own ideal structure of life. If he has been free to follow his natural bent, he sees his particular lamination at the top of the prism, and from this height he looks down with more or less toleration on what, to him are more lowly callings. If his conception pictures more glorified planes, and he has any red blood in his veins, he will move heaven and earth to bore up his ideal, and start to climb the new heights from which with broader vision he can see, and aspire to still nobler achievement.

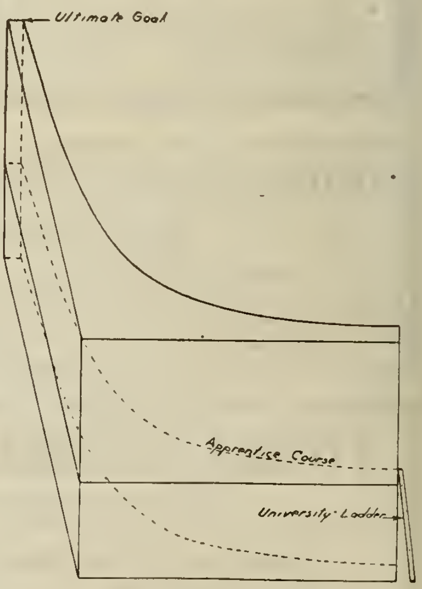


Fig 2.

DARLING BROTHERS EQUIPMENT

Installed in the

Mount Royal Hotel, Montreal

This hotel is heated by Webster System throughout, manufactured by Darling Brothers. All hot water used in the building is furnished by five Darling Heaters.

Below is shown the two automatically controlled Darling Vacuum Pumps installed in the Mount Royal Hotel.

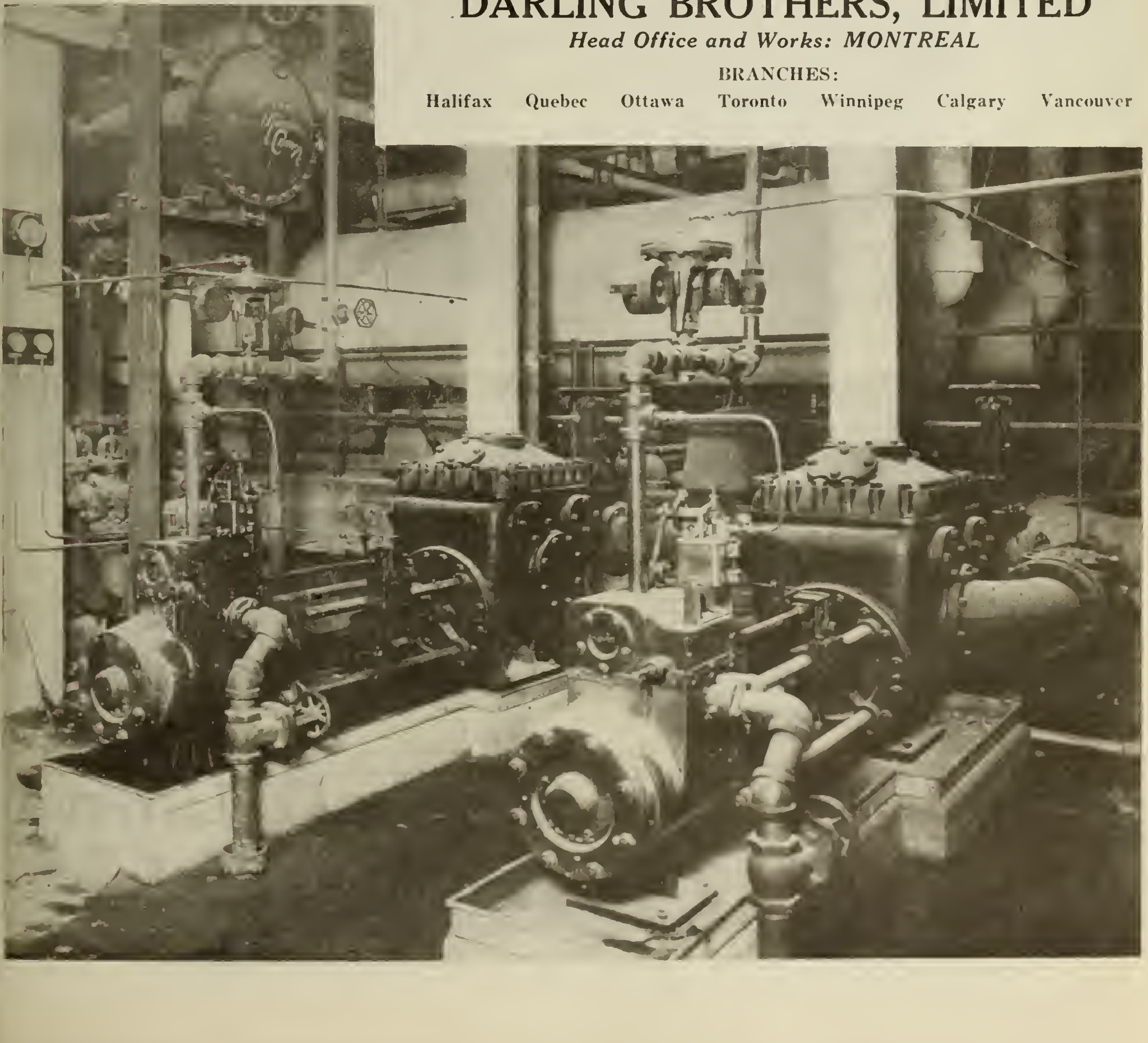
The choice of this equipment for "the largest hotel in the British Empire" is evidence of the popularity of the lines manufactured by Darling Brothers—a popularity due to long and satisfactory service.

DARLING BROTHERS, LIMITED

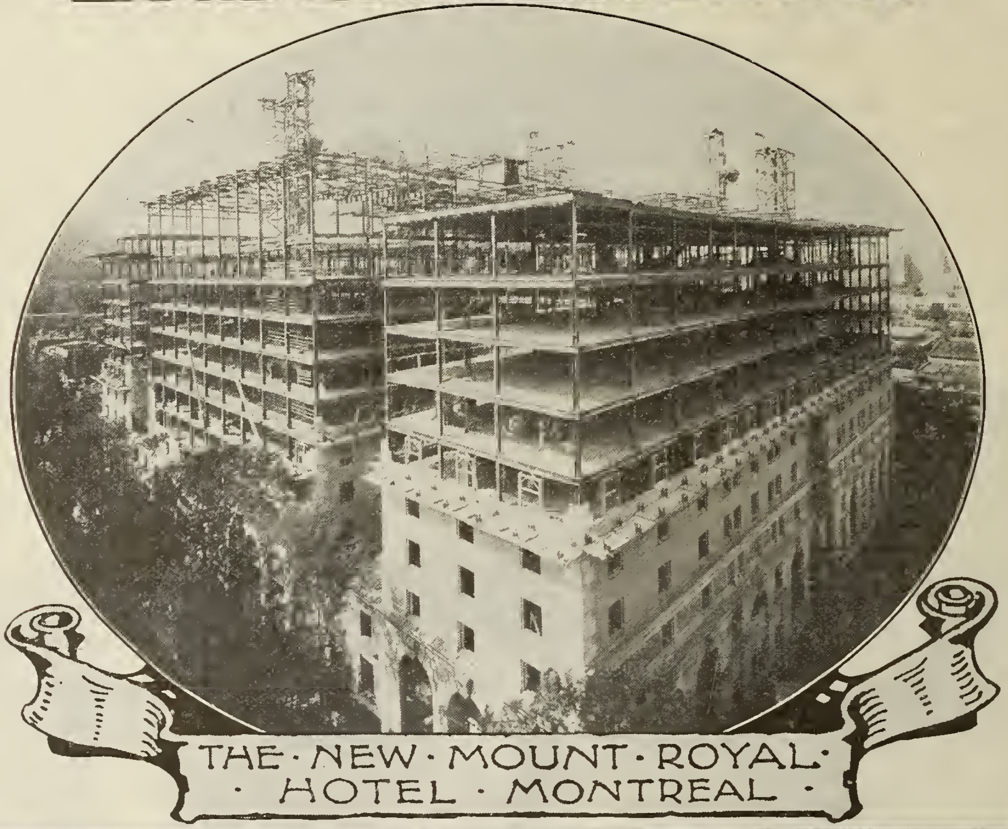
Head Office and Works: MONTREAL

BRANCHES:

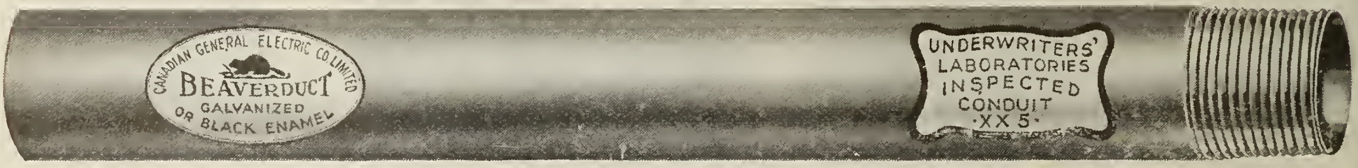
Halifax Quebec Ottawa Toronto Winnipeg Calgary Vancouver



ANOTHER BEAVERDUCT INSTALLATION



THE · NEW · MOUNT · ROYAL ·
· HOTEL · MONTREAL ·


CANADIAN GENERAL ELECTRIC CO LIMITED
BEAVERDUCT
GALVANIZED
OR BLACK ENAMEL
UNDERWRITERS' LABORATORIES INSPECTED CONDUIT ·XX 5·

Beaverduct is a Canadian made conduit, manufactured in a modern plant under the underwriters' inspection. Its use on such an installation, as this, is a fitting testimonial of its superiority.

Good conduit can only be produced in a plant where the equipment permits only absolutely clean material being used. Electrical apparatus and plating solutions must be kept up to the mark under scientific management. The proper application of the enamel, after the galvanizing of the outside, is of vital importance. And, lastly, rigid inspection.

"Made in Canada"

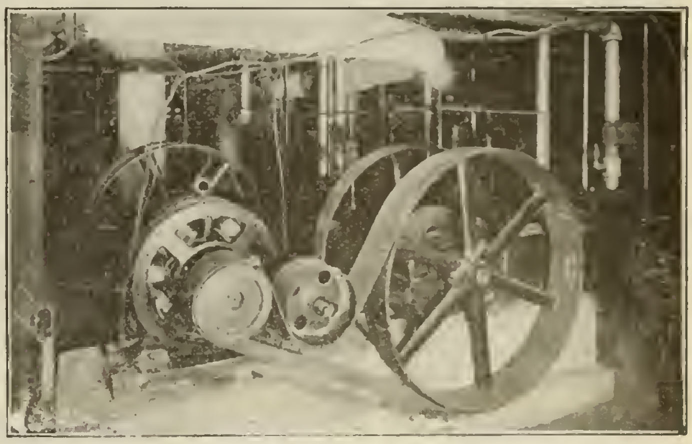
Canadian General Electric Co., Limited

HEAD OFFICE TORONTO

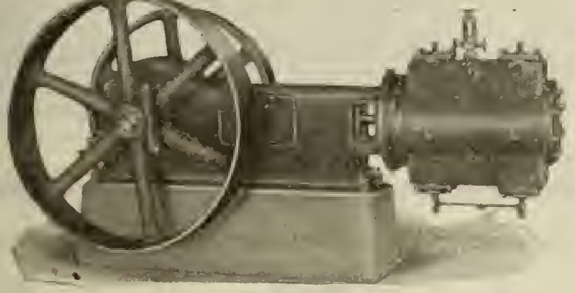
Branch Offices: Halifax, Sydney, St. John, Montreal, Quebec, Cobalt, Ottawa, Hamilton, London, Windsor, South Porcupine, Winnipeg, Calgary, Edmonton, Vancouver, Nelson and Victoria.

Ingersoll-Rand *Compressors* *Serve* Mount Royal Hotel

Pure, aerated water for the largest and most modernly equipped hotel in the British Empire is supplied by an "Ingersoll-Rand" Imperial Type "VA" Air Lift System.



The Compressor Installation Under Construction.

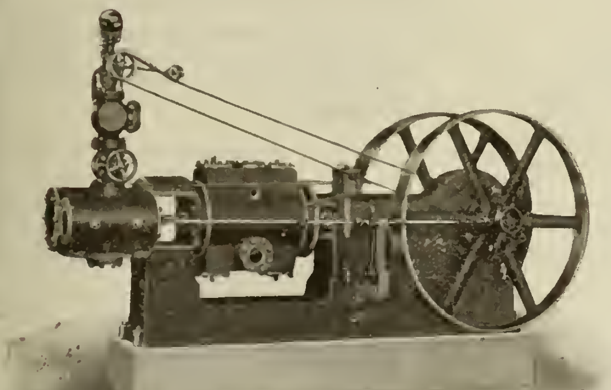


A Class "E-R-1" Power Driven Compressor is used for regular service at the Mount Royal Hotel.

There is no better source of water supply than a properly designed Air Lift System. The water secured is cool and of the best quality; the supply steady and reliable, and the cost of pumping is usually lower than by any other means.

Satisfactory performance, however, is largely dependent upon the experience of the manufacturer and the efficiency of the equipment used.

This Company's experience in Air Lift Pumping is coincident with the inception of this method of elevating well water and its reputation for the production of highly efficient air compressors—*the heart of an Air Lift System*—is unchallenged.



For Stand-by Purposes the Mount Royal Hotel employs a class "FR-1" Steam Driven Compressor.

Interesting and informative bulletins sent to those interested on request.

Canadian Ingersoll-Rand Co. Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

Associated Offices in all civilized countries.

Ingersoll-Rand

As installed in the Mount Royal

The choice of prudent buyers

Naturally for such a modern Hotel as the **Mount Royal,** at Montreal, THE GENUINE FAIRBANKS SCALES were chosen.

Not only the speedy dial Scale pictured here, but also the large Auto Truck Scale for weighing their Coal.

These installations confirm Fairbanks Scale leadership.

Interesting Scale data on request.

The Canadian
FAIRBANKS-MORSE Co. Limited

Montreal Toronto St. John Winnipeg Quebec Ottawa
Windsor Vancouver Calgary Regina Victoria

Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.

DURABLA
TRADE MARK REGISTERED

Strength; Goodness; Quality—these features distinguish durable Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

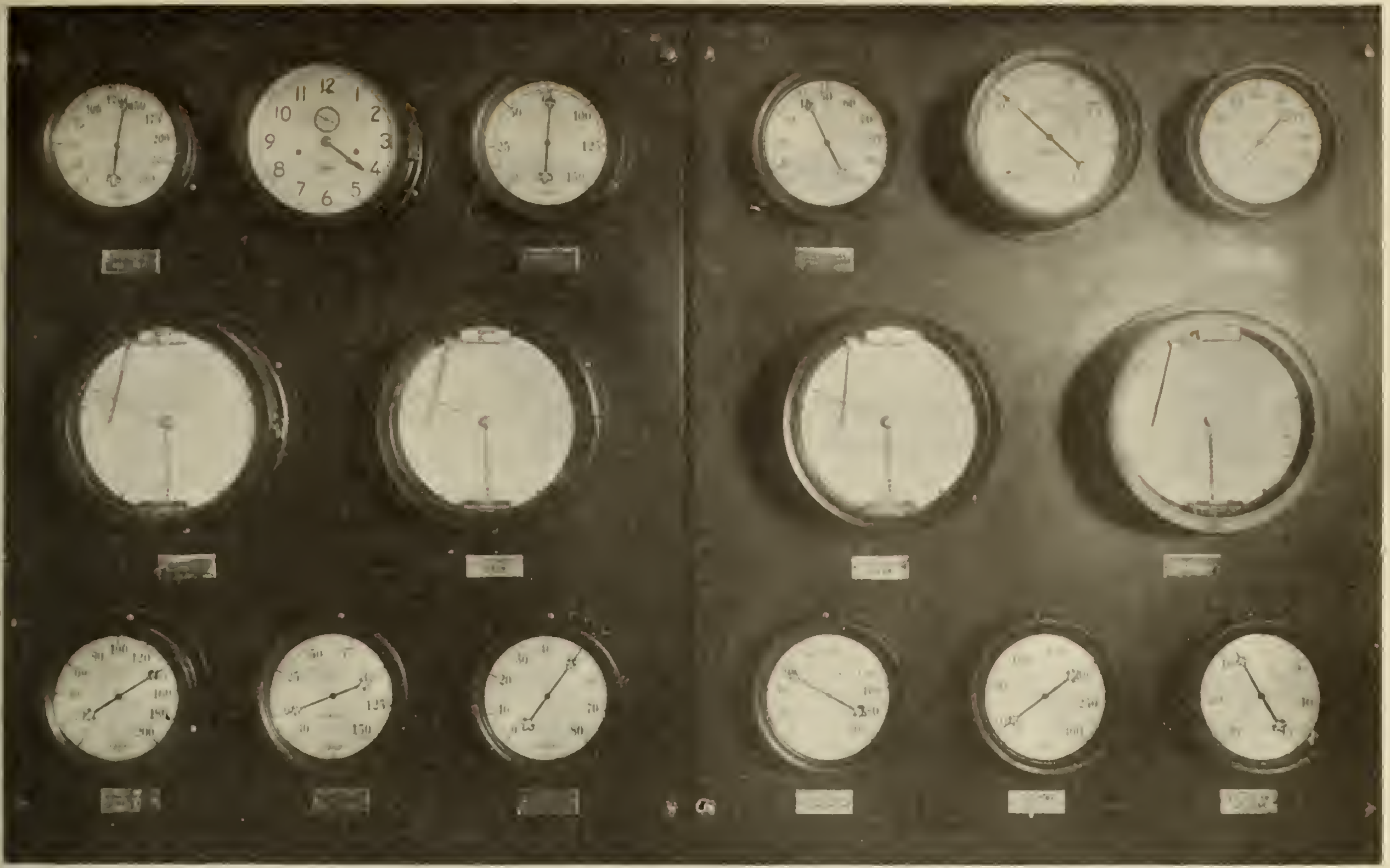
DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

DURABLA is not affected by vibration or condensation. It will not burn out, blow out or pulp at the points. Let us send you a trial sample. Made in stock sizes 36 in. wide x 144 in. long, and 48 in. wide x 144 in. long, in thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Orders Filled Promptly.

Made in Canada by Canadian Durabla, Limited
and sold on a service basis by
THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED
Sales Offices in all leading Canadian cities

DURABLA



In the New Mount Royal Hotel

IT MIGHT be taken as singular tribute that Foxboro indicating and recording instruments were installed in the largest hotel in the British Empire, "The Mount Royal" of Montreal. But as a matter of fact Foxboro instruments are used in the largest establishments throughout the country.

The view here shows a special instrument-board in the chief engineer's room of the Mount Royal. All the instruments on the board were made by the Foxboro Co., of Foxboro, Mass., and were supplied by Peacock Brothers, Ltd., Montreal.

The indicating instruments are mostly used for indicating water pressure; while the recording instruments are for showing boiler pressure, outside temperature, flow and distribution.

We shall be glad to furnish complete information regarding Foxboro instruments. Write to Dept. C.F.

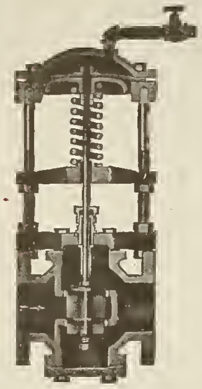
THE FOXBORO CO. INC. Foxboro, Mass., U.S.A.

New York Chicago Boston Tulsa
Pittsburgh Philadelphia San Francisco Birmingham

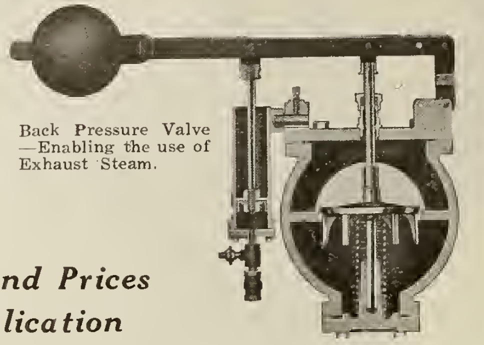
Peacock Brothers, Limited, 179 Delorimier Avenue, Montreal, Canada.

FOXBORO
TRADE MARK
THE COMPASS OF INDUSTRY

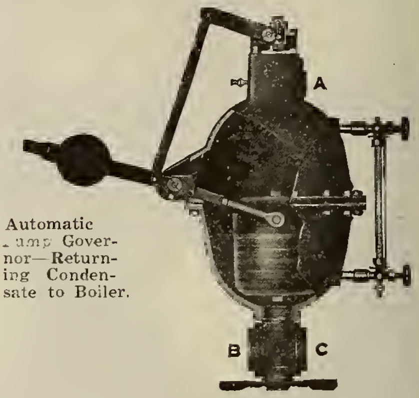
"KIELEY" ECONOMY OUTFIT



Reducing Valve—from High to Low Pressure.



Back Pressure Valve—Enabling the use of Exhaust Steam.



Automatic Pump Governor—Returning Condensate to Boiler.

Details and Prices on Application

All our equipment is made to meet the demands of modern power plant installations.

The Kieley & Mueller Co., Inc.

34-38 West 13th Street
New York City

CANADIAN REPRESENTATIVES:

THE ARTHUR S. LEITCH CO., Toronto.
J. J. CONLIN, Montreal, Que.
JAMES S. ROBERTSON CO., St. John, N.B.

A Partial List of Our Automatic Steam Specialties.

Beginning at the boiler with the **Non-return Pilot Valve** that closes in case of rupture to either power piping or boiler.

High and Low Water Alarm indicating when not enough water or too much is in the boiler.

Feed Water Controlling Device to maintain constant water level in high pressure boilers.

Damper Regulator to control draft dampers.

Pressure Reducing Valves from high to medium or above vacuum. Also for water, gas or air.

Combination for controlling engine and draft for mechanical stoker fired boilers.

Steam Separators and Traps.

Oil Separators and Grease Traps.

Back Pressure Valves, enabling the use of exhaust steam for heating purposes.

Pump Governor to return condensation from high and low pressure returns direct to boilers.

Exhaust Heads, Blow-off and Drip Tank Controllers.

Temperature Controller for hot water tank.

Combination Pump Governor and Lever Float Valve for keeping water supply tank filled.

Low Pressure Boiler Water Feeders and Damper Regulators.

Lifting and Return Traps to return condensation back to boiler where radiators or coils are set below same.

All the Piping of the Entire Heating System

Was Installed in the

"Mount Royal"

By

This is but one of the many large installations completed by the GARTH Company.

If it's a big job and has to be put through on time—it's GARTH'S!

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we willtell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
Arthur S. Leitch Co., Ltd., Toronto.
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.

AMMETERS
Can. Fairbanka-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

AMMONIA PLANT EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
Under-feed Stoker Co. of Canada, Ltd. Toronto.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co.,: Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Muellor Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W R Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd., Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windaor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mualler Mfg Co., Limited, Sarnia, Ont.

BELT CEMENT
D K. McLaren, Limited, Montreal, Que.

BELLS
Jas Morrison Brass Mfg. Co., Toronto

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D K McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
D. K. McLaren Limited, Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D K McLaren Limited, Montreal, Que.

BELT HOOKS
D. K. McLaren, Limited, Montreal, Que.

BELT TIGHTENERS
Wateroua Engine Works Co., Brantford.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Worka Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, FABRIC
D. K. McLaren Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. McLaren, Limited, Montreal, Que.

BELTING, SOLID WOVEN
D. K. McLaren, Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont
Arthur S. Leitch Co., Ltd., Toronto.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

CORD CLOTHING
D K. McLaren Limitod, Montreal Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd., Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morae Co., Ltd., Montreal.
Canadian Johna-Manville Co., Ltd., Toronto.
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelpbia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Oblo.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Suply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane'a Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt
Leonard & Sons Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C B. Turner, Toronto.

BOILER TUBE PROTECTORS
C B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co. Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Obio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penbertby Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brasa Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren, Limited, Montreal, Que

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCulocb Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenbelmer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd. Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Worka Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Bolco Supply, Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

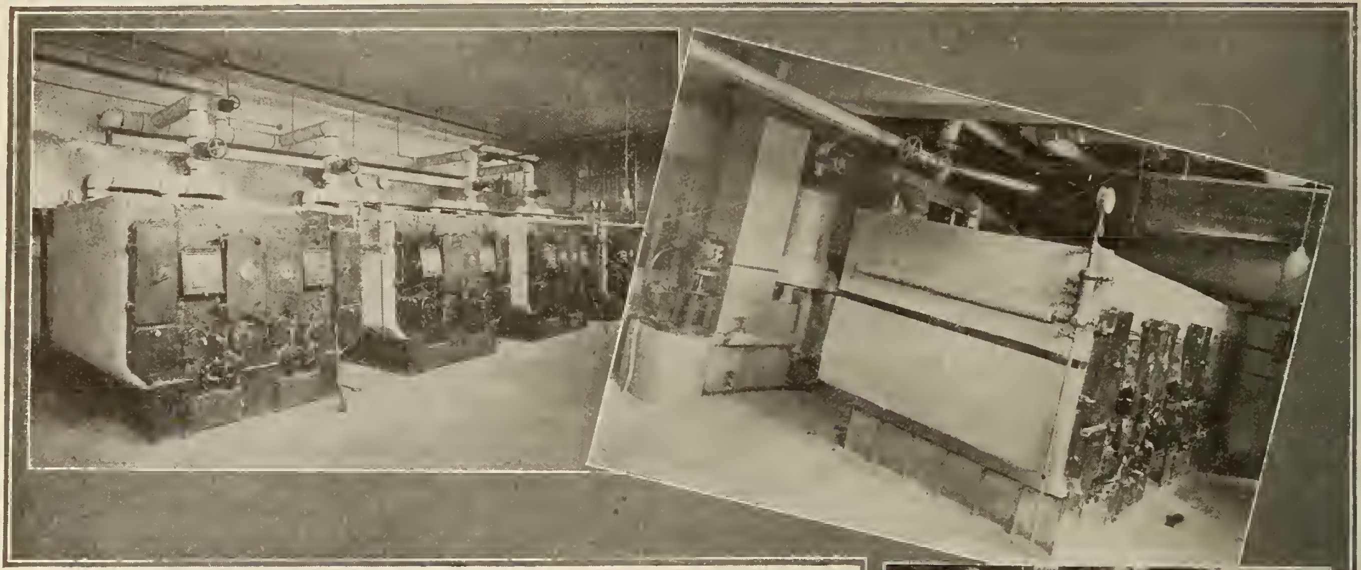
CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co. Toronto.

CHIMNEYS
Arthur B. Leitch, Co., Toronto.

A Spencer for Every Heating Requirement

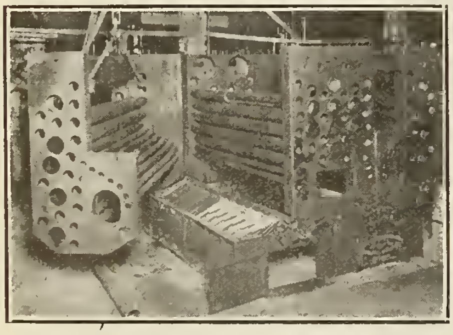
Hot Water or Steam

SPENCERIZED HEATING
SAVES FUEL SAVES LABOUR



Note these Boiler Rooms
Compact, Smokeless, Clean and Efficient.

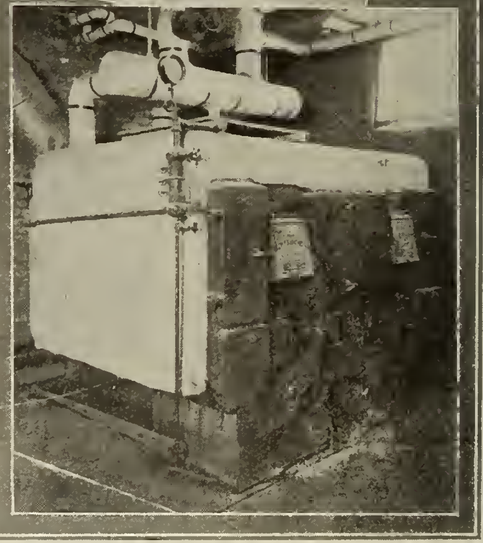
Installations of every size from the smallest to the largest of Public Buildings.



Sectional view of the Spencer, the Master Mind of Boiler Construction

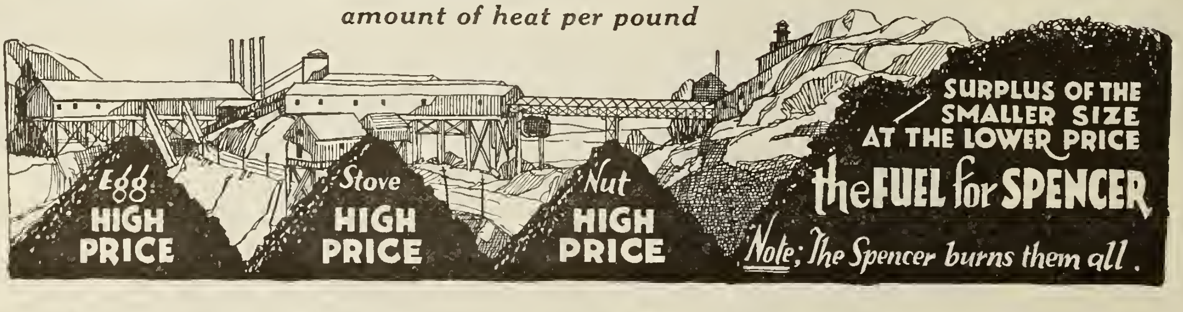
For
OIL BURNING

No radical change necessary to make it the most suitable and satisfactory for Oil Burning.



WRITE FOR INFORMATION

All sizes of Coal contain the same amount of heat per pound


Egg HIGH PRICE
Stove HIGH PRICE
Nut HIGH PRICE
SURPLUS OF THE SMALLER SIZE AT THE LOWER PRICE
the FUEL for SPENCER
Note; The Spencer burns them all.

SPENCER HEATER CO. OF CANADA, LIMITED

68 Adelaide Street East
WINNIPEG TORONTO MONTREAL

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St, West, Toronto.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CARBONIC ACID GAS
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

COUPLINGS
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal,
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach, Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal,
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & **Lamb, Montreal.**

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injetor Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd. Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal,
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto and Boston

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont,

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR DRIVES
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E. London, Ont.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St, Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E. London, Ont

EXHAUST HEADS
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto and Boston.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co, of Canada, Ltd, Toronto, Ont.

FEED WATER HEATERS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Wm, B. Scaife & Sons, Pittsburg, Pa.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., Erie, Pa.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.
Wm, B. Scaife & Sons, Pittsburg, Pa

FILTERS, WATER
Frick Co., Waynesboro, Franklin Co., Pa
Graver Corp., East Chicago, Ind.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Scaife & Sons, Wm. B., Pittsburg, Pa
York Mfg. Co. York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Boston Plastic Fire Brick Co., Inc., Rome. N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane, Limited, Montreal.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N. Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.

FLUE CLEANERS
Shell Bar Boico Supply Ltd, Toronto
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg Co, St. Louis, Mo.

FLUMES, STEEL
Wm, B. Scaife & Sons, Pittsburg, Pa

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd, Toronto

FUEL ECONOMY DEVICES
The Boiler Repair and Grate Bar Co., Toronto, Ont.

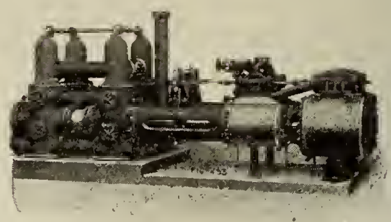
FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

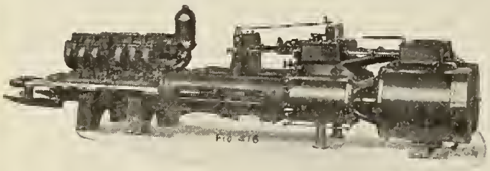
FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co, Chicago, Ill

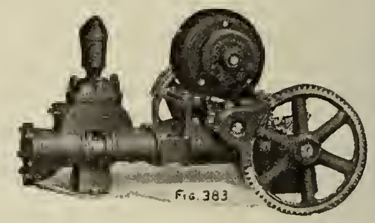
McGOWAN PUMPS

STEAM DRIVEN -:- POWER DRIVEN

Every Part Interchangeable







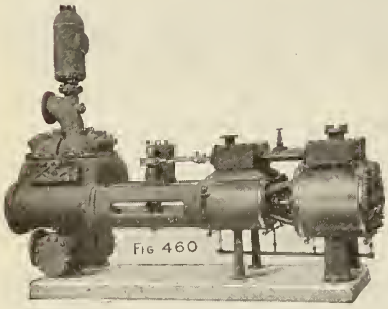
Reduce Complaints

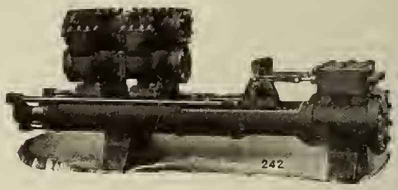
The consumer whose service is interrupted "Can Hear No Excuse." Reduce complaints by using McGowan Duplex Steam or Power Pumps to handle your water system.

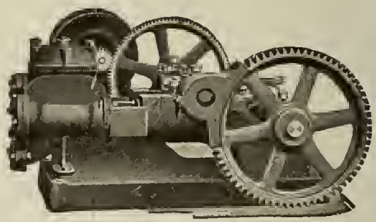
Every detail of our designs has been given the closest attention and the result of our 70 years in business brought to bear on same.

All parts of McGowan Pumps are interchangeable.

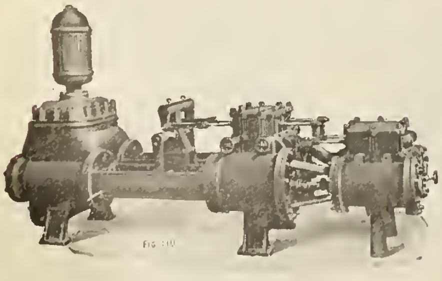
All parts are made to gauge.

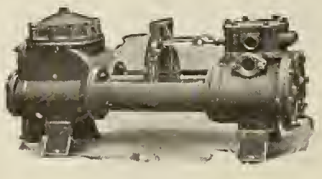


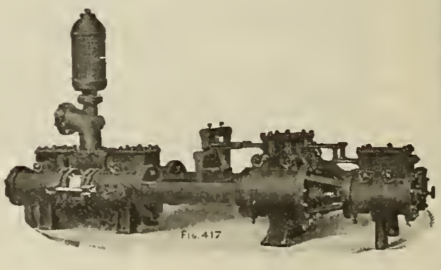




THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.







FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Canadian Johns-Manville Co., Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HAND-HOLE
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Beldam Asbestos (Canada) Co., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.

GASKETS, LEAD, COPPER AND SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbenks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreel.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Bress Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Rellence Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

HANGES, GAUGES, AMMONIA, OIL, GAS, AIR
Schaffer & Bundenburg Mfg. Co., American Steem Gauge & Velve Co. Division, Brooklyn, N. Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Jas Morrison Braes Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreel.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steem Geuge & Valve Co., Div-Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steem Genge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford
Smart-Turner Machine Co., Ltd., Hamilton,
Leitch Co., Arthur S., Toronto, Ont.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreel

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Bebcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal
Canadian Steem Boiler & Equipment Co., Toronto.
Canedien Plenet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonerd & Sons, E. London, Ont.
The Boiler Repair end Grete Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottewa.
Weterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRATE BARS, FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Ber Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.
Tho Boiler Repair and Grate Ber Co., Toronto, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lemb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Mechine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Cen. Feirbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Weterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreel.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Gelt.
Leurie & Lemb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicego, Ind.

HEATERS METERING
Yernall-Waring Co., Philedelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., Eest Chicego, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont
Waterous Engine Works Co., Brentford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Gerlock Pecking Co., Hemilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Feirbanks-Morse Co., Ltd., Montreal.
Gerlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Grever Corp., Eest Chicago, Ind.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smert-Turner Mechine Co., Ltd., Hemilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Frick Co., Waynesboro, Franklin Co., Pa
Jamieson Cold Storage Door Co., Hagerstown, Md
Linde Can Refrigeration Co., Montreal,
York Mfg Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Menville Co., Ltd., Toronto, Ont.

INDICATING THERMOMETER, SARCO
Sarco Co., Inc., New York.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Taylor Instrument Co., Toronto, Ont.
Yernall-Wering Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canedian Johns-Menville Co., Ltd., Torono, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Cen. Johns-Manville Co., Ltd., Toronto.

LACE LEATHERS
Can. Johns-Manville Co., Ltd., Toronto.
D. K. MecLeren Ld., Montreal, Que.

LAMPS, ARC
Cen, Feirbanks-Morse Co., Ltd., Montreal
Cenadien Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williems & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Falrbenks-Morse Co., Ltd., Montreal.
Cenadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MecLaren Ltd., Montreal, Que.

LINK BELTING
Can. Link-Belt Co., Toronto. Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinneti, Ohio.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mo.

MACHINERY TRANSMISSION (POWER)
Cen. Mead-Morrison Co., Mo.

MARINE CASTINGS
Mueller Mfg., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Scheeffer & Bundenberg Mfg. Co., American Steem Geuge & Velve Co. Division, Brooklyn, N. Y.
Teylor Instrument Co., Toronto, Ont.

METERS, F.M.
Cenedien Generel Electric Co., Toronto,
The Bailey Meter Co., Cleveland, Ohio.
Cen. Johns-Manville Co., Toronto.

MILL AND MINING MACHINERY
Can. Feirbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Weterous Engine Works Co., Brantford

MIXING VALVES
Crane's Limited, Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont

MOTORS
Can. Feirbanks-Morse Co., Ltd., Montreal
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto

OILS, ENGINE
Imperial Oil, Ltd. Torono

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbenks-Morse Co., Ltd., Montreal
Direct Separator Co., Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto

OILING SYSTEMS
Lunkenheimer Co., Cincinnati, Ohio.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos Canada Co., Toronto
Beveridge Suppy Co., Montreal
Canedian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto
Crene Ltd., Montreal.
Crano Packing Co., Chicego, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutte Percha & Rubber Co., Limited
Holmes Metallic Pecking Co., Wilkesbarre, Pa.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Pecking Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Ber Boico Supply Ltd., Toronto.

PACKING, METALLIC
Canedian Raybestos Co., Ltd., Peterborough, Ont.
Crene Packing Co., Chicago, Ill.
Flexible Metellic Packing Co., Windsor, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, OIL
Canadian Reybestoa Co., Ltd., Peterborough, Ont.
Crane Pecking Co., Chicago, Ill
Flexible Metellic Packing Co., Windsor, Ont.

PACKING, H. P. ROD
Canadien Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Reybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont

PAINTS
Shell Ber Boico Supply Ltd., Toronto, Ont

PENSTOCKS
W. M. B. Scarfe & Sons, Pittsburgh, Pa

PIPE COILS
Frick Co., Weynesboro, Franklin Co., Pa
The Superheater Co., Ltd. Montreal
Page-Hersey Tubes, Ltd., Toronto, Ont
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
H. Mueller Mfg. Co., Limited, Sarnia, Ont
The Superheater Co., Limited, Montreal

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Cen. Johns-Manville Co., Ltd., Toronto

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal,
Pege-Hersey Tubes, Ltd., Toronto, Ont

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE STEEL
Pege-Hersey Tubes, Ltd., Toronto, Ont

PIPES, WATER
Page-Hersey Tubes, Ltd., Toronto, Ont

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford,

PLUG COCKS
Lunkenheimer Co., Cincinnati, Ohio

MAGNOLIA

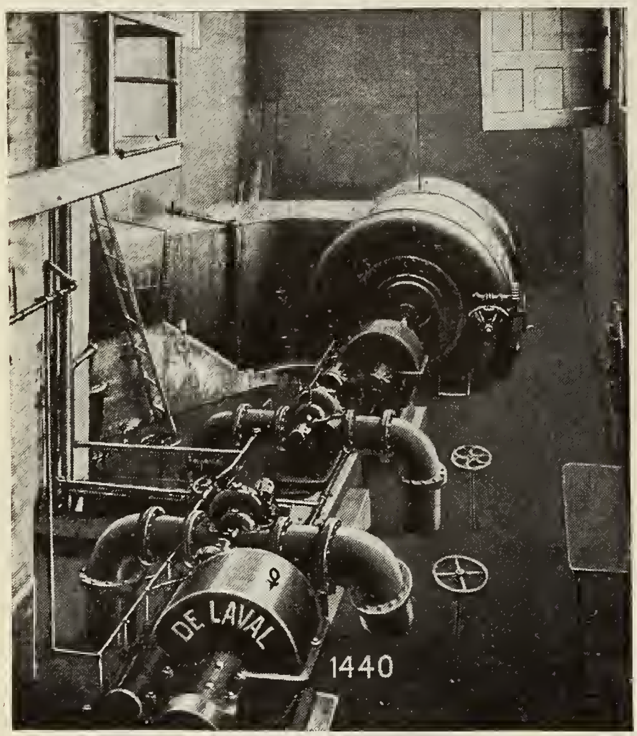
Magnolia Anti-Friction Metal has been proven by U. S. Government tests to improve bearing service, effect saving in metal, power, fuel, lubricants, machinery parts and maintenance attention, and to be decidedly superior for its work. It is easy to handle, is absolutely homogeneous, and comes in convenient forms, for ready use. It will pay you to standardize on Magnolia Anti-Friction Metal. Its users invariably prefer it to lower grades.

Magnolia Metal Company, 113 Bank Street, New York

Chicago San Francisco Montreal

REG. U.S. PAT. OFF.

ANTI-FRICTION METAL



Water Pumped by Water Power

THE City of Cornwall, Ont., was formerly supplied by triplex and duplex pumps driven by a horizontal hydraulic turbine, with steam driven pumps for emergency service. Having plenty of water available under low head, the City installed two De Laval centrifugal pumps driven by low speed water turbines. Each pump can handle the normal pumping load with a capacity of 3,500,000 gallons per day against a service head of 180 ft. and operates at a normal speed of 1,670 R.P.M. To obtain the inherent high efficiency of the De Laval centrifugal pump, the pumps are driven through De Laval double helical speed increasing gears by water turbines operating at their normal speed of 200 R.P.M., with a loss in transmission of power from turbine shaft to pump shaft of less than 1½%. Through a simple piping arrangement, the two pumps can be operated in series at a moment's notice to deliver over 4,500,000 gallons per day against a head of 308 ft. for fire protection.

Read our book W-100 "Ten Years' Progress in Water Works Pumps."

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

TAYLOR ENGINEERING CO., LTD.
Vancouver, B. C.

255

A Striking Message

A STRIKING message to manufacturers of power-house equipment is derived from a letter written by a "Power House" reader in reply to a request for a criticism of the paper and for suggestions as to how it could be improved. Here is the letter:

"I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. This is a **mistake on their part**, but for all I know to the contrary it may be due to the lack of energy on the part of the Power House ad. manager in getting after them. **It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages so much as on the ADVERTISEMENT PAGES."**

PLUMBING SUPPLIES
Jas Morrison Brass Mfg Co., Toronto
H Mueller Mfg Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C A Dunham Co., Toronto, Ont.
H Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Pratt & Cady, Hartford, Conn.
Smart-Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, GAS
Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co., (Inc., Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

OIL PUMPS FOR FUEL OIL BURNING SYSTEMS.
Albany Pump Co., Toronto, Ont.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMP TANK, RECEIVER
American Steam Pump Co., Batle Creek
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
American Steam Gauge and Valve Co Division, Brooklyn, N Y.
Canadian Johns-Manville Co., Ltd., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa

RECORDERS CO-2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Tayor Instrument Co., Toronto, Ont.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamieson Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Inde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATING VALVES
H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester Mass.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London.
Waterous Engine Works Co., Brantford.

SOOT BLOWERS
Canadian Planet Engineering Co Ltd Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch, Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM JETS
Green Engineering Co., East Chicago, Ind

STEAM SPECIALTIES
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
The Reliance Gauge Column Co., Cleveland, Ohio.
Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Watson & McDaniel Co., Philadelphia
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM CALORIMETERS
American Steam Gauge and Valve Co. Division, Brooklyn, N Y
Sarco Co., Inc., New York.

STEAM TRAPS
American Steam Gauge and Valve Co. Division, Brooklyn, N. Y.
Julian D'Este Co., Boston 14, Mass.
Sarco Co., New York, N. Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa

STEEL DRUMS
Smart-Turner Machine Co., Hamilton
Scaife & Sons, Co., Wm., Pittsburgh, Pa

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal

STOKERS
Canadian Planet Engineering Co. Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd., Montreal.
Green Engineering Co., East Chicago, Ind
Underfeed Stoker Co., of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
Sturtevant, Co., B. F., Toronto and Boston

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. and Eng. Co., Ltd., Lindsay.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd, Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B Scaife & Sons Co, Pittsburg, Pa

SUPERHEATER, MARINE
The Superheater Co., Ltd, Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co, Galt
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STATIONARY
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, LOCOMOTIVE
Superheater Co., Ltd, The, Montreal.

SUPERHEATER, STEAM SHOVEL
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd, Toronto.

A Big Fine Issue

at a reduced price with no change in the high standard of its editorial excellence.

Not the least of MacLean's features is the valuable information contained in its advertising pages.

You will enjoy

"Patricia's Pearl Necklace"

by Gilbert Frankau—England's most popular young fictioneer.

NOW 15¢ Pre-War Price

"The Heavy Hand"

by Bertrand W. Sinclair

A Long Complete Novelette of Love, Hate and Justice long delayed.

"Jack Canuck—Gamekeeper"

A wonderfully interesting article on Canada's wild animals, illustrated with a series of faithful photographs from real life.

REVIEW OF REVIEWS

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

JANUARY 15th

Why PYRRICO JOINTLESS FURNACE LINING

is better than fire brick—

This plastic furnace lining is better than fire brick because:

1. It is jointless.
2. It is plastic.
3. It is air and gas tight.
4. It will stand 3100° F.
5. It will save fuel.
6. It can be installed by inexperienced labor.
7. It will outlast fire brick.
8. It can be used in any boiler, furnace or oven.
9. It can be used where ever fire brick is used.
10. It cannot be excelled for patching broken and burned out linings.

JOINTLESS FIRE BRICK CO.

1142 Clay St., Chicago, Ill.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's, Ltd., Calgary, Alta.

Even if you put

A water tender on every boiler—

—every man working his best to feed only one boiler — even then you could not get the safety, and the fuel savings, that are assured by the COPES SYSTEM OF BOILER FEED REGULATION.

Careful tests between COPES feed and hand feed, in actual practice—have proved again and again that the fuel savings and labor savings of the COPES pay back its cost many times over.

The COPES varies the feed water instantly, according to every change in load conditions.

It is simple and strong with no uncertain features of construction no springs or diaphragms, no floats or displacement bodies. The only parts are a sturdy expansion tube and a balanced valve. There is no chance for sticking or lag.

Its reliability has made the COPES the standard it is used by 98 per cent. of the leading Central Stations.

Our new booklet "Regulating Boiler Feed Water" shows how marked savings in fuel—2% to 8% ordinarily—can be effected by COPES Regulation.

Write for Catalog D.

NORTHERN EQUIPMENT CO., 112 West 11th St., ERIE, PENN.

Branch Plants:
Hamilton, Ontario, Canada; Croydon, England; Paris, France; Cologne, Germany.

COPES
SYSTEM OF BOILER FEED CONTROL

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N. Y.

SYPHONS
Jas Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Canadian Johns-Manville Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa,
Waterous Engine Works Co, Brantford.

TANKS, OIL, KEROSENE, GASOLINE
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Wm B. Scaife & Sons Co., Pittsburg, Pa
Waterous Engine Works, Brantford

TANKS, WATER
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

THERMOMETERS, INDICATING AND RECORDING
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.
Uehling Instrument Co., New York, N Y

THERMOSTATS
Sarco, Inc., New York, N.Y.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N Y

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
Sarco Co., Inc., New York, N.Y.
Wason & McDonald Co., Philadelphia.
Taylor Instrument Co., Toronto, Ont.

TACHOSCOPES
The Reliance Gauge Column Co., Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and Am-American Steam Gauge and Valve Co., Division, Brooklyn, N.Y,

TRAPS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Grant E. Cole Co., Toronto, Ont.
Julian D'Este Co., Boston, 14, Mass.
Sarco Co., Inc., New York, N.Y.

TRAPS, DUMPING
Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F. Toronto and Boston.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

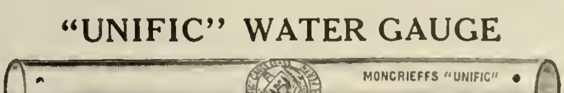
TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ld., Toronto
Sturtevant Co., B. F., Toronto and Boston

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal.
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES OF ALL KINDS
Reading Steel Casting Company, Inc.
Pratt & Cady Division,
Bridgeport, Conn.
Reading Steel Casting Company, Inc.
Reading Valve and Fittings Division,
Bridgeport, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Shell Bar Boico Supply, Ld., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.



MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

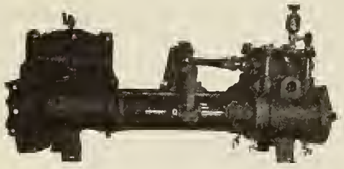
Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

HINTS TO BUYERS



ECONOMY through QUALITY

is the keynote in the manufacture of

SMART-TURNER PUMPS

The Smart-Turner Machine Co., Ltd.
Hamilton .·. Canada

LADD WATER TUBE BOILERS

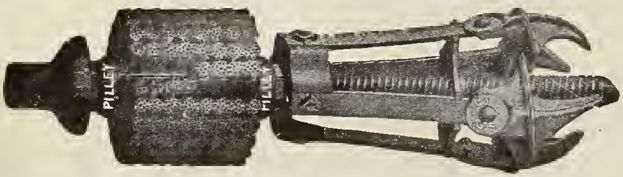
can be built from the smallest practical water tube unit up to 1,500 H.P. in the single type and to upward of 9,000 H.P. in the multi-drum type.

Write for descriptive catalogue.

THE GEORGE T. LADD COMPANY
First National Bank Building
Pittsburgh, Pa.

Chicago Office: 528 McCormick Bldg.
New York Office: 18 Warren St.

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

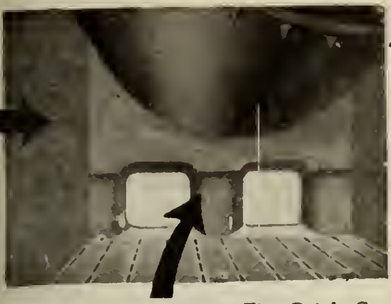
ENGINEERING & CONTRACTING

The T.J. CUNERTY Company
Room 240 17, Queen St, East. Toronto

GARLOCK
Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS
THE GARLOCK PACKING COMPANY



Be Rid of Boiler Furnace Lining Troubles

Arches and Furnace Linings in one piece. No brick, no joints. Any handy man installs it without special forms or tools.

Betson Plastic Fire Brick kept on hand for emergency repairs and for use in building sloping baffles always proves profitable. **Write for instructive booklet.**

Betson Plastic Fire Brick Co., Inc. P. O. Box 386-6, ROME, N. Y.

CANADIAN DISTRIBUTORS: International Chemical Co., 26-6 Adelaide St. E., Toronto, Ontario, Canada

McDaniel Improved STEAM TRAP

FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
6 Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.

"Pop Off" Steam Carries Ashes Away

"Into the hole and away they go" describes ash removal with a Green Steam Jet System. At the Kewanee Boiler Co., they use "Pop off" waste steam to do the work.

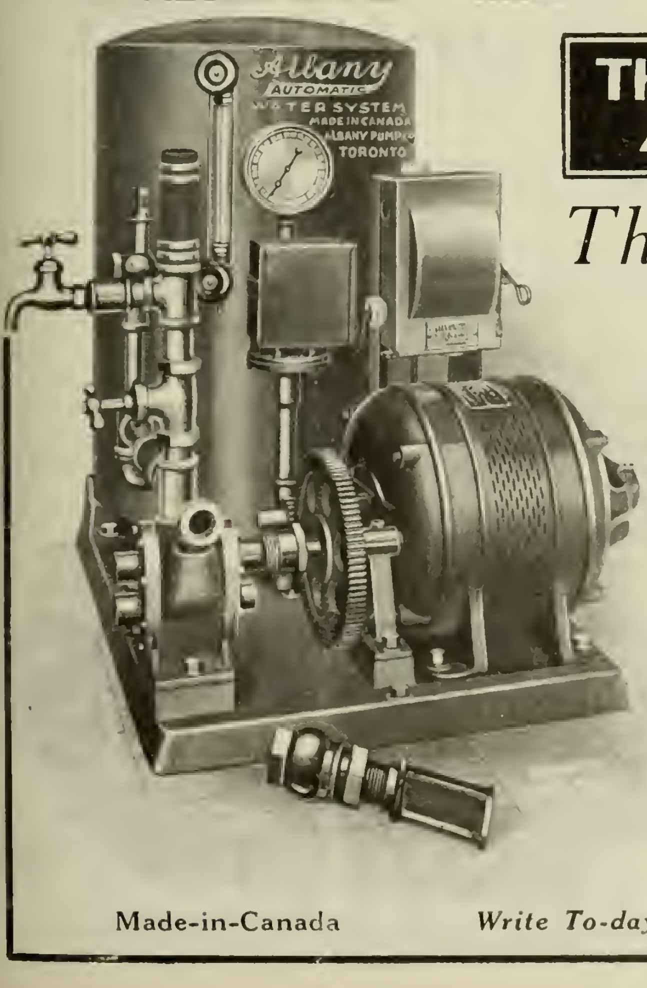
Write to Dept. X for descriptive literature.

GREEN ENGINEERING COMPANY
175 Kennedy Avenue
EAST CHICAGO INDIANA

Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario



The "ALBANY" Water Sealed ROTARY PUMP

The **AlbanyA utomatic Water System**

Advantages Over All Other Water Systems

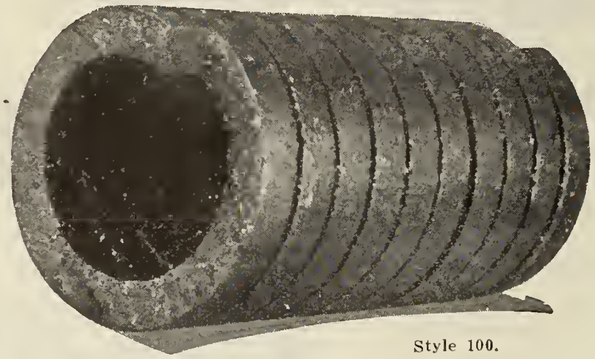
Low Price Small Installation Cost
Low Operating Cost
No Cumbersome and Expensive Storage Tank
Absolutely Automatic
Water Fresh from the Well
Floor Space Occupied for the Complete Equipment, 2 ft. 9 in. x 1 ft. 6 in.
Suction Lift up to 22 Feet
No Valves in These Pumps. Nothing to Get Out of Order
(Patented in all countries)

As a Vacuum Pump of its type it has no equal.

ALBANY PUMP CO.
159 Richmond St.W., Toronto, Ont.

Made-in-Canada *Write To-day*

A COMPLETE SERVICE IN
"John Crane"
FLEXIBLE METALLIC PACKING



Style 100.

You have not demonstrated Metallic Packing until you have used "John Crane."

Style 100 above is the key to our complete packing service. It is spirally wound babbitt foil impregnated with purest graphite. Has low coefficient of friction; is non-abrasive, practically impervious to chemical disintegration and made in most convenient possible form.

INVESTIGATE. Let us send you our 64 page scientific text book "Metallic Packing." Of vital interest to every engineer. Complimentary. Write today.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS PACKING & GENERAL MFG. CO., LTD.,
Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B.C.
"MADE IN CANADA."

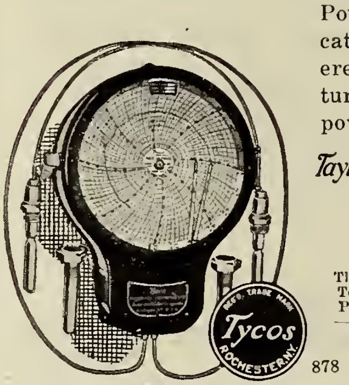
Tycos and Condensers

Efficient condenser operation is only determined when accurate records of ingoing and outgoing temperatures are kept and studied. This is possible with a *Tycos* Bi-Record Recording Thermometer. It writes both ingoing and outgoing temperatures on the same chart.

Power operators send for catalog part one. A reference book on temperature instruments for power plants.

Taylor Instrument Companies
Tycos Bldg.
110-112 Church St.
TORONTO, ONT.

There's a *Tycos* or *Taylor* Temperature Instrument for Every Purpose. Indicating—Recording—Controlling.



878

INDEX TO ADVERTISERS

A
Albany Pump Co. 71
Audel, Theo. 53

B
Babcock & Wilcox, Ltd. 51
Betson Plastic Fire Brick Co., Inc. 71
Bailey Meter Co. 18
Buyers' Directory. 61, 63, 65, 67, 69
Builders Iron Foundry 6

C
Calard, Geo. 53
Canada Cement Co. 16
Canadian Allis Chalmers Co., Ltd. 56
Canadian Ingersoll Rand Co., Ltd. 57
Canadian Fairbanks-Morse Co., Ltd. 58
Canadian Link Belt Company, Ltd. .... Back Cover
Canadian Steam Boiler and Equipment Co. 52
Cole Co., Grant E. 10
Cory & Sons, Inc., Chas. ......
Cunerty, Co., T. J. 70

D
Darling Bros., Ltd. 55
D'Este Co., Julian 12
De Laval Steam Turbine Co. .. 66
Detroit Stoker Co. .... —
Dominion Belting Co. 4
Durham Co., C. A. 12
Durabla Mfg. Co. 58

E
Engineer and Mach. Works of Canada 8

F
Fisher Governor Co. 7
Foxboro Co., Inc. 59
Flexible Steel Lacing Co. 3
Flexible Metallic Packing Co. . 72
Frick Refrigeration Co. 17

G
Gelinas Pennock Reg'd 11
Garth Co., The 60-71
Green Engineering Co. 71
Goldie & McCulloch 20
Gutta Percha & Rubber Co. ... 5

J
Jamieson Cold Storage Door Company 10
Jenkins Bros. ...... Front Cover
Jointless Fire Brick Co. 69

K
Kieley & Mueller Mfg. Co. ... 60

L
Ladd, Geo. T. 70
Laurie & Lamb Co., Ltd. 19
Laurie Engine Co. 53
Lunkenheimer Co. ...... Inside Back Cover

M
Magnolia Metal Co. 66
Maclean Underfeed Stoker Co. . 8
McGowan Co., The John H. ... 61
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncrieff. Ltd. 52
Mueller Mfg. Co. 9

N
Northern Equipment Co. 69

P
Page-Hersey Tubes, Ltd. 10
Peacock Bros., Ltd. 14
Pilley Packing & Flue Brush Mfg. Co. 70

R
Robbins & Meyer Co. of Canada 18

S
Sarco Co., Inc. 7
Sanford Riley Stoker Co. 2
Sexton Boiler Setting, W. R. .. —
Shell Bar Boico Supply Co. ... 4
Smart-Turner 70
Spencer Heater Co. of Canada, Ltd. 62
Sterling Engine Co. 6
Sturtevant Co. 53
Superheater Co., Ltd., The 72

T
Taylor Instrument Co., The ... 72
Taylor Stoker Co. 13
Thomson-Gordon, Ltd. 71

U
Underfeed Stoker Co. of Canada 2

V
Victoria Foundry Co. 53

W
Wall, W. J. 52
Waterous Engine Works Co. .. 1
Watson & McDaniel Co. 71
Watson, M. Barry, M. E. 53
Williams & Co., J. H. 12
Westaway, W. J., & Co. ... Inside Front Cover

Y
York Mfg. Co. 53
Young Pump Co. of Canada .. —

SUPERHEATERS
ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

WESTERN REPRESENTATIVES:
THE TAYLOR ENGINEERING CO., LTD.,
VANCOUVER, B.C.

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

MADE IN CANADA
WORKS AT SHERBROOKE, QUE

Standard Pattern
Iron Body Bronze Mounted

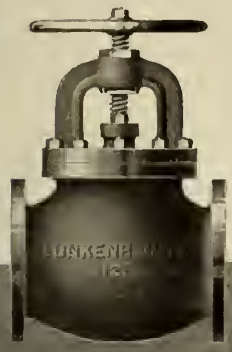
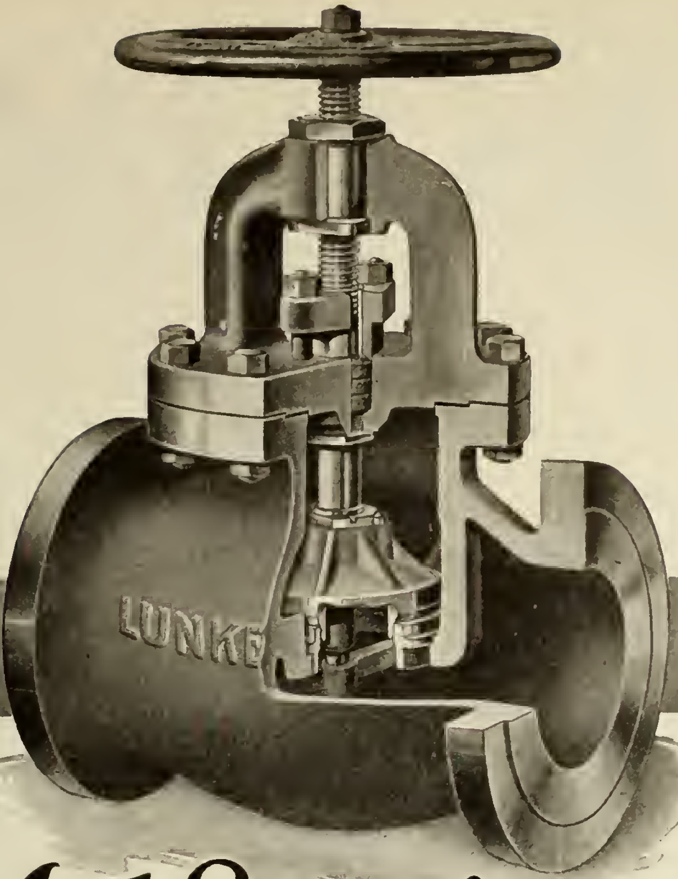


FIG. 1123



Ex. Hy. Pattern
Iron Body Bronze Mounted

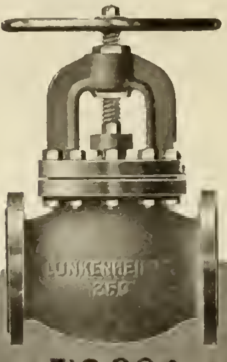


FIG. 884

A TYPE FOR EVERY PURPOSE

And Service 'way beyond the average!

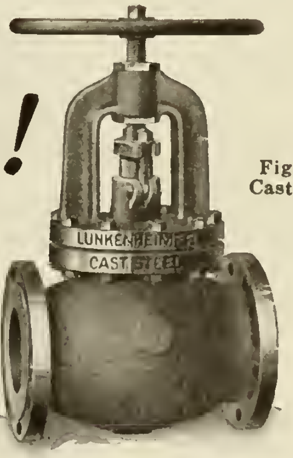


Fig. 606
Cast Steel

Be it a small or large size for low or high pressures and temperatures, there is a Lunkenheimer Valve especially suited to the purpose. Every type is designed to give maximum service under extreme operating conditions, and with the line complete, standardization throughout the plant, with its many advantages, is easily accomplished.

With seating surfaces regrindable and all parts made to gauge and renewable, the installation of Lunkenheimer Valves means permanence in the line with a minimum expense for maintenance and repairs.

Our catalog No. 58-D.C. illustrates and describes the various types in detail. A copy will be sent on request.

If you have a valve problem, we will help you,—no obligation.

"America's Best since 1862"

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO CINCINNATI, U. S. A. LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

1300-20A-43

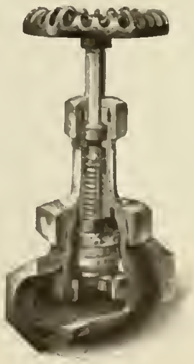


Fig. 73
"RENEWO"

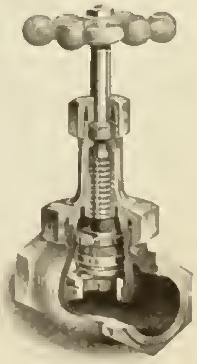


Fig. 1021
"FERRENEWO"

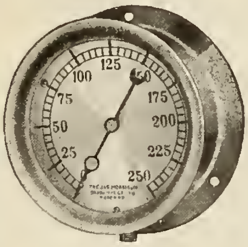
LUNKENHEIMER

MORRISON

GAUGES

FOR EVERY PURPOSE

Acknowledged as the CANADIAN STANDARD



Pressure Gauge

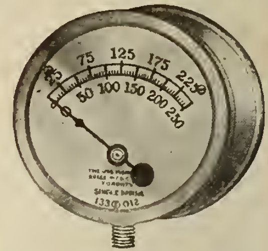
Equalized Altitude Gauge.

Duplex (Elec. Light) Gauge.

Recording Gauge.

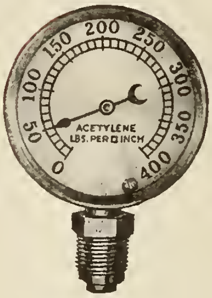
Diaphragm Gauge.

Duplex Gauge



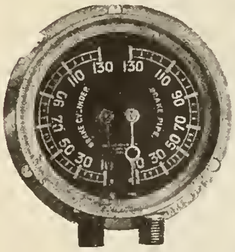
Single Spring Pressure Gauge.

Compound Gauge.

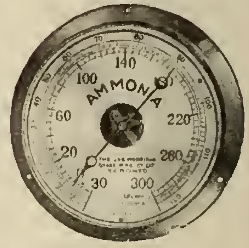


Acetylene Gauge.

Revolution Counter.



Duplex (Black Dial) Gauge.



Ammonia Gauge.

Engineer's Clock.

Sprinkler System Alarm Gauge.

Pyrometer Gauge.

Hydrostatic Gauge.

Vacuum Gauge.

Air Gauge.

Steam Heat Gauge.

First in the Field

"Every Installation is a Demonstration of Merit"

Send for Full List

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. West, TORONTO

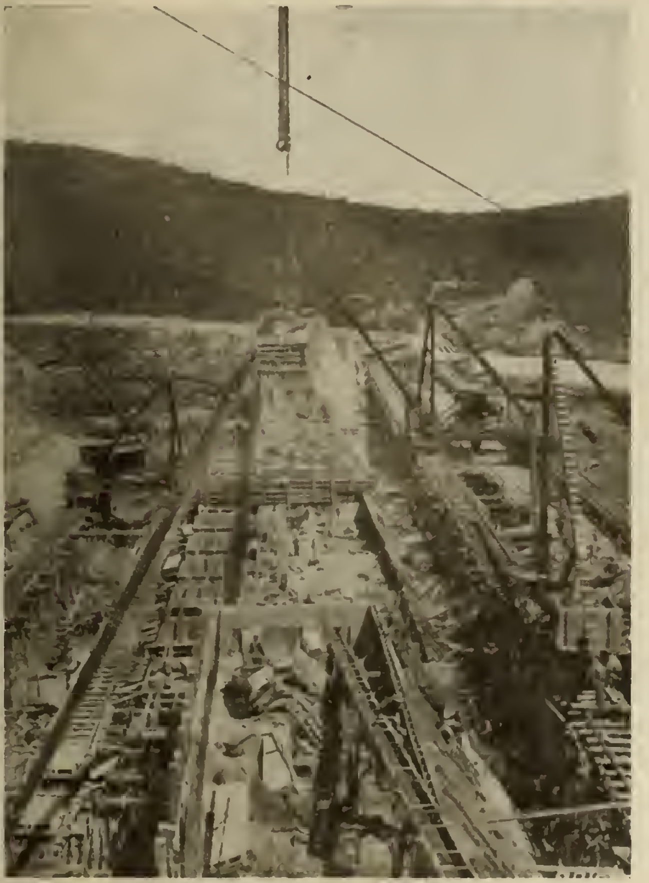
POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission and Application of Steam, Gas, Electric Air and Water Power ; the operation of Refrigerating Machinery ; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street, E. C. NEW YORK, BOSTON, CHICAGO.

Vol. XVI—No 3. Publication Office, Toronto—February 5, 1923

Published Semi-Monthly.
Canada, $2: U.S. $2.50 a year



Gouin Dam Under Construction

CANADA CEMENT
CONCRETE
FOR PERMANENCE

The Canada Cement Company maintains a comprehensive library of information. This library and the Service Department are at the disposal of all interested in concrete constructions.

The Gouin Dam
on the
St. Maurice River

THE Province of Quebec has adopted the policy of regulating the flow of its rivers. This policy was first put into effect on the St. Maurice River, with the construction of the Gouin Dam, forming the second largest artificial reservoir in the world.

The dam is located 240 miles from the St. Lawrence and completely controls the water supplied by a drainage area of 3,650 square miles.

Seventy-two thousand yards of concrete were used in it. The concrete was mixed in proportions of 1:2:5, into which was embedded an average of a little over 15 per cent. of displacers or "plums."

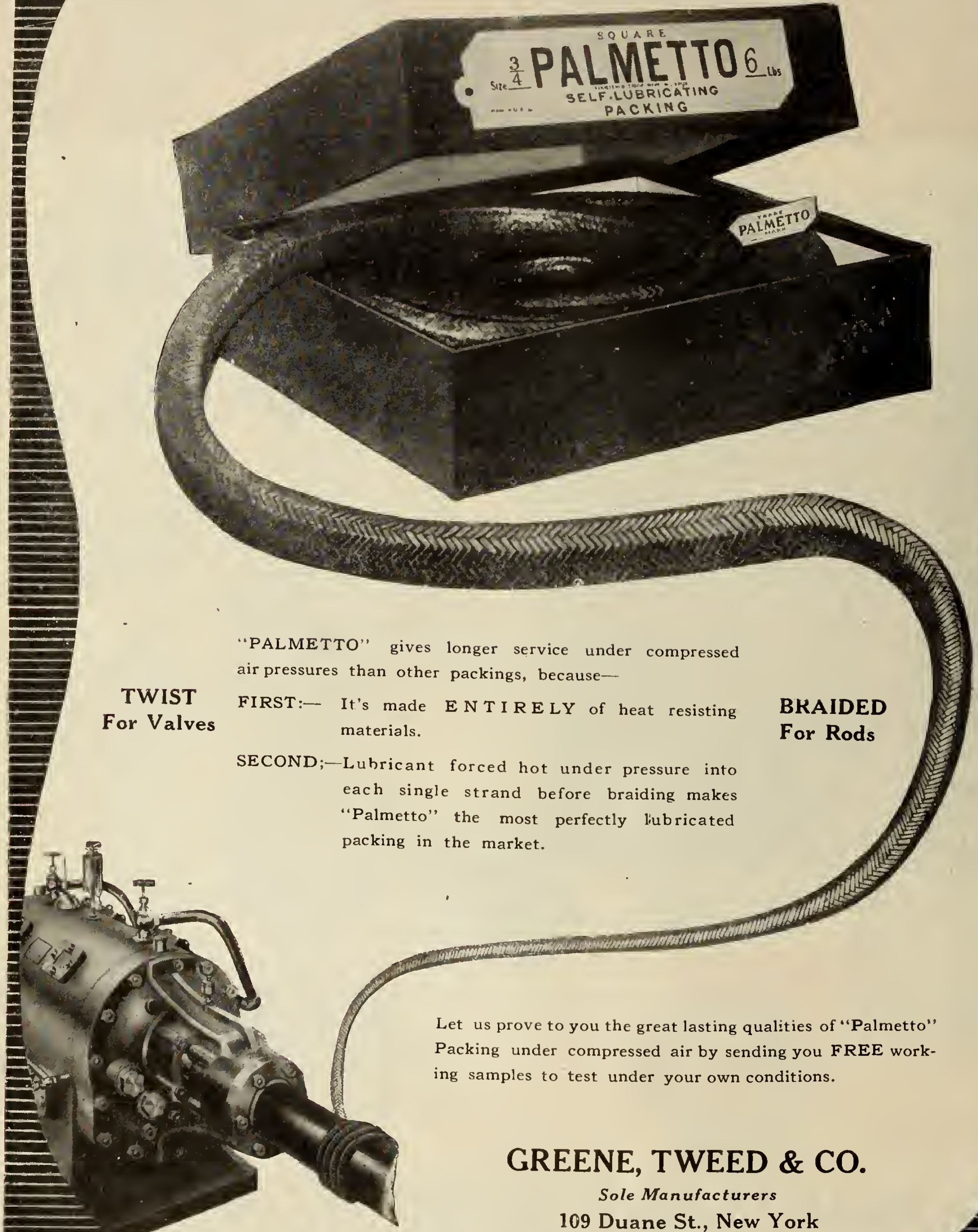
This regulation work is responsible for a tremendous power increase — the amount of power now generated on the St. Maurice River being 500,000 H. P., with an equal additional amount possible.

CANADA CEMENT COMPANY LIMITED

Canada Cement Company Building Phillips Square Montreal

Sales Offices at MONTREAL TORONTO WINNIPEG CALGARY

How Long Does Your Rod Packing Last Under Compressed Air Pressures?



TWIST
For Valves

"PALMETTO" gives longer service under compressed air pressures than other packings, because—

FIRST:— It's made ENTIRELY of heat resisting materials.

SECOND;—Lubricant forced hot under pressure into each single strand before braiding makes "Palmetto" the most perfectly lubricated packing in the market.

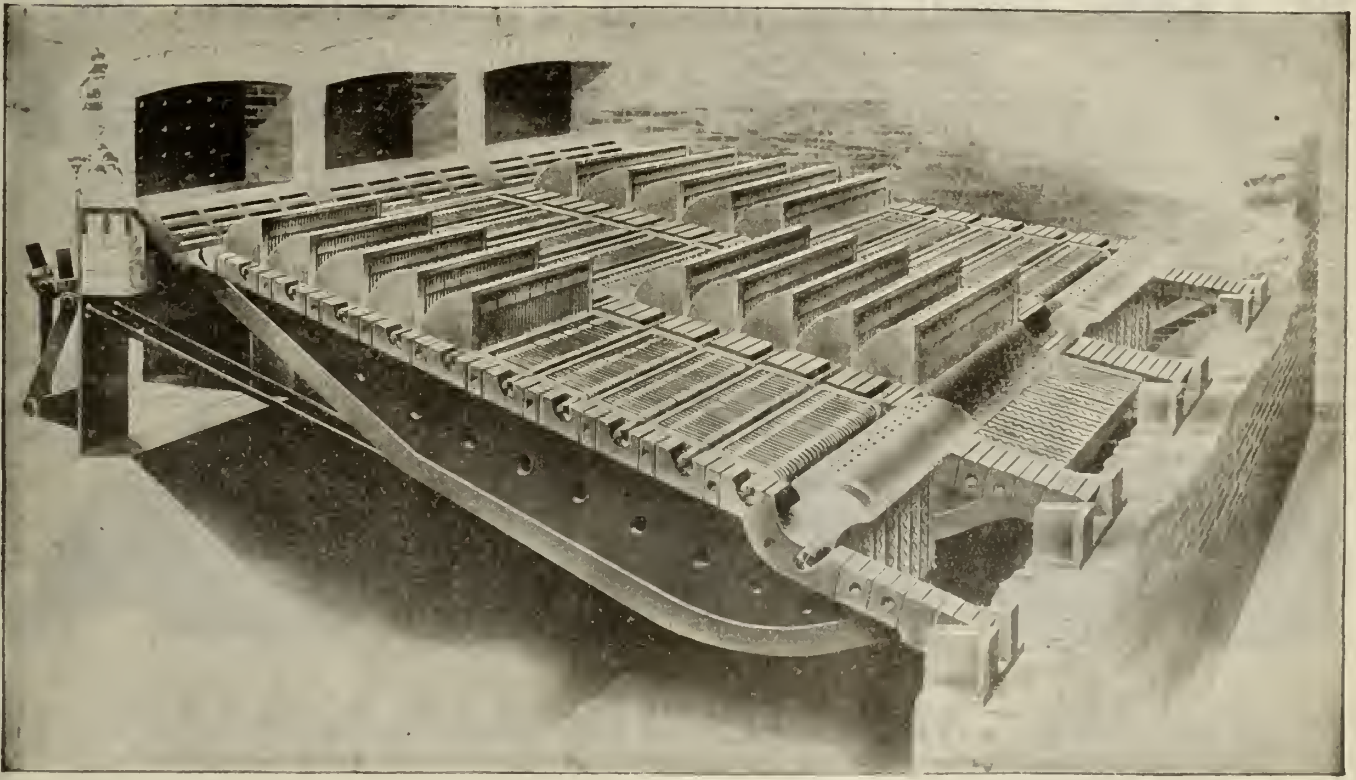
BRAIDED
For Rods

Let us prove to you the great lasting qualities of "Palmetto" Packing under compressed air by sending you FREE working samples to test under your own conditions.

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane St., New York

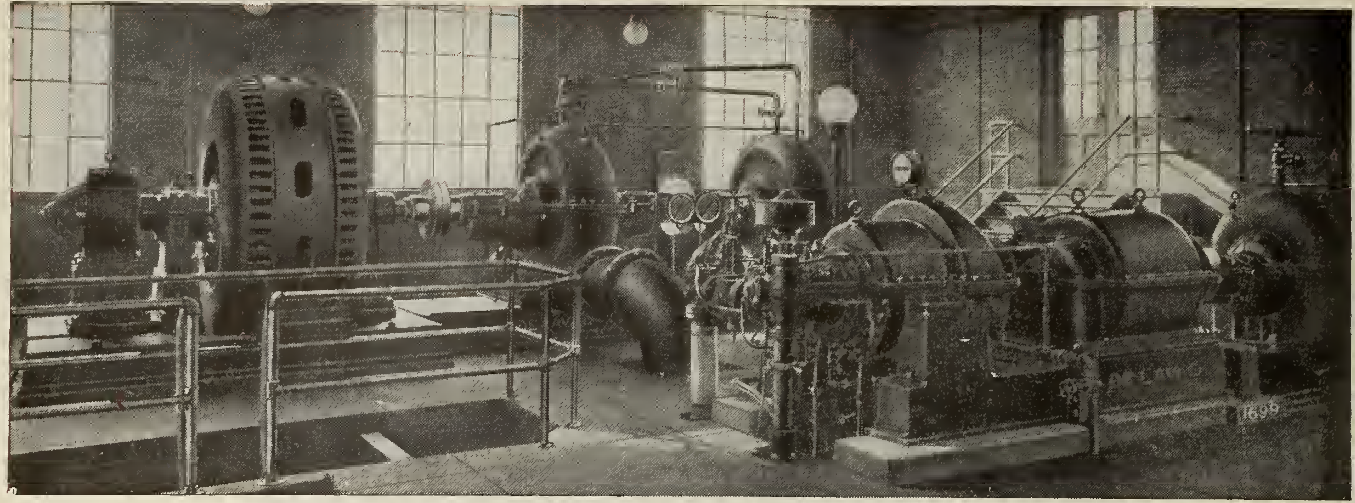
Files Stokers

Hand Operated



Waterous

BRANTFORD, ONTARIO, CANADA



DE LAVAL PUMPING UNITS AT HAMILTON, ONT.

THE City of Hamilton uses hydro-electric power to drive the De Laval Centrifugal Pump which supplies the regular water requirements, but also has installed a De Laval Geared Turbine Driven Centrifugal Pump for standby and peak load service. The official tests showed a combined efficiency of 75.98 per cent. for the motor and pump unit when delivering 10,028,751 gal. per day against 299.92 ft. head, and for the steam turbine driven pump a duty of 117,000,000 ft. lb. per 100 lb. of dry steam, at 169.7 lbs. gage pressure when delivering 11,110,000 gal. per day against 310.4 ft. head.

Our engineers will be glad to study your conditions. Ask for Catalog B-100.

De Laval
Steam Turbine Company

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

TAYLOR ENGINEERING CO., LTD.
Vancouver, B. C.

DURABLA

NOW MADE IN CANADA

Durabla Sheet and Gaskets are now made in Canada by Canadian Durabla, Limited.

Guaranteed to make a tight joint wherever a permanent gasket is required.

Distributors:

The Canadian Fairbanks-Morse Co., Limited

Sales Offices in all Leading Cities

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

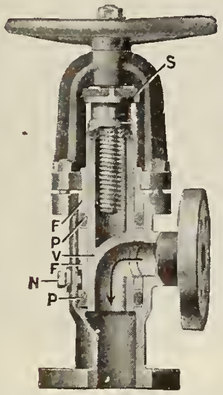
"Economical!"

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO :: CANADA
Sales Offices - - Coast to Coast

These YARWAY SEATLESS BLOW-OFF VALVES

have been in Continuous Service Since 1910



Yarway Seatless Blow-Off Valve—send for celluloid model illustrating operation of this unique valve.

In June, 1910, the Stanley Works installed three YARWAY SEATLESS BLOW-OFF VALVES in their New Britain, Conn., plant. To-day, after more than twelve years of continuous service, these valves are still in good condition.

In March, 1911, the same company installed three additional YARWAY SEATLESS BLOW-OFF VALVES; in May, 1912, three more; in September, 1912, three more; in December, 1920, two more—a total of four repeat orders.

All of these valves are giving excellent service.

The Stanley Works is one of several hundred concerns that have made a permanent investment in YARWAY SEATLESS BLOW-OFF VALVES. Names and records of other users are given in Booklet B-410. There's a free copy here for you—write for it to-day.

YARNALL-WARING COMPANY

Mermaid Lane and Ardleigh St., Philadelphia

207 St. James St., MONTREAL. 400 Penobscott B'dg., DETROIT.

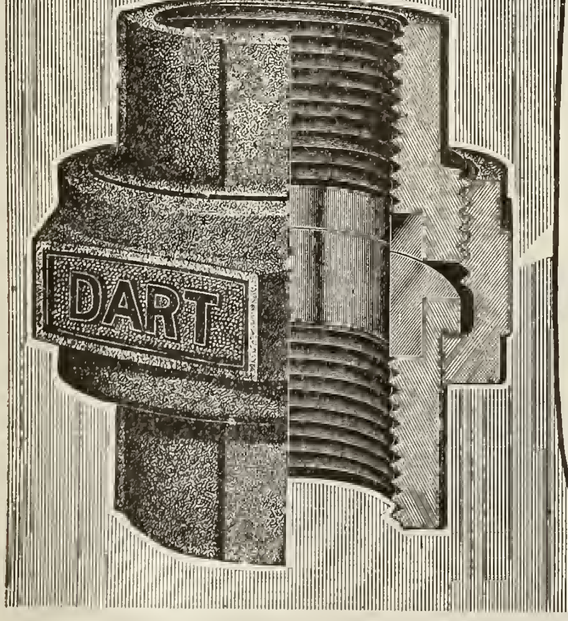
Some of the 14 Yarway Seatless Blow-off Valves at The Stanley Works, three of which have been in continuous service since 1910.

YARWAY

The ideal combination for blow-off service — Yarway Seatless Blow-off Valve and Yarway Double Tightening Valve in tandem

POWER PLANT DEVICES *to save fuel*

DART UNIONS



Are used where permanency in pipe connections count, and where lasting service means more than first cost.

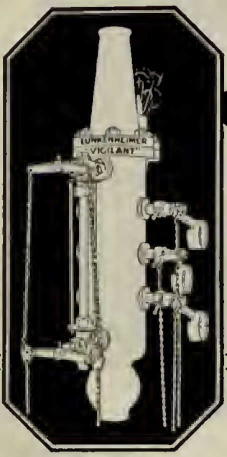
Your Jobber Keeps a Stock for Prompt Delivery

Manufactured by

Dart Union Co., Limited, Toronto

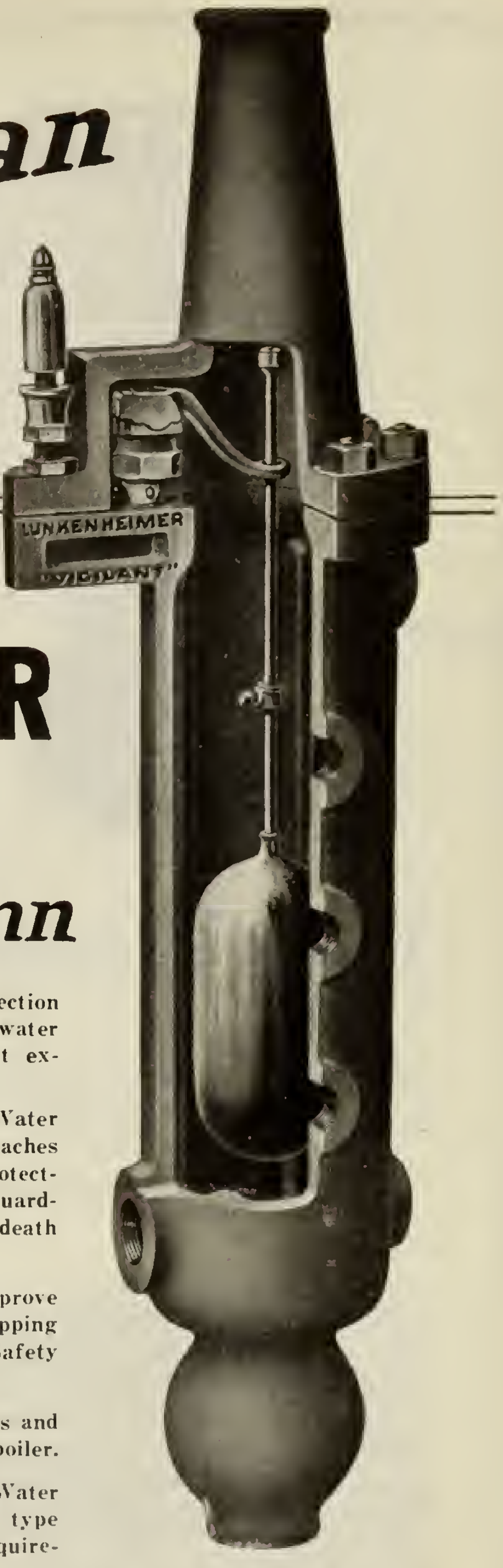
Bronze to Bronze at the Joint

MADE IN CANADA



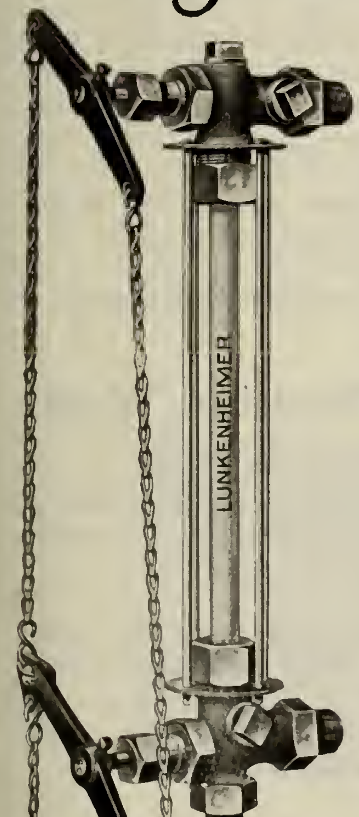
Sounds an alarm

—when danger is near.



LUNKENHEIMER

"Vigilant" Safety Water Column



A safety device as essential for the protection of the boiler against extreme high or low water levels as the Pop Safety Valve is against excessive steam pressure.

The Lunkenheimer "Vigilant" Safety Water Column sounds an alarm before the water reaches either danger limit. It thereby aids in protecting the boiler against accident and in safeguarding the boiler attendants against injury or death and the plant from destruction.

Statistics covering boiler accidents will prove the desirability — yes, necessity of equipping boilers with the Lunkenheimer "Vigilant" Safety Water Column.

For the highest prevailing steam pressures and in sizes suitable for any make or type of boiler.

From the large variety of Lunkenheimer Water Gauges and Gauge Cocks may be selected a type particularly adapted to meet individual requirements.

Ask for Booklet 519-DC.

FIG. 919
"Vigilant" Safety Water Column.

FIG. 1335
Automatic Pattern Ex. Hy. Regrinding Water Gauge.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO CINCINNATI, U. S. A. LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

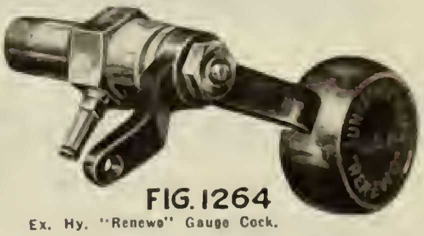


FIG. 1264
Ex. Hy. "Renewo" Gauge Cock.

"America's Best since 1862"

KERR

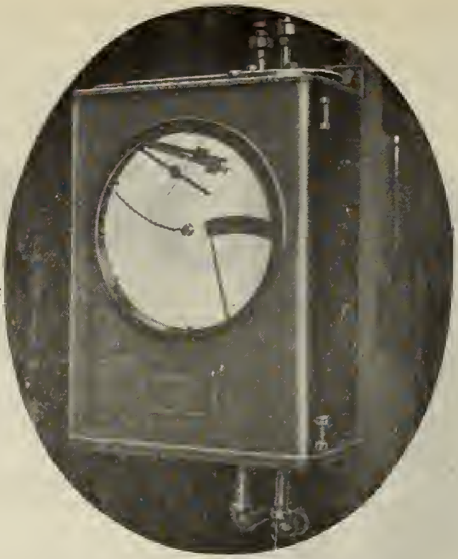
"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville Ontario



Bailey Boiler Meter. Records steam flow, air flow and flue gas temperature all on one chart.

BAILEY
Boiler Meters

It is not enough simply to know how much steam a boiler is making for it is equally important to know how efficiently this steam is being generated. A boiler may make a good deal of steam but do it very inefficiently as when it is running at low rating during the light-load period.

Manufacturing conditions to-day make it imperative to

Prevent Needless Waste

And in a boiler plant the best results can be obtained only by a constant record of the relationship between the operating factors.

This is the main purpose of the Bailey Boiler Meter. It shows the fireman exactly what the operating conditions are at every instant so that he can control steam output and maintain maximum efficiency.

Write for Bulletin No. 42

Bailey Meter Company, Limited
177 Delorimier Ave. Montreal, Que.

All it costs is $136.22 per annum

to own this modern, new, thoroughly efficient Boiler. Think of it! Think of the coal savings, the repairs savings, the boiler room labor savings you can effect if you discard that present worn out, inefficient Boiler and put in a high-grade, up-to-date Boiler from us. And the cost is really moderate. The sum mentioned above is an annual 7% interest charge on a Boiler investment of $1,946, which gets you a 66″ x 16′ horizontal return tubular Boiler, 110 h.p., 125 lb. pressure, built to suit Interprovincial Codes, complete with suspension harness and columns. Other sizes in proportion. Easily one of the best investments you can make because your savings will offset several times this modest investment charge.

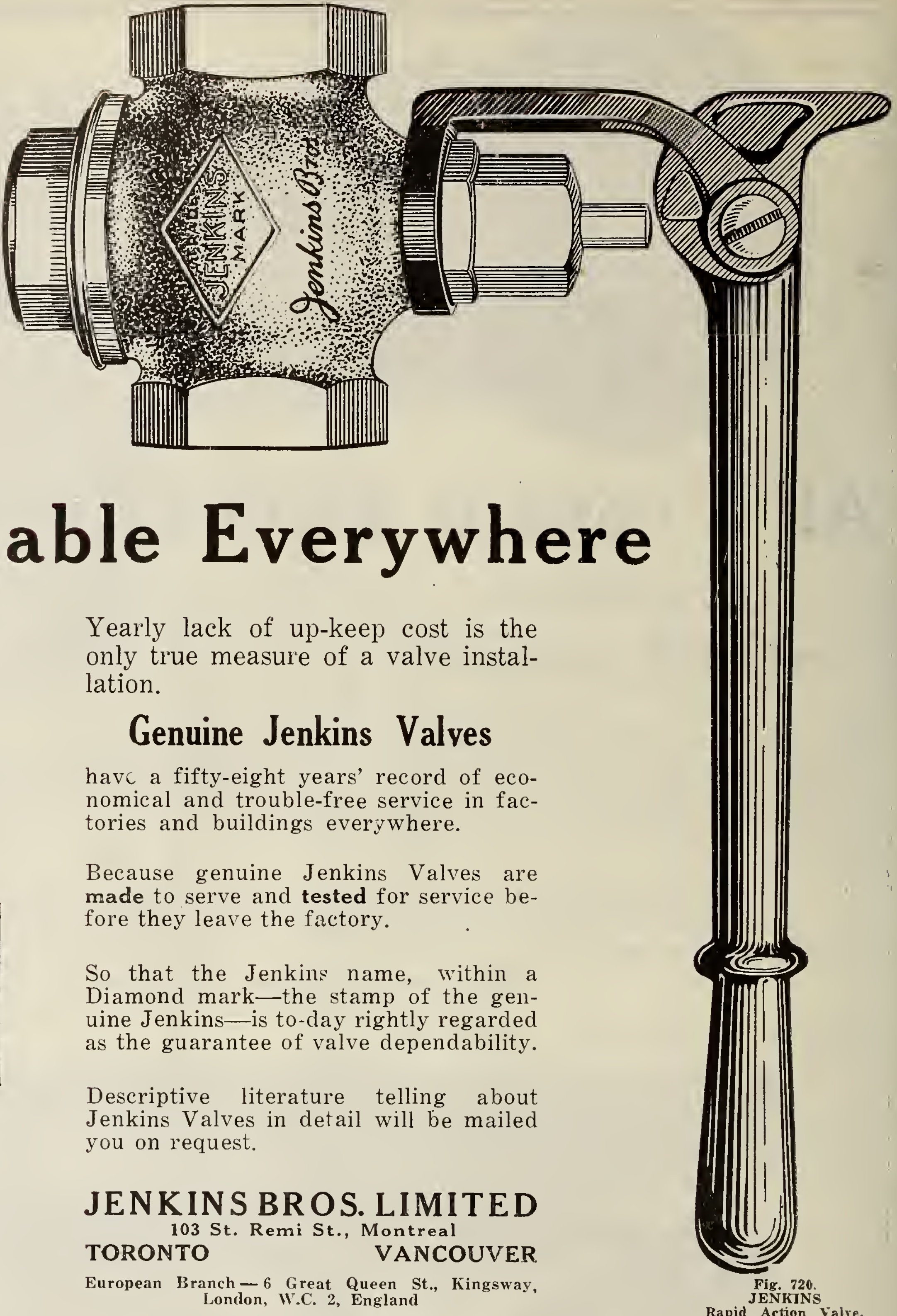
Instal National Hand Fired Stokers which give unusual steam results from low grade fuels, with common, inexpert labor, and your savings will be very substantially increased.

Write us for further particulars.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal



Dependable Everywhere

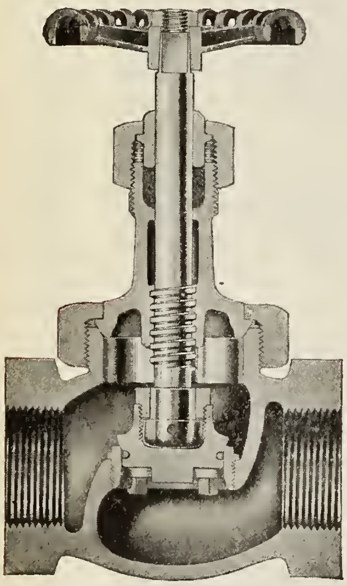


Fig. 500.
"STERLING"
Regrinding Bronze Globe Valves
(Sectional View.)

Yearly lack of up-keep cost is the only true measure of a valve installation.

Genuine Jenkins Valves

have a fifty-eight years' record of economical and trouble-free service in factories and buildings everywhere.

Because genuine Jenkins Valves are **made** to serve and **tested** for service before they leave the factory.

So that the Jenkins name, within a Diamond mark—the stamp of the genuine Jenkins—is to-day rightly regarded as the guarantee of valve dependability.

Descriptive literature telling about Jenkins Valves in detail will be mailed you on request.

JENKINS BROS. LIMITED
103 St. Remi St., Montreal
TORONTO VANCOUVER
European Branch — 6 Great Queen St., Kingsway,
London, W.C. 2, England

Fig. 720.
JENKINS
Rapid Action Valve.

Jenkins Valves

SINCE 1864

Service Considered—

There's Only One Real Test

Whatever may be claimed for any belting, the one sure way of testing its real value is by watching your transmission cost sheets.

In many of the largest Canadian shops, the adoption of

D. K. McLAREN'S BELTING

is giving a "service on the pulley" that is reducing transmission costs to an absolute minimum. One reason for this is the

Genuine British Oak Tanning Process

to which every inch is subjected—that, and the fact that only the **back portions** of specially selected hides are used in its manufacture.

D. K. McLaren's Leather Belting is stamped with an Oak Leaf as your guarantee of this—look for it.

D·K·McLAREN
LIMITED

Head Office and Factory:
351 St. James St., Montreal, P.Q., Can.

BRANCHES:
TORONTO, ONT., 194 King St. W. ST. JOHN, N.B., 90 Germain St.

STOCK DEPOTS:
VANCOUVER B. C., Gorman's Ltd., 1158 Homer St. : EDMONTON, Alta., Gorman's Ltd., : CALGARY, Alta., Gorman's Ltd.

REFRIGERATION DEPARTMENT

Made in Canada

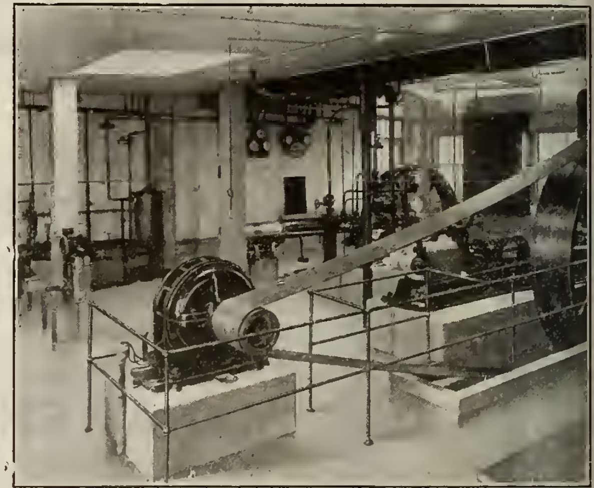
LINDE

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants. Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

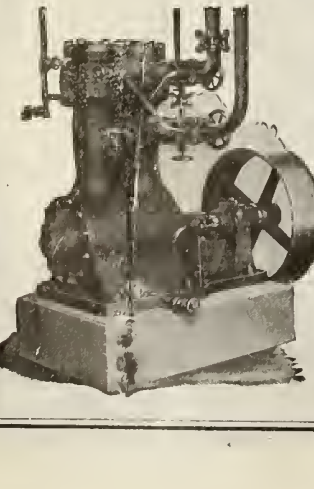


This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

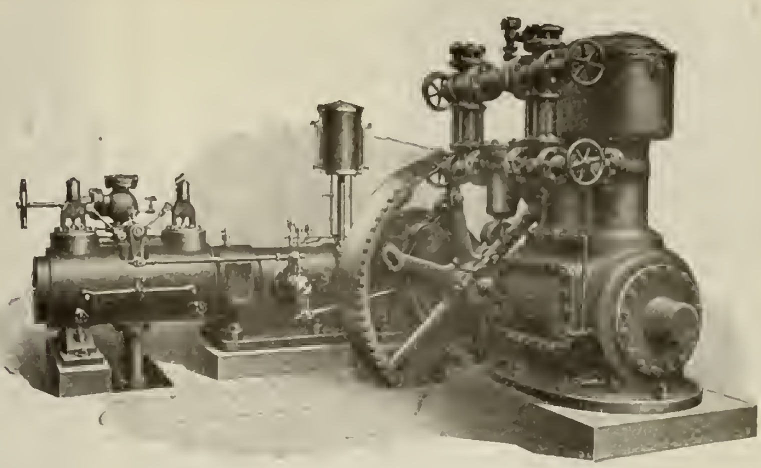
The Vilter Manufacturing Company

242 Beecher St. - - - - Milwaukee. Wisconsin

REFRIGERATION

Safe—Simple—Economical

Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.



We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

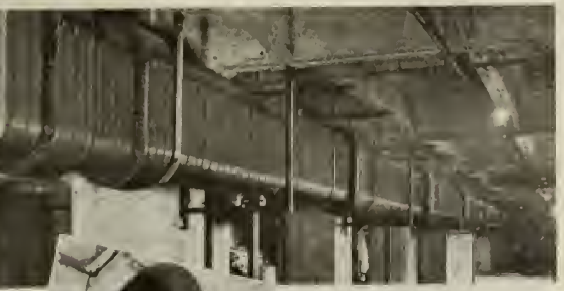
See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

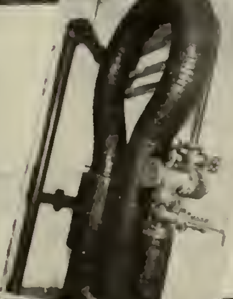
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

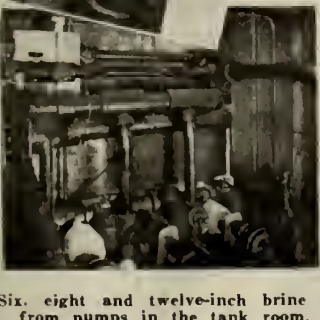
Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto



Part of 250 feet of double 15-inch brine main in the basement.



Eight-inch return expansion bend.



Six, eight and twelve-inch brine lines from pumps in the tank room.

SIZE Is No Obstacle

IN THE Harbor Commissioners Cold Storage Plant at Montreal, Canada, are long runs of 8-inch, 12-inch and 15-inch brine lines. All of them, with their immense fittings, bends and connections, are insulated with Nonpareil Cork Covering.

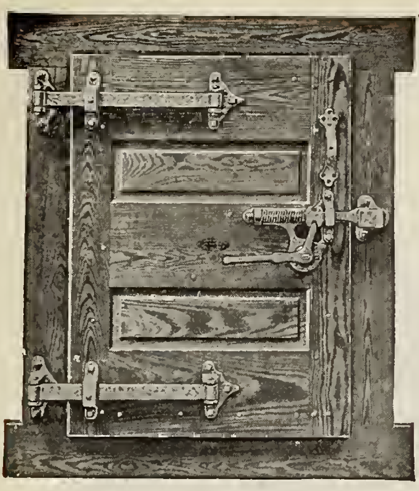
The selection of Nonpareil Cork Covering for such work as this was dictated by the necessity for using a covering that not only would afford the utmost insulating value, but that could be depended upon absolutely for permanence. Think of the expense of replacing insulation on such lines. No possible saving (?) in the first cost of some inferior material could justify such a risk.

Whether you have long runs of big lines or short runs of little ones, Nonpareil Cork Covering offers you the same assurance of permanence and maximum saving of refrigeration. No plant, whether large or small, can afford to insulate brine and ammonia lines with anything less efficient and durable than Nonpareil Cork Covering.

Write for data on cold lines losses and how to stop them. Samples and full information will be furnished promptly and free of charge.

Armstrong Cork & Insulation Co., Ltd.

902 McGill Bldg., Montreal, Que. 11 Brant Street, Toronto, Ont.



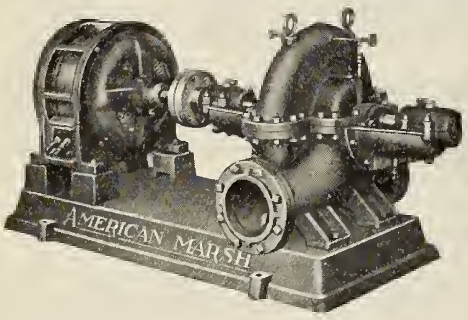
Jamison HEAVY DUTY
Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)
HAGERSTOWN MARYLAND, U.S.A

AMERICAN-MARSH PUMPS
Centrifugal and Direct Acting



Designed for use in power plants where absolute reliability and high efficiency are essential. For over thirty-five years American-Marsh Pumps have been recognized as standard throughout the Dominion. There are over 160,000 in successful operation.

The sturdy rugged construction and heavy cast bronze fittings insure long life and a minimum repair expense.

American-Marsh Centrifugal Pumps are built with the same painstaking care that characterizes the construction of the direct acting line.

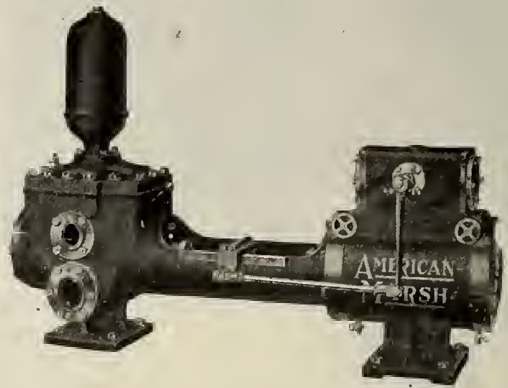
The Line includes :

- Boiler Feed Pumps
- Air Compressors
- Deep Well Engines
- Centrifugal Pumps
- Jet Condensers
- Vacuum Pumps
- Condensation Pumps
- Sump Pumps

May we send you our general Catalog ?

AMERICAN STEAM PUMP CO.
BATTLE CREEK, MICH.

CANADIAN AGENTS:—A. R. Williams Machinery Co., Ltd., Toronto; Williams & Wilson, Ltd., Montreal; London Engine Supplies Co., Ltd., London; A. R. Williams Machinery Co., Ltd., Winnipeg; Mechanics' Supply Co., Ltd., Quebec; Gorman's Ltd., Edmonton and Calgary; J. T. Allan Ritchie, Vancouver.



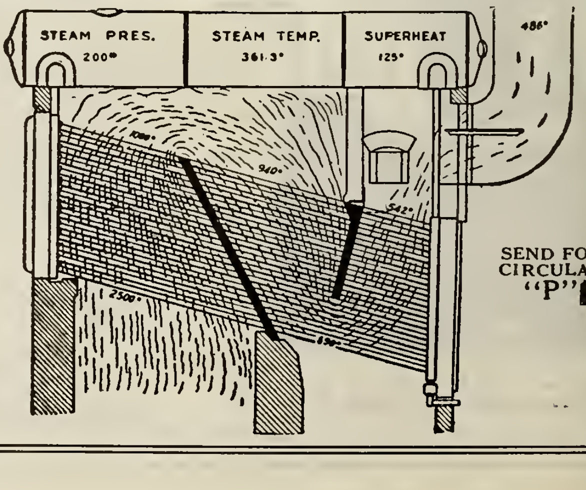
"MONO" TRADE MARK REG. U.S. PAT. OFF. BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE

AND ARE NOT DAMAGED WHEN TUBES ARE WITHDRAWN, REPLACED OR BY THE USE OF A TURBINE CLEANER.
OUR ENGINEERS ARE AT YOUR SERVICE TO HELP YOU SOLVE YOUR COMBUSTION PROBLEMS. THE CUT ON THE RIGHT IS AN EXAMPLE OF WHAT WE CAN DO FOR YOU.

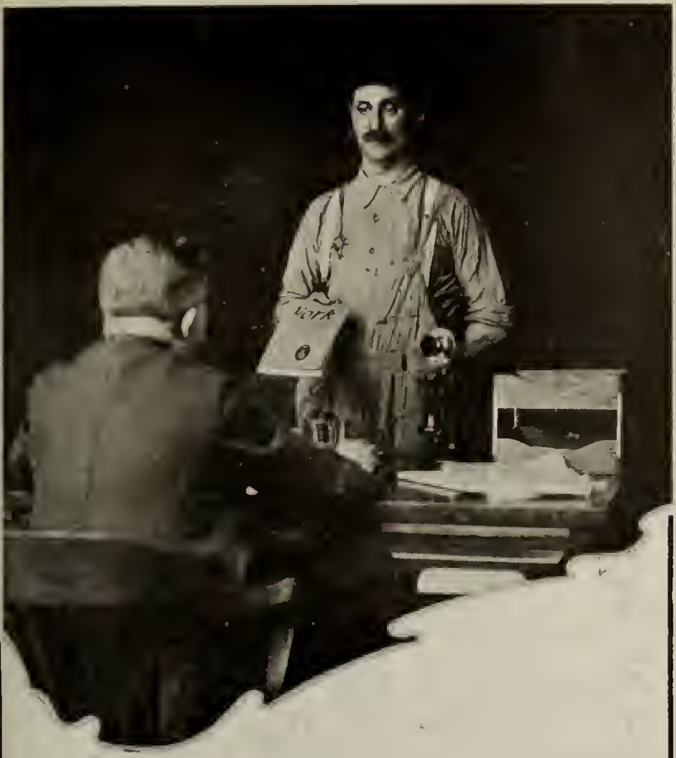
KING REFRACTORIES CO.

Sole Canadian Representatives:

GRANT E. COLE CO.
21-23 River St., Toronto, Canada
Represented in Vancouver, Winnipeg, Montreal, Halifax.



SEND FOR CIRCULAR "P"



"For Reliable Service give me YORK Equipment"

When the Operating Engineer of an Ice Making or Refrigerating Plant insists upon the Plant Manager buying York Ammonia Fittings and Supplies, he knows he is saving himself a lot of time and trouble and also reducing the operating costs of the plant.

He knows, because he has learned through past experiences of his own, or perhaps from another Engineer, that York Equipment is designed and made to meet the severest Service.

Surely, the man who is responsible for the operation of the plant, who sees and handles the equipment every day, should be best able to judge the merits of each piece of apparatus.

And the engineer out of justice to his employers and to himself, will recommend York Apparatus, which he realizes will give satisfactory results in actual service. That's why more York Ammonia Fittings and Supplies are sold each year than any other make.

There is perhaps no other concern of its kind in the world able to handle such a large number of orders or such a heavy volume of business.

A trial order will convince you of the Superior Quality of York Ammonia Fittings and Supplies.

CANADIAN ICE MACHINE CO., LTD.

Toronto: Villiers and Munition Sts., Eastern Harbor Terminals; **Montreal:** 324 Craig St. West; **Winnipeg:** 1415 Whyte Ave.; **Vancouver:** 1158 Homer St.

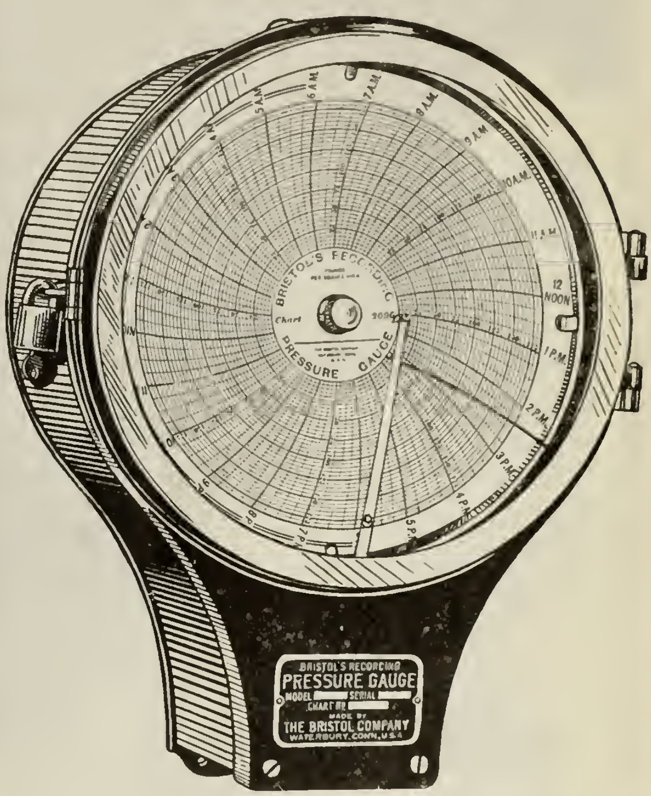
Representing

YORK MANUFACTURING CO.

Ice Making and Refrigerating Machinery Exclusively

YORK PENNA., U.S.A.

A Necessity for Every Power Plant



Pressure fluctuations on your steam, water and air lines are sure to result in cost in economy.

Protect yourself against this unnecessary loss with the continuous day and night records obtained in the use of

TRADE MARK

BRISTOL'S

REG. U. S. PAT. OFFICE.

Recording Pressure Gauges

They show every rise or fall in pressure and are a direct check on how well the men are holding the specified pressure.

Thousands of the best operative power plants find them of invaluable assistance in maintaining economical operation. Bristol's Gauges afford lasting service without constant attention.

Catalog 1006-A mailed on request.

The Bristol Company

Waterbury, Conn. :: U.S.A.

Canadian Distributors:

Eastern Territory—A. H. Winter Joyner, Toronto and Montreal.

Western Territory—Gorman's Ltd., Edmonton.

CRANE

No. 014
Extra Heavy
Steam Separator

Oil and Steam Separators

mechanically eliminate oil and water from exhaust steam,—thus conserving the strength and serviceability of the boiler.

Manufacturers of Valves, Fittings and Piping Equipment for all pressures and purposes—and distributors of Pipe, Plumbing and Heating Supplies.

No. 03
Low Pressure
Oil Separator

Branches and Warehouses:
HALIFAX, OTTAWA, TORONTO,
HAMILTON, LONDON, WINNIPEG,
REGINA, CALGARY, VANCOUVER.

Sales Offices:
ST.JOHN,N.B.,QUEBEC,SHERBROOKE
EDMONTON, VICTORIA,
SYDNEY, AUSTRALIA.

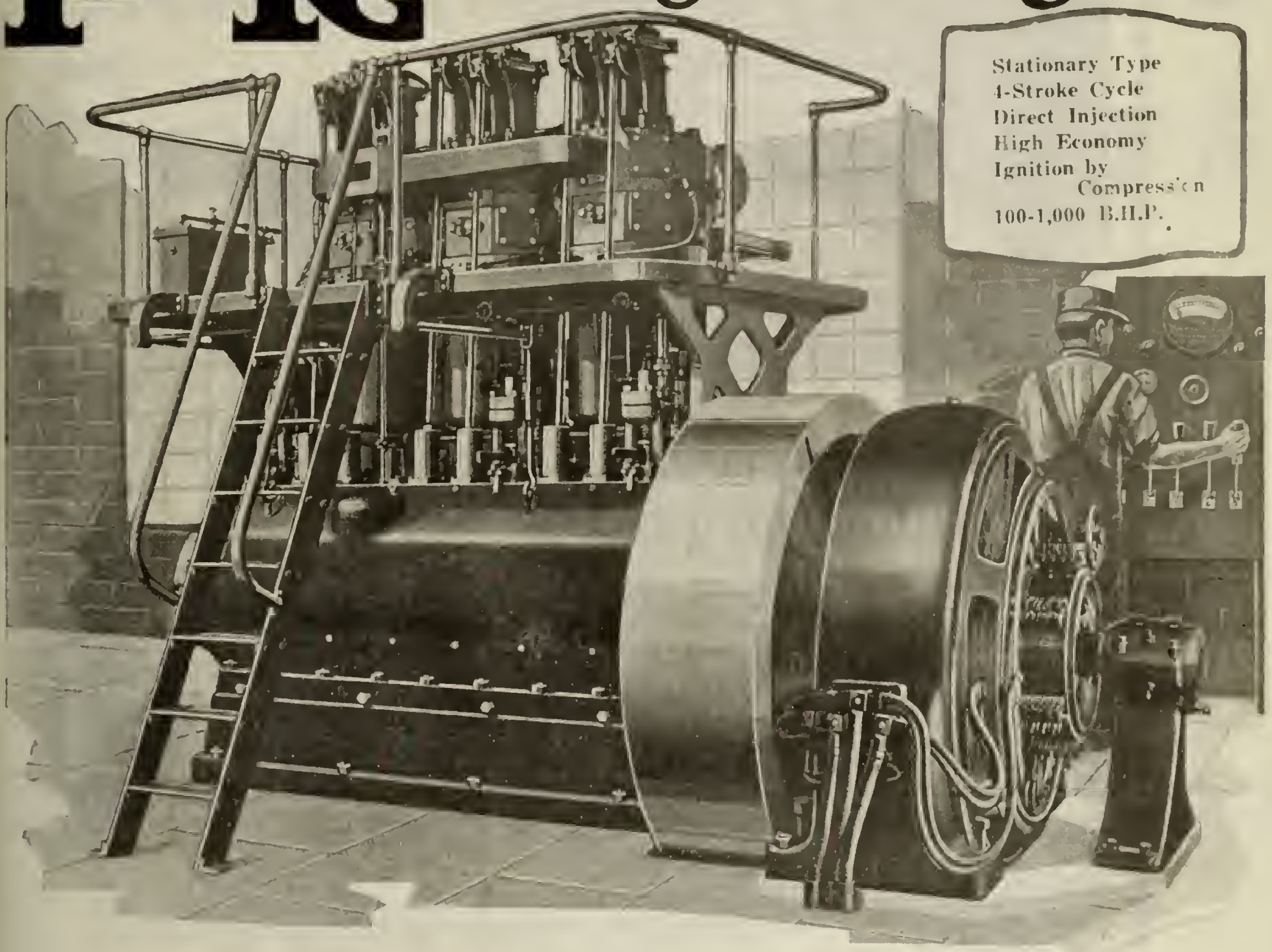
CRANE
LIMITED
General Office & Exhibit Rooms
386 BEAVER HALL SQUARE
MONTREAL
Works
1280 ST. PATRICK ST.
MONTREAL

CRANE-BENNETT
LIMITED
Head Office and Warehouse:
LONDON, ENGLAND.

Sales Offices:
BIRMINGHAM, CARDIFF,
GLASGOW, LEEDS, MANCHESTER.

14a

P-R Heavy-oil Engines



Stationary Type
4-Stroke Cycle
Direct Injection
High Economy
Ignition by
Compression
100-1,000 B.H.P.

Lowest Cost Per Horse Power Hour

There is but one true measure of efficiency of the complete power plant and that is the **cost per unit of useable power.**

The P-R Engine converts the fuel **directly** into power; no boiler plant is used. This alone represents a large saving.

Furthermore, the P-R Engine operates with remarkably high efficiency, the **guaranteed fuel oil economy at full and ¾ loads being 0.45 pounds per horsepower hour and the guaranteed lubricating oil economy one gallon per 4000 horsepower hours.**

Fuel injection is direct and positive without the use of compressed air.

Ignition is by temperature of compression alone, there are no hot plates or bulbs or liners.

The P-R Engine is not only mechanically efficient, but has many remarkable features which make it easy to take care of.

The P-R Engine produces each unit of **useful work at lowest cost.**

Horizontal and marine types are also available.

Write for bulletins describing the type or types in which you are interested.

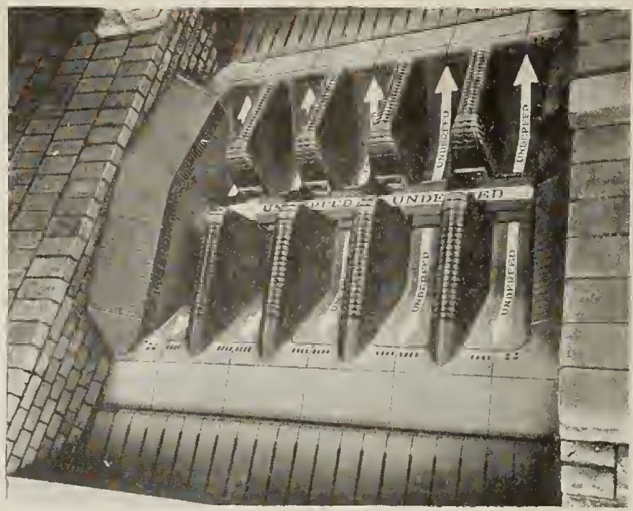
Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

Associate Offices in all civilized countries

Ingersoll-Rand

Drills, Air, Gas and Ammonia Compressors, Condensers, Pumps, Air Tools.



"Multiple retort" in everything but price—

BEFORE the *"lateral retort"* principle was developed there was no such thing as a strictly *underfed* side-cleaning stoker. Consequently, the many advantages of underfeeding coal were confined to more expensive stokers of the high-duty multiple retort type.

Now, as a result of the revolutionary *"lateral retort"* principle, the advantages of the multiple retort stoker —high capacity and efficiency—are combined with the advantages of the side-cleaning stoker—lower first cost, reduced installation cost, and adaptability to old boilers.

The *"Lateral Retort"* Stoker is not claimed to be a substitute for multiple retort stokers—*but*—it *does* bring the advantages of multiple retort stoking to the plant that otherwise would install an inferior stoker, thus providing multiple retort efficiency while effecting a marked saving in initial and installation cost.

The illustration above shows how the truly underfeed effect is accomplished. The coal follows the path of the arrows. It is first underfed along the line of the main arrow into the central retort by means of a main ram. It is then underfed—always underfed—into the *"lateral retorts"* by means of an auxiliary steam cylinder which operates lateral pusher rods.

There is only one simple moving unit for distributing fuel in five or more *"lateral retorts"* and, since this feeding mechanism is controlled independently of the main fuel feed, ideal distribution is possible under all conditions.

A trench 6 to 18 inches below the floor line is sufficient excavation for ash pits. This reduces installation cost and makes the stoker adaptable to boilers already in service. The many good points of this stoker are covered in greater detail by a new bulletin. Where shall we send it?

The Under-Feed Stoker Co. of Canada, Ltd.
146 King Street, West · Toronto

Sales agents for: Jones Stokers, Riley Stokers and Murphy Automatic Furnaces

Alta. & West. Sask.:
Mr. J. Twomey Camrose
Alberta

Man. & East Sask:
W. W. Hicks & Co.
Winnipeg

British Columbia:
E. A. Earle, Ltd.
Vancover, B. C.

Quebec:
The Cleaton Co., (Can.
Ltd., Montreal, Que.)

The "Lateral Retort"
Trade Mark
Stoker

Trade Mark

Advantages of
the *"Lateral Retort"*
Principle

Coal is underfed throughout—not overfed on to side grates. This is the only truly *underfed* side-cleaning stoker.

One simple moving unit for five or more retorts—The feeding mechanism of the *"loterol retorts"* is controlled independently of main feed, permitting ideal fuel distribution under all conditions.

Simplest cleaning mechonism—a perfectly balanced dump plate easily operated by hand.

No need for basement ash pits—A trench 6 to 18 inches below the floor line is sufficient excavation for ash pits. This greatly reduces installation cost and makes the stoker adaptable to boilers already in service.

Plate tuyeres — reduce siftings and lower replacement cost.

High air cooled front and rear tuyere blocks—keep fire and clinkers away from front wall and bridge wall, reducing furnace maintenance.

The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
JONES
MURPHY

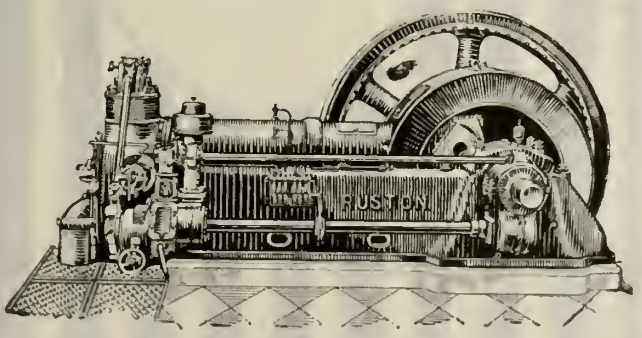
Automatic Valved Soot Blowers

Soot blowers having automatically operated valves were originated and developed by us, and are covered by patents issued and pending. Infringements of these patents will be prosecuted.

Diamond Specialty Limited, Windsor, Ont.

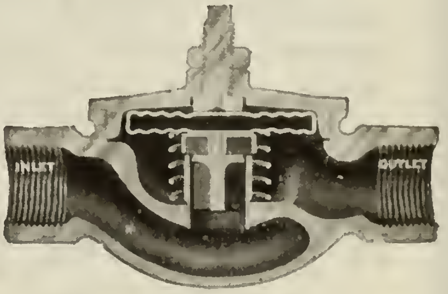
Ruston & Hornsby Ltd.

Lincoln, England



CRUDE OIL ENGINE

Uses cheapest grade oil.
Best fuel economy.
Starts instantly from cold.
May we send you catalogue.



Welldeck Steam Trap

(Standard Type)

Suitable for 150 lbs. pressure. Cannot get out of order. Price reasonable.

Stock in Montreal
Made in England.

AGENTS:

LAURIE & LAMB, BOARD OF TRADE BUILDING **MONTREAL**

Designed To Withstand High Pressure

The Mueller Composition Disc Globe Valve is built for the hardest kind of steam line service. Thickness and weight come where strength is most needed.

The threads are full length and tapered. The Mueller Composition Disc used in this valve enables it to withstand high pressure and high temperature. This valve is so constructed that it can be repacked without shuting off the steam.

Scientifically designed by engineers with years of experience and manufactured from the finest materials by expert workmen, Mueller "Globe A-3006" will give years of efficient and economical service. Send for a sample.

H. Mueller Mfg. Co.
LIMITED
Sarnia - Ontario

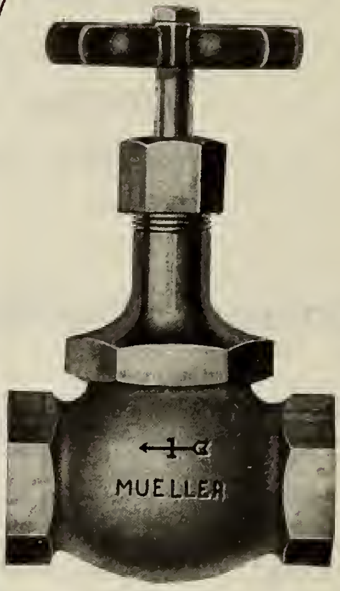
Water, Plumbing and Gas Brass Goods and Tools

American Factory at Decatur, Illinois, U.S.A.

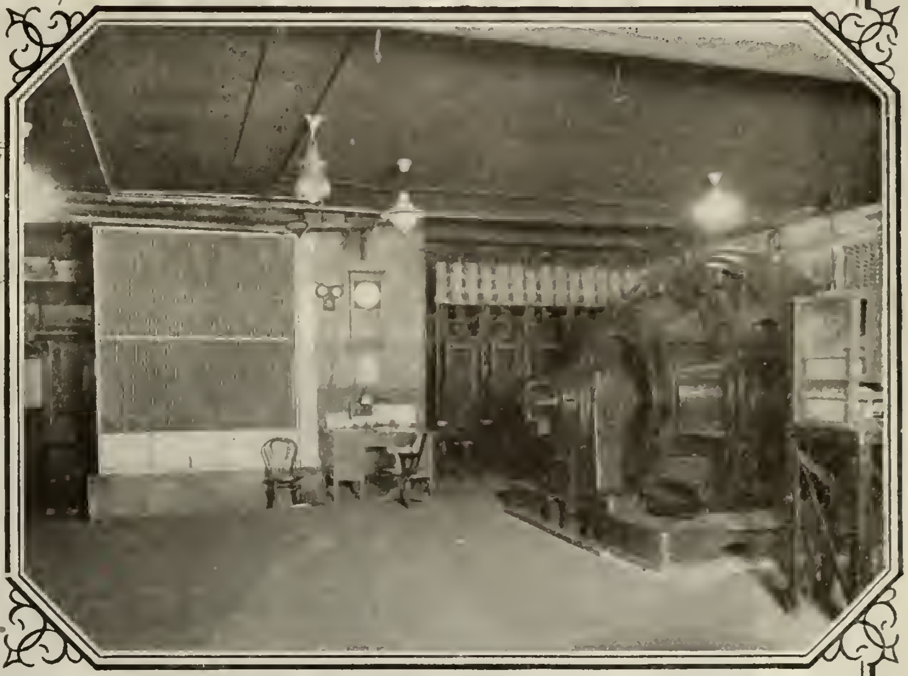
Branches—New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

Make Canada Prosperous by Buying Canadian Products



A-3006



Clean Washed Air Means Clean Cool Generators

Heat and dust are the enemies of generators and motors.

Dust produces an overheated condition. Collecting on windings and in air spaces it partially insulates against proper heat dissipation. Add to this a hot stagnant atmosphere, and overheating is inevitable.

Clean, cool air is the remedy for overheating of electrical apparatus. Canadian Sirocco Air Washers supply cool air in any needed quantity—air that is passed through a blanket of finely divided mist that rids it of dirt and dust, and cools it to a degree that insures efficient operation of the generators and motors.

Bulletins of interest to producers of electrical power, describing various types of Canadian Sirocco equipment, will be sent upon request.

Canadian Sirocco Company Limited, Windsor, Ont.

Branch Offices in all Principal Cities (231)

"Sirocco" Products

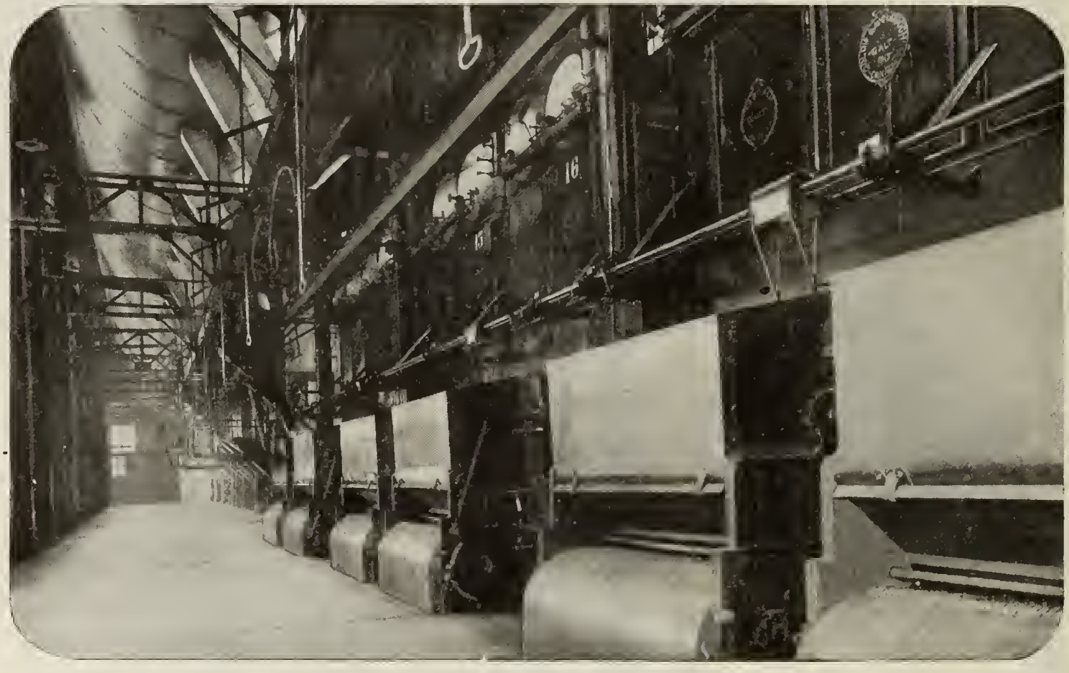
TRADE MARK

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

GOLDIE & McCULLOCH
Dependable Power Plant Equipment

G. & McC. Water Tube Boilers
Built for Rapid Steaming



The rapid-steaming qualities of Goldie & McCulloch Water Tube Boilers and their ability to withstand steam fluctuations from nominal to peak loads without strain make them particularly adaptable to plants where the service is variable and at certain periods extremely severe.

Illustration shows boiler room at the Sarnia plant of the Imperial Oil Company. Equipped with 6 G. & McC. Co. Sec.-Type "B" Water Tube Boilers. 10 of the same type are installed at their Dartmouth, N.S., plant and 2 at Regina. 18 in all.

The following statements in a letter recently received from Mr. Montgomery, their Chief Engineer, speak for themselves:—"I am pleased to advise that our experience with these boilers has been very satisfactory. We are able to operate them at very high overloads, exceeding, at times for quite long periods, 200 to 225 per cent. rating. They have in every way been up to our expectations."

THE GOLDIE & McCULLOCH CO.,
LIMITED.
Head Office and Works: GALT, ONTARIO, CANADA
Toronto Office: Suite 1101-2 Bank of Hamilton Bldg. **Western Branch:** 248 McDermott Ave., Winnipeg, Man. **British Columbia Agents:** Robert Hamilton & Co., Vancouver, B.C. **Quebec Agents:** Ross & Greig, 400 St. James St., Montreal, Que.

POWER HOUSE

Members of the
Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Determining Boiler Operating Factors

Discussion of the Methods Used to Determine the Essential Factors for the Economical Operation of Boiler Rooms—Results of Tests Given—Method of Calculating Combined Efficiency of Boiler

By D. C. HESS, Philadelphia, Pa., Stoker Engineer, Service Department, Westinghouse Electric and Manufacturing Co.

RECENTLY there has been a radical change in the method of operating boiler plants equipped with Underfeed Stokers. There were times when it appeared to be common practice to drive all the boiler units in service at their maximum rating without regard for operating economy or maintenance costs. There are times in the average boiler plant when the sudden demand for steam requires that the boiler be operated at high ratings for long periods has geniod. However, continued operation at high ratings for long periods has generally been recognized as not good engineering practice because of subsequent low operating efficiency, economy and increased expense of maintenance.

Combustion Rates and Efficiencies

There is a certain combustion rate where the stoker and boiler operate at their highest efficiency. This can be determined by running a series of short tests at various rates of combustion, and therefore an effort should be made to run as near this point as possible. However, usually this can not be done because, in case of a new plant, the designing engineers have to consider various elements such as first cost, labor, etc. In the case of old installations, it will often be found that the load demand upon the station has outgrown the station, with resultant high capacities. In this discussion it should be considered that the plant will operate at the highest efficiency point, for if the plant operates at any other point, the same discussion holds good but in a lesser degree.

Figure 1 shows the result of a series of tests using Illinois coal in a 6-retort Westinghouse Underfeed Stoker and a 558 horsepower boiler. The grate area was 105.66 square feet. A rating of 328 per cent. was obtained. The unit operated most efficiently at 160% of normal boiler rating, when burning approximately 3,300 pounds of coal per hour, 550 pounds per retort, or 31.2 pounds per square foot of grate surface.

Fig. 2 shows the results of a series of tests run with Pittsburgh district coal. Each 650 horsepower boiler had a grate area of 123.27 square feet which was supplied with fuel by a 7-retort Westinghouse Underfeed Stoker. The best efficiency was obtained at 185% of normal boiler rating. It is also interesting to note the similarity between the combined efficiency CO_2 curves of this test. There was a gradual rise in the flue gas temperature as the boiler rating was increased.

Operating Deductions

The results brought out by these tests show the essential conditions which are necessary to maintain the best operation of the stoker equipment. The point of highest combined efficiency for the first installation is 160% of rating, while the second equipment, the best efficiency, was obtained between 170 and 185% of rating.

The operating force in this plant has found that they can force this equipment to 328% of rating if necessary. The condition of the furnace after a high rating test will determine the effects of the high temperature on the furnace walls and stoker parts.

Stoker Drive

The type of stoker and fan driving equipment should be determined by the heat balance of the entire plant. If

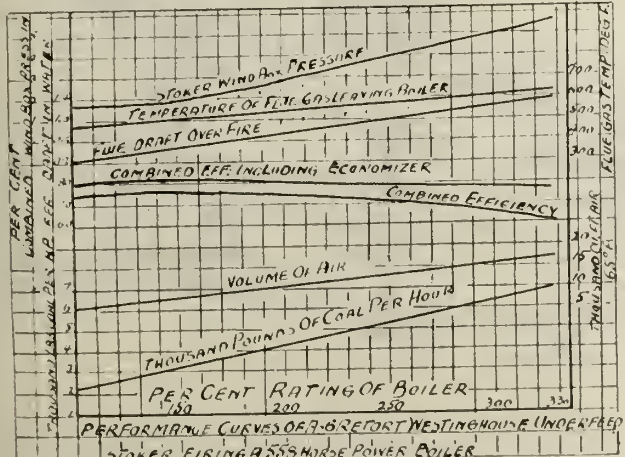


Figure 1.—Performance curves of a six retort Westinghouse Underfeed Stoker and 558 horsepower boiler.

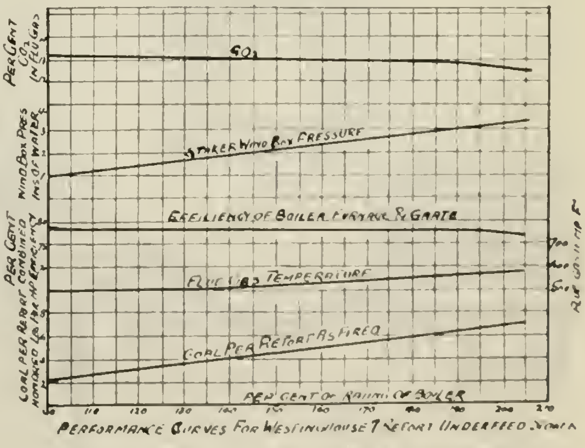


Figure 2.—Performance curves of a seven retort Westinghouse Underfeed Stoker firing a 650 horsepower boiler.

additional exhaust steam is required for feed water, engine or turbine drive will be preferable from an economy standpoint. On the other hand if plenty of exhaust steam is available it might be preferable to use motor drive.

Prevention of Clinker Formation

Clinker trouble is usually not so pronounced in most Underfeed stoker installations until high ratings are reached, and high furnace temperatures are being maintained. If the coal being used contains a low fusing ash, it is evident that clinker trouble will be encountered. Clinker in the fuel bed is hard to avoid, and in cases where they do not move to the rear with the movement of the fuel bed, a hook or slice bar has to be used. Recent changes in the design of boiler bridgewalls tend to decrease furnace temperature and with it to some extent the formation of clinkers. This is accomplished by sloping the front surface of the bridgewall backward so that the rays of heat impinged upon it reflect directly into the boiler tubes and not back into the fuel bed. Also, the latest engineering practice is to expose all tube surface possible to the fire, thereby decreasing the furnace temperature.

In some plants side wall and bridge wall clinker troubles are avoided by the use of steam jets. On the other hand many plants are using side wall tuyeres in connection with Underfeed stokers. These side wall tuyeres are cast iron air boxes which extend above the side retorts and down the side walls.

They are rectangular in shape and fit closely together, but allow room for expansion and contraction. A large cored central space feeds air to the holes in the surface. The air issues at right angles to the wall or tuyeres face. At plants where these side wall tuyeres are in use the side wall clinker trouble has been entirely eliminated, also the life of the boiler walls has been considerably increased. While the maintenance of the tuyeres is very low, due to air cooling the metal, stokers equipped with these tuyeres burn high ash western coals and low ash western coals equally well. Several furnaces have been in operation over three years with very satisfactory results. The air admitted through these side wall tuyeres has little or no effect on the CO_2 as the air is admitted below the surface of the fuel bed, and serves as an aid to complete combustion.

Figure No. 3 shows an installation of the side wall tuyeres.

Instruments Aiding Efficient Operation

Central station engineers are fully aware of the necessity for supplementing an expensive boiler plant with a few reliable instruments that are absolutely necessary for efficient and successful stoker operation. This does not mean that an elaborate set of instruments is necessary, but every boiler plant unit should be equipped with draft gauges for measuring the pressure of the air; in the windbox, in the combustion chamber and in the last pass or in front of the stack damper. A recording or indicating CO_2 apparatus is also desirable for close combustion regulation.

Steam flow meters are extremely valuable boiler appliances. The use of such equipment gives a good check on the combined efficiency of the boiler and stoker.

The ability of the coal to ignite and burn readily in the grates is quickly determined by such actual operating tests. Moreover, such tests have repeatedly proven that very good results can be obtained from cheap coal. The proper ratio between the rate of coal feed, and approximate air pressure for various grades of coal will be quite evident after a series of such tests, at different ratings.

Pyrometers are valuable for determining the flue gas temperature. A high stack temperature means that a relatively small amount of heat is being absorbed by the tubes. This is caused in most cases by defective baffling and dirty tube surfaces. Also a balanced draft in the combustion chamber decreases the infiltration of air through the setting, which is conducive to higher efficiency. Power plant engineers have taken time to study the theoretical side of combustion from its economy standpoint and have saved thousands of dollars each year in the fuel alone. They understand just what a two or three per cent. increase in CO_2 means. Also, the greater evaporation per pound of coal by keeping the flue gas temperature at its lowest possible point. The result in dollars and cents has been most gratifying.

Figure No. 4 shows a CO_2 record for 24 hours operation, the average value being about 12.5 per cent. While Figure No. 5 shows a chart with an average CO_2 content of 14.5 per cent. on the same unit. These CO_2 charts were made at a Western Pennsylvania steel plant. They certainly tell the story to the management, who can quickly judge the best firemen. Also which unit is getting the best results. Note the CO_2 drop at each fuel bed cleaning period, which is caused by excess air being admitted through the side doors and dump grate openings. This emphasizes the advantage of the mechanical steam dump which aids the operator in cleaning the fires quickly. Dampers are provided on the dump grates of the stokers under consideration, to prevent an excess of air from being admitted up through the dump grates at cleaning periods. These damp-

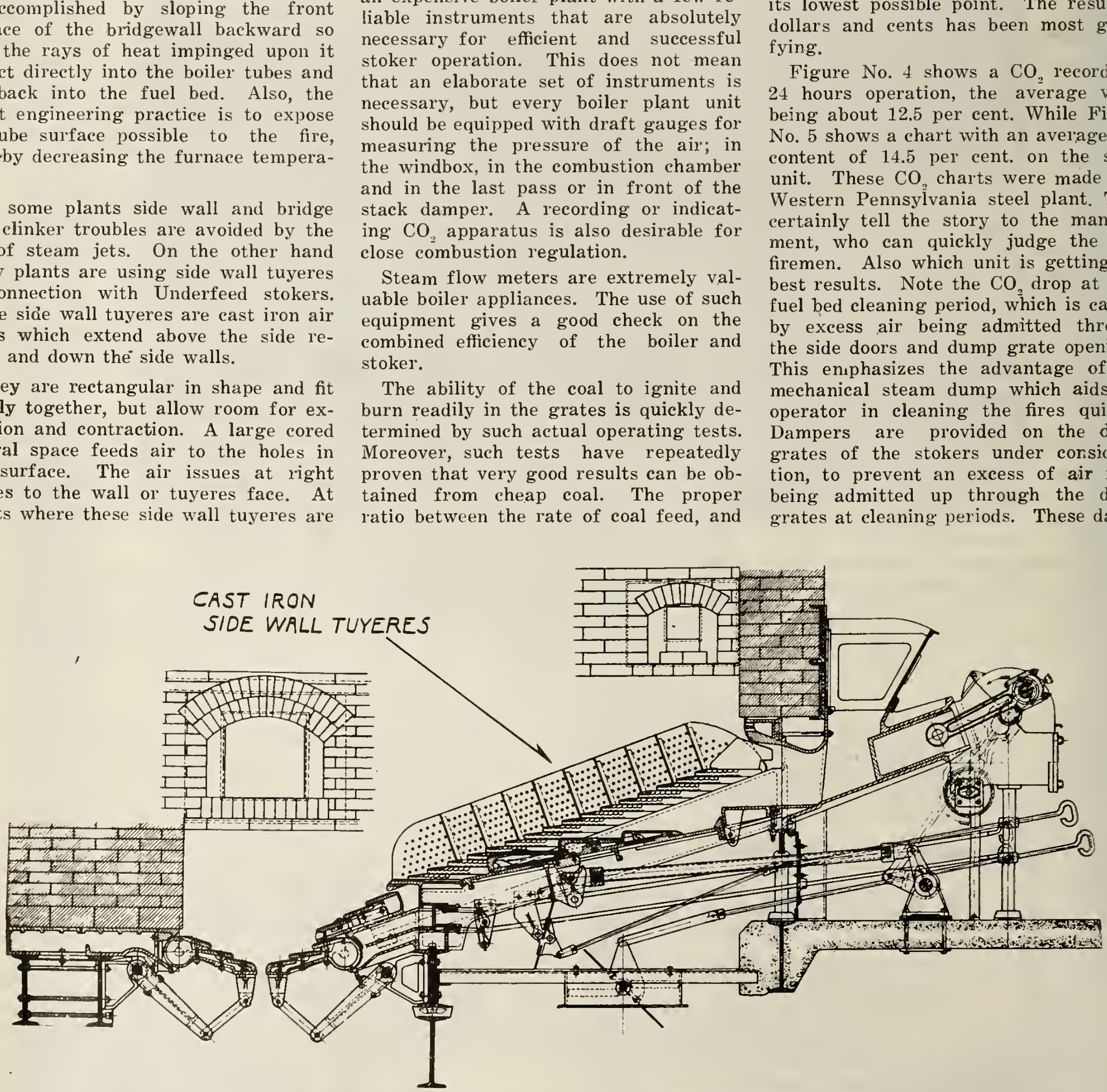


Figure 3.—A double dump moving grate 17 tuyere Westinghouse Underfeed Stoker with side wall tuyeres.

ers are opened to burn excess fuel on the dump grates, thereby increasing the combustion rate and reducing the carbon content in the refuse. In comparing the two CO_2 charts you will note that there is 2 per cent. difference between the average of figures number 4 and 5. This is, approximately 2 per cent. fuel loss in the operation of the stoker from which Figure 4 was taken. This fact emphasizes the importance of the boiler test for setting the operating space.

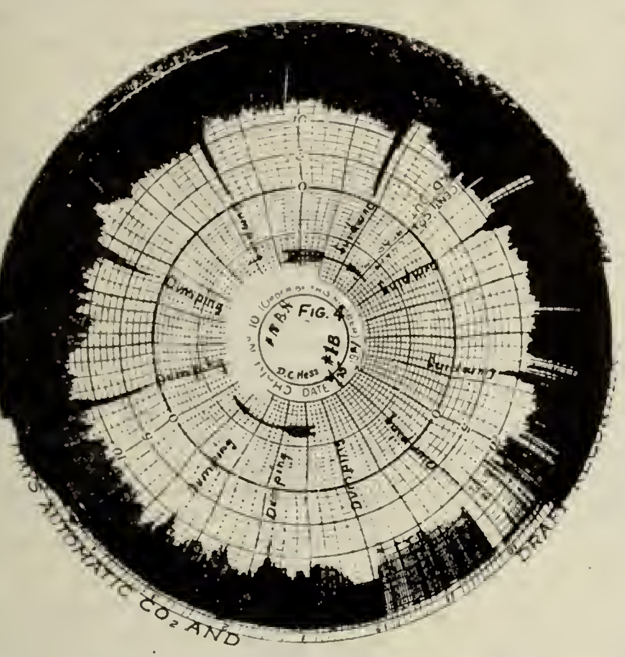


Figure 4.—A 24 hour CO2 chart taken at a Western Pennsylvania Steel Plant, average value of CO2 12.5 per cent.

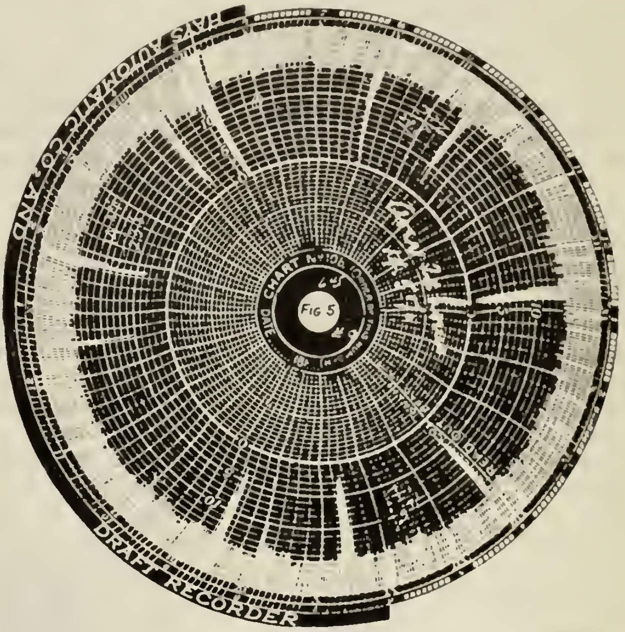


Figure 5.—A 24 hour CO2 chart taken at a Western Pennsylvania Steel Plant, average value of CO2 on the same unit 14.5 per cent.

Three Factors for Firing Furnaces

The principal final product of complete combustion of fuel is carbon dioxide (CO_2). In order to obtain high CO_2 the most important factors to take into consideration are:

First, keep the fuel bed in good condition. That is, prevent the formation of holes in the fire. Maintain the correct thickness and contour of the fuel bed.

Second, eliminate all air leaks in the boiler walls.

Third, maintain as nearly as possible a balanced draft or a slight vacuum in the combustion chamber. Avoid bottling up the gases which would cause a pressure in the furnace. Such a pressure would be very destructive to the brickwork and stoker parts. One type of baffle graduates the cross section of the flue gas passage, so that the velocity of the gas will be uniform throughout the boiler and also eliminate any dead pockets where there is no circulation of gas.

Figure No. 6 is a calculation curve based on the CO_2 per cent. volume at flue gas temperatures of 400° Fahrenheit, 500° Fahrenheit, and 600° Fahrenheit with no carbon monoxide. Theoretically, perfect combustion of pure carbon will give 20.7 per cent. of CO_2 in the flue gases. However, perfect combustion is not possible in boiler room practice.

Referring now to Figure No. 6, suppose the flue gases analyse 6 per cent. CO_2 and that by decreasing the amount of excess air and giving careful attention to the fuel bed the CO_2 is increased to 15 per cent. A glance at the curves shows that the relative fuel loss has been reduced from 40 per cent. to 17, which amounts to a fuel saving of 10 to 12 per cent.

The general definition of the efficiency of an apparatus is the ratio of the energy developed by the apparatus to the energy available for its use.

The efficiencies of the different parts of a boiler installation and of the installation as a whole are defined in so many ways that there is frequently confusion. The following definitions are recommended.

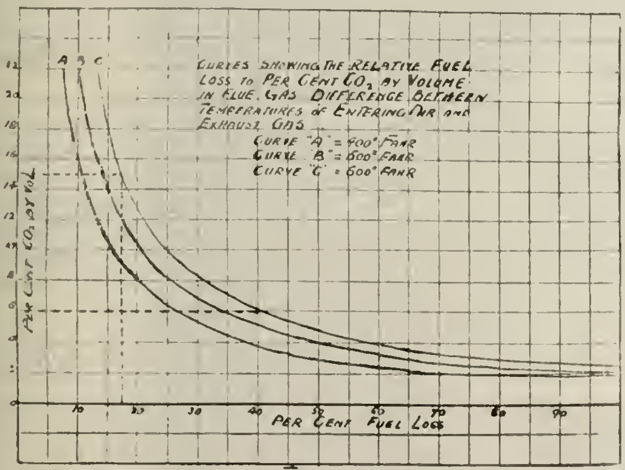


Figure 6.—Calculated CO2 curves based on the per cent. CO2 by volume at flue gas temperatures of 400° Fahrenheit, 500° Fahrenheit, and 600° Fahrenheit, with no carbon monoxide present. Shows fuel saving by increasing the CO2 values.

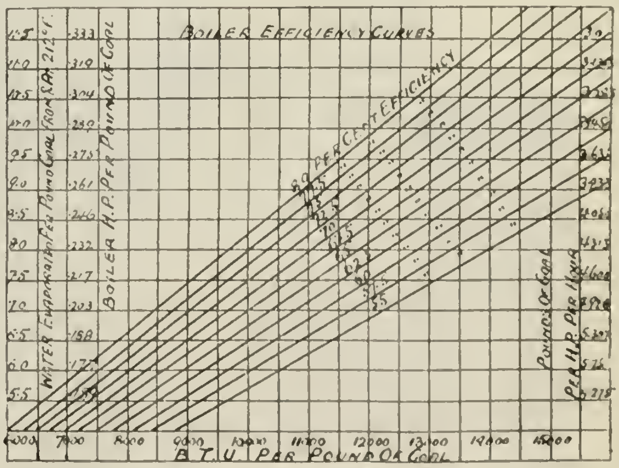


Figure 7.—Combined boiler efficiency curves based on pounds of water evaporated from and at 212° Fahrenheit per pound of coal, of various B.T.U. values.

What is ordinarily called the efficiency of the boiler is in reality the combined efficiency of the boiler, furnace and grate, and is the heat absorbed per pound of fuel divided by the heating value per pound of fuel. The value obtained will be approximately the same whether the efficiency is based on dry fuel or fuel as fired. All the fuel is not burned, some of it goes through the grates or is dumped out with the ash while cleaning the fire. It is obviously unfair to charge this loss to the boiler. On the other hand, the boiler user must pay for it and is justified in charging it against the furnace.

The combined efficiency can be expressed as

$E=W\ (h+L+sS-f)\ DH$

Where W=Lb. of water evaporated in a unit of time.

D=Lb. of coal fired in a unit of time.

s=.48=specific heat of steam.

h=Heat of Liquid at steam pressure.

L=Latent heat.

S=Deg. supt.

h+L+sS=heat in 1 lb. of steam as delivered by boiler.

f=heat in 1 lb. of water as received by boiler.

H=heat value of 1 lb. of coal in B.T.U. as fired.

The numerator of the above fraction equals 970.4 Q, where Q is the factor of evaporation.

Specimen Heat Balance

A typical heat balance worked out according to the above formula is given below:

The calculations are made as follows:

24 hour test of 2,400 H.P. boiler operated at 137% of rating

Coal as fired: 76.87% Carbon; 5.31% Hydrogen; 7.19% Ash; 1.80% Moisture; 13,810 B.T.U. per lb.

Dry Coal=98.2% of coal fired.

Dry coal basis: 78.30% Carbon; 7.32% Ash; 5.41% Hydrogen; 1.83% Moisture; 14,090 B. T. U. per lb.

Coal fired 246,000 lbs.=241,500 lbs. dry coal.

Refuse produced 21,375 lb.=8.88% of dry coal.

Carbon in refuse=8.88—7.32=1.56% of dry coal.

This statement assumes that all of the ash is in the refuse.

Flue gas analysis: 14.6% CO_2, 0.36% CO, and 3.30% O_2. CO is seldom found in the products of combustion but if produced it is treated as follows in the heat balance.

Water evaporated, 2,480,000 lb. steam pressure 160 lb. gauge, superheat 100°=1,254 B.T.U. per lb. above 32°F.

Average temperatures: Feed water 220° Fahrenheit, flue gas 560° Fahrenheit, room 72° Fahrenheit, air 63% saturated.

Heat Balance Calculations

	B.T.U. per lb. dry coal	% of total heat
1. Heat absorbed by boilers: 2,480,000 (1254—(220—32)) /241,500	10,960	77.79
2. Heat lost by evaporation of moisture in coal: 0.0183 (212—72+970+0.47 (560—212)	23	0.16
3. Heat lost in steam from hydrogen in coal: 9 x 0.0541 x (212—72+970+0.47 (560—212))	609	4.32
4. Heat lost in dry flue gases: Air = 3.036 (0.7830—0.0156) (1—0.1460—0.0036—0.0330) / (0.1460+0.0036) = 12.45 lb. per lb. of dry coal. Gases 12.45+(1—0.0888) =13.36 lb. per lb. dry coal. Loss=0.24x13.36 (560—72)	1,565	11.10
5. Heat lost in unburnt CO = (0.7830x10,150x 0.0036) / (0.1460+0.0036)=	193	1.37
6. Heat lost in combustible refuse = 14,600x 0.0156 = ...	246	1.75
7. Heat lost in heating moisture in air—63% at 72°F.= 0.0168 x 0.63 =0.0105 lb. per lb. of air (0.0105 x 12.45 x 0.46 (560—72)=	29	0.21
8. Unaccounted for (Radiation, unburned hydrocarbon, errors of observation) by difference=	465	3.30
Total	14,090	100.00

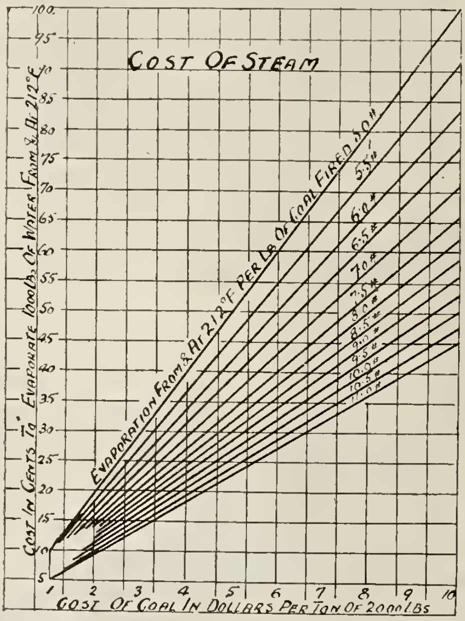


Figure 8.—Cost of steam based on the pounds of water evaporated from and at 212° Fahrenheit per pound of coal fired.

Figure No. 7 is a set of curves showing combined efficiencies based on pounds of water evaporated from and at 212°Fahrenheit per pound of coal of various B.T.U. values. These curves also give the boiler horse power per pound of coal and pounds of coal per housepower per hour.

Cost of Steam Curves

Figure No. 8 is a set of curves showing the cost of steam based on the pounds of water evaporated from and at 212° Fahrenheit per pound of coal fired. The column at the left shows the cost in cents to evaporate 1,000 pounds of water which is plotted against the cost of coal in dollars per ton of 2,000 pounds.

"The Three Graces"

After you have made a thorough study of your boiler room conditions and heat balance, you will no doubt come to a final conclusion that the economical operation of your boiler plant narrows down to three things.

First, maintaining high CO_2. This means good combustion of the fuel. This is accomplished by keeping the proper ratio between the fuel feed and air supply, good fuel bed conditions and careful attention to the operation of the stokers and boilers.

Second, keeping the flue gas temperature as low as possible. That is, absorb all the heat possible from the furnace gases before they reach the breeching.

Third, reducing the combustible in the refuse as low as possible. This signifies good operation on the part of the fireman, who should control the fuel bed conditions so that a minimum amount of carbon is dumped with the ash.

These three items are the main factors in boiler room operating from an economy standpoint.

TO BRIGHTEN TARNISHED BRASS AND COPPER

To brighten tarnished brass and copper clean the brass by warming it, and dipping in water charged with washing soda, then into clear water to remove the grease. Next dip it in a bath of one part sal-ammoniac, two parts nitric acid, and four parts water. Dip for a moment, then dip in clear water, and dry in hot sawdust. Oxalic acid dissolved in soft water—say, ½ oz. to a pint—is one of the best-known means for cleaning and brightening brasswork. — Mechanical World.

North Vancouver, B. C., will build an addition to the waterworks plant to cost $40,000. G. H. Morden is mayor.

The time for receiving bids on drydock machinery for Esquimalt, B. C., has been extended until Feb. 15. R. C. Desochers is secretary Department of Public Works, Ottawa.

Resumption of work on the Esquimalt drydock at Victoria, B. C., has been ordered by J. H. King, federal minister of public works. The work is expected to be completed about June, 1924, and will cost $1,500,000. Tenders for $500,000 worth of operating plant and equipment will be called for soon.

Water Turbines and Their Principle

A Description of the Forces Involved in Converting Head-Pressure Into Useful Work, and the Means of Effecting This Through Various Types of Turbines and Illustrating Practical Installations

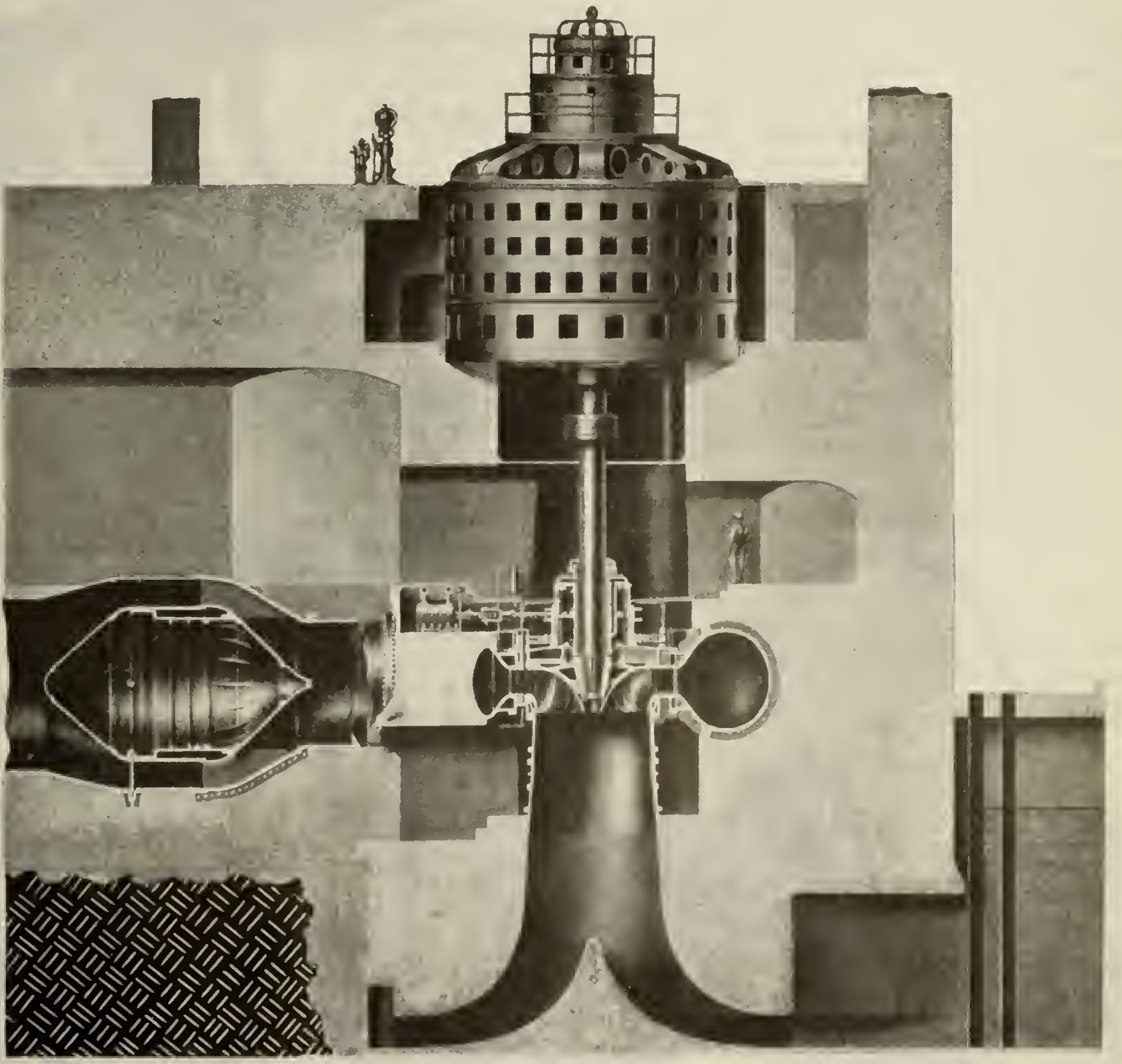
By W. B. ROBERTS, Editor

When we look at the vast natural sources of water power in this country there is little wonder that very special attention is being paid to the machine that is being used for converting this natural energy into useful work. A large number of power plant engineers will always associate the steam engine with the electrical generation of power, although they know that much hydro-electric power is generated. They have perhaps, no idea of the large percentage of hydro-electric power that is generated compared with the total electric power generated throughout the Dominion and it might not, therefore, be out of place to give a few figures, made by the government in 1918, showing the amount of H. P. developed due to hydro power, steam engine and the internal combustion engine.

The electric power developed through hydro was 1,806,618 H. P., compared with 288,202 H. P. for steam, or in other words, nearly seven times as much. The electric power developed due to the internal combustion engine was only 12,923 H. P., which is only a very small proportion of the whole. It will, therefore, be seen that the water turbine is a machine that ranks amongst the principal prime movers in this country and it will no doubt be an interesting study to investigate the development of these machines and understand their application from first principles.

Before we start to deal with any form of turbine, it would be just as well to refresh our memories with some simple facts regarding hydraulics and the peculiarity of water under certain conditions.

The pressure of the atmosphere can be taken to be 14.7 per square inch with a 30-inch barometric height. In a water barometer, the height of water this would support would be 34 feet. If, therefore, we divide this head of water



QUEENSTON-CHIPPAWA DEVELOPMENT.
Cross section through 55,000 horse power unit, the largest in the world, showing generator, turbine, water-supply pipes, valve and draft tube. The enormous size may be judged by the man standing in the gallery.

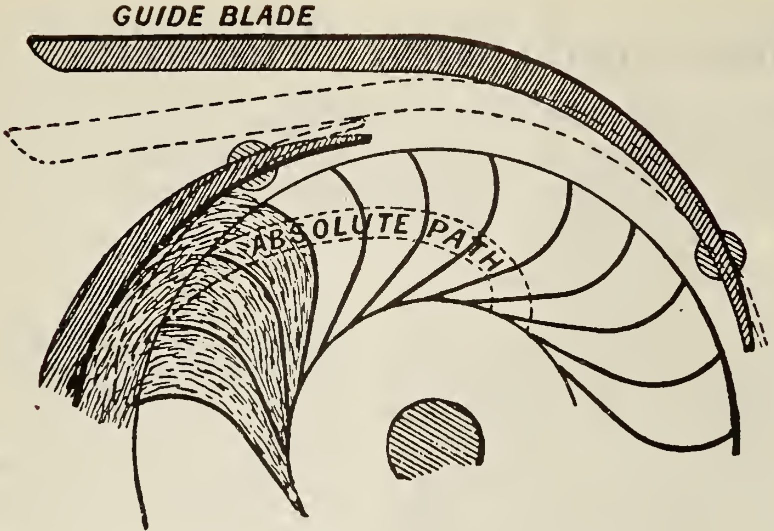


Fig. 1. Diagram of Pressure Turbine.

(34 feet) by 14.7, we will get the height of water corresponding to one pound pressure.

$\frac{34}{14.7} = 2.3$ feet, or 1 lb. per sq. inch.

also a cubic foot of fresh water $= 62.5$ lbs.

and a cubic foot of salt water $= 64$ lbs.

To thoroughly understand the relation between head and pressure, let us consider a tank H high, having an area of A square feet filled with water, with an opening on the side at the bottom, through which the water is allowed to flow at a velocity of V. A water barrel is a typical example of what we mean, with a small bung-hole at the bottom.

Let $P =$ pressure per sq. ft.
$H =$ height of column.
$A =$ area in sq. ft.
$W =$ the weight of water per cu. ft.

Then $P \times A\ W \times H \times A$
or $P = W \times H$ (the A's cancel out).
and $H = \frac{P}{W}$

In other words this means that the weight of water in the tank is equal to the pressure of the water at its lowest point, multiplied by the area.

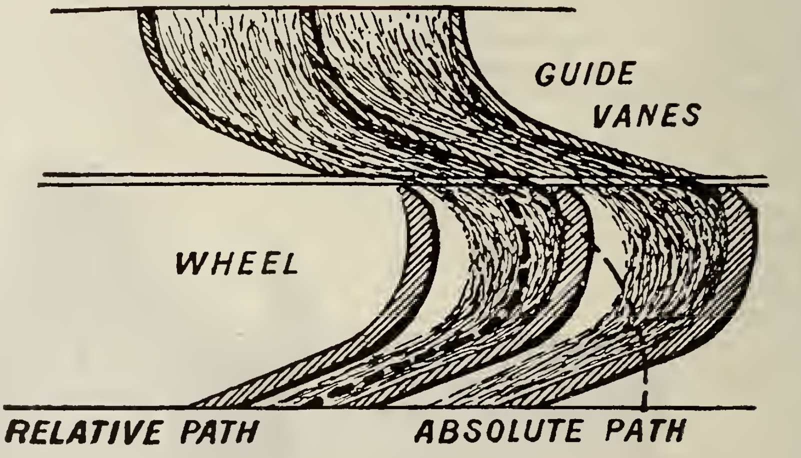


Fig. 2. Diagram of Impulse Turbine.

To show how potential energy is converted into kinetic energy, we will now take a certain weight of water W at the top of the tank and at a height H. By allowing this portion of the water to fall to the level of the hole in the side of the tank, it has performed so many foot pounds of work, and in so doing, has been converted into kinetic energy.

The water in its original position at the top of the tank has, therefore, so much potential energy which can be denoted by the letters $W \times H$.

Kinetic energy is weight or mass multiplied by velocity, similar to the blow delivered with a hammer. The hammer head does not vary in weight, but we all know that a heavier blow can be effected by increasing the speed.

The formula for kinetic energy is $\frac{WV^2}{2g}$

When $W =$ Weight, $V =$ Velocity in feet per second, $g =$ gravity, which equals 32.

Considering, therefore, that the water which was at the top of the tank whilst at rest contained a certain amount of potential energy ($W \times H$), but upon falling through the distance H, it has become converted into kinetic energy

$\frac{W \times V^2}{2g}$ so that

$$W \times H = \frac{W \times V^2}{2g}$$

(the W cancels out and by transposing the formula we get)

$V = \sqrt{2gH}$

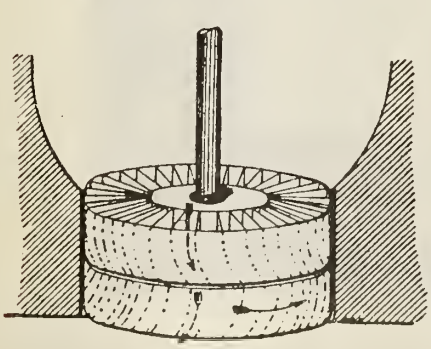


Fig. 3.—Jonval's Turbine.

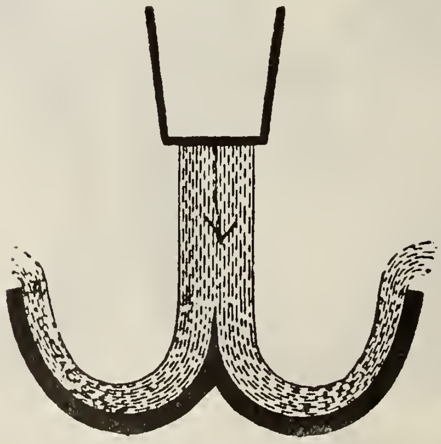


Fig. 4.—Pelton Wheel Bucket.

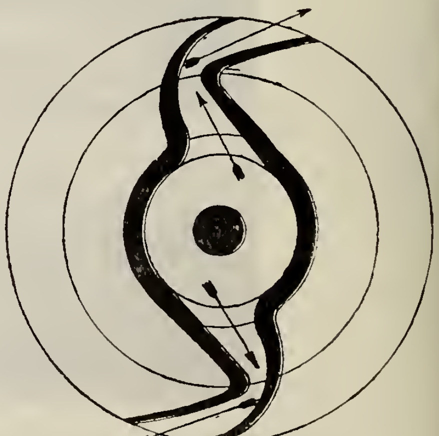


Fig. 5—Wheel with Wide mouthed nozzle.

By looking at the experiment illustrated in Fig. 7 you will see at a glance how pressure and velocity are convertible. The liquid flowing from the vessel A through the pipe C. E. F., must increase in velocity at the contracted portions with a corresponding loss in pressure as seen by the level of the water in the open ended tubes. The velocity of flow is inversely as the size of cross section, and the pressure inversely as the velocity. If, therefore, the difference in height between the level of the water in the tank and the pipe is measured, it will be found to be equal in each case to $H = \frac{V^2}{2g}$ where H is the difference between the pipe levels and tank level.

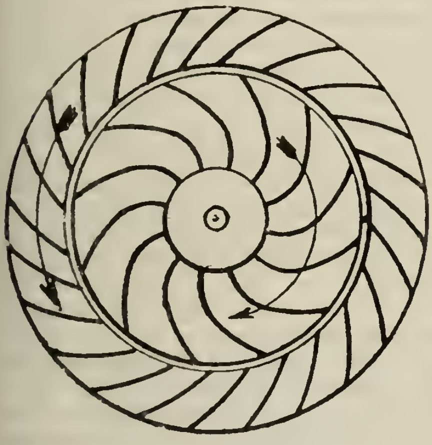


Fig. 6—Combined Pressure and Impulse Turbine.

The illustration of the tank of water can therefore be applied to any practical case, such as the water flowing from a reservoir, or from some high level to a lower level, and in which case the whole head H is expended in three forms.

$\frac{P}{W}$ due to pressure,

$\frac{V^2}{2g}$ due to velocity,

and the combined effects $H + \frac{B}{W} + \frac{V^2}{2g}$

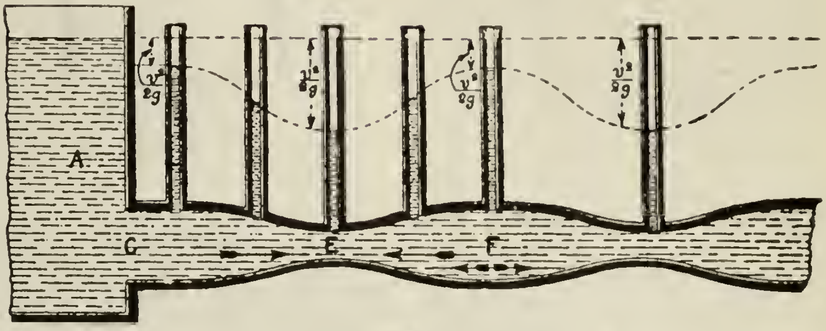


Fig. 7—Hydraulic Experiment.

The turbines that we are now to consider, act either by the first, second or all three forms of energy, but we had better at this point describe a few of the different designs of turbines.

Water turbines are divided into two distinct classes, i.e. Pressure turbines and Impulse turbines. These can be again subdivided into several other classes, such as Axial Flow Turbine—Inward, Fig. 3, Radial Flow Turbine, with water flow from the outer to the inner periphery, Fig. 1, the Outward Radial Flow Turbine, where the water flows from the inner to the outer periphery, Fig. 5, Mixed Flow Turbines, etc., etc., but for the purpose of this article we will deal simply with the first two classes mentioned.

In the Pressure Turbine the rotor acts partly by the pressure of the water and partly by its momentum. The water after it enters the turbine has a certain amount of pressure since the energy due to the fall has not all been converted into velocity. It also has velocity which is given up in the turbine and converted into the corresponding amount of energy.

In the Impulse Turbine, the head of water is converted into a jet of great velocity due to the fall, but these jets have no side pressure.

Water under pressure transmits that pressure sideways, forward, and in every direction, but in a column of water moving at full velocity, there is no side pressure since the whole energy is in the forward movement.

Pressure turbines work best when drowned so that no part of the fall is lost. They will, however, work well up above the tail race if the mouth of the overflow pipe is carried below the surface of the tail water. This facility is of great value since it is not always possible to have the turbine at the level of the tail water. The impulse turbine, however, must be placed above the highest level of the tail water and will not work drowned, hence the whole fall can-

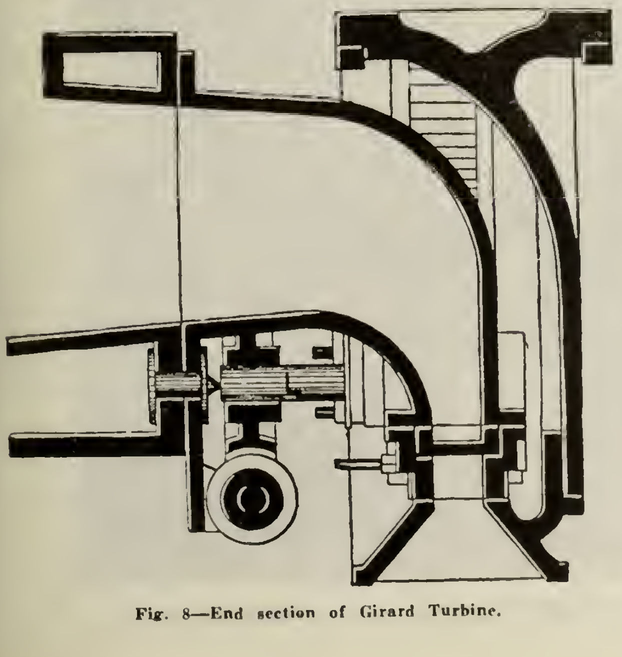


Fig. 8—End section of Girard Turbine.

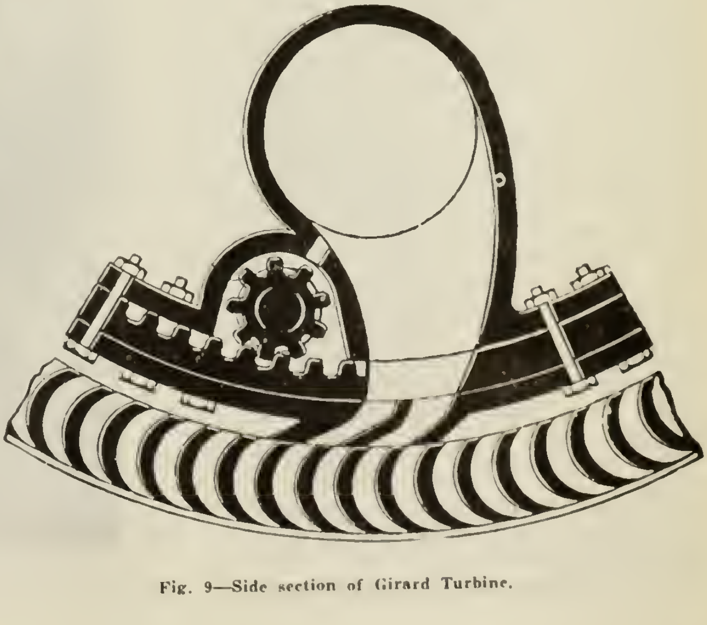


Fig. 9—Side section of Girard Turbine.

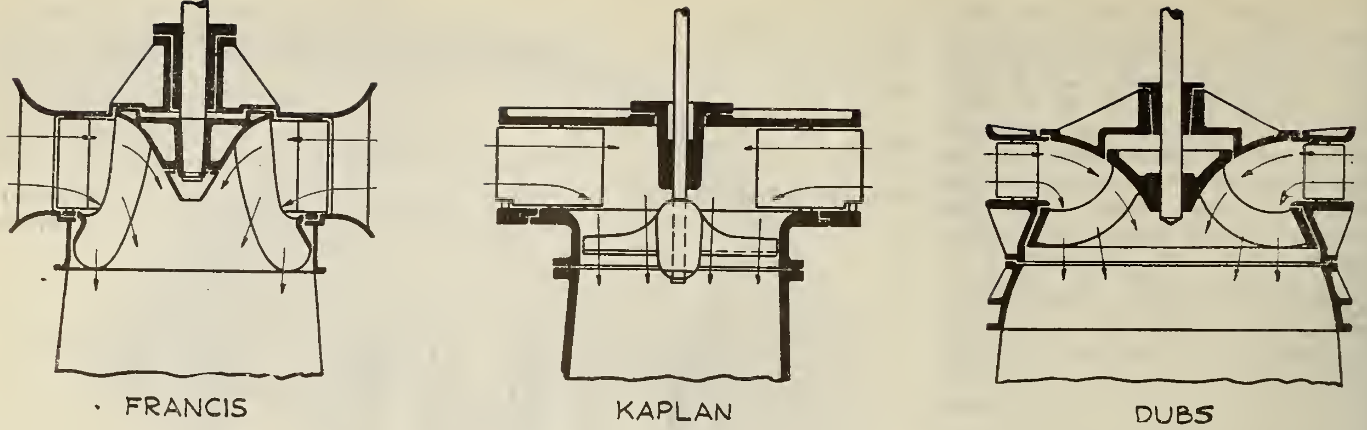


Fig. 10. Types of High Speed Turbine.

not be utilized at low water level in the tail race.

The two forms of turbine are illustrated in Figs. 1 and 2. The turbine in the first illustration is a pressure turbine inward flow with guide plate to give direction to the water and regulate the quantity. Fig. 2 is an impulse turbine wherein the water is spurted at full velocity against the vanes in the wheel. In this turbine there are as many guide plates as buckets and the water may flow full bore all around, but this is not necessary.

The simplest form of impulse turbine is one that is illustrated in most mechanical test books in the form of the Pelton Wheel, illustrated in Fig. 4 and which is driven by a free jet. The wheel has attached to its periphery a series of double cupped buckets. The jet at full velocity strikes the dividing rib, splits in two and glances off the wheel reversed in its motion which exerts great pressure on the cups. The impulse pressure on the turbine blades is equal to the momentum before entering minus momentum on exit.

Although the Pelton wheel gives good results it was not designed with a scientific knowledge of the subject. We understand that Mr. Pelton had a number of cup-shaped buckets on a wheel, one of which worked loose and being displaced relative to the jet, the latter struck the side instead of the centre of the bucket. It was observed under these conditions that the mill driven by this wheel ran faster. From this, it was arranged to fit two sets of buckets mounted on either side of the wheel, the side thrust of one set of buckets being compensated by that of the other.

We understand that an efficiency of 91.85 per cent was attained by Professor Hiccock on a 26-in. Pelton wheel at the engineering laboratory of the Ohio State University in 1897, which was obtained with a head of 163 feet, the flow of water being 2,085 lbs per minute, with a bucket velocity of 46.2 feet per second.

In Figs. 8 and 9 we have a section of a radial outflow turbine, giving view of wheel, guide-blade and passages in the first illustration, and the orifices and nozzles and their means of regulation by a sliding rack and pinion in Fig. 9.

The blades are specially spread out to enable the water to spread as it passes through the passages so that the arc of the outer passages is somewhat greater than that of the inner. The ratio of the radius of these passages should be about 1.18 to 1. The efficiency is about 75 per cent. when Q = 240 cubic feet per min. h = 400, the weight of one cubic foot of water = 62.5 lbs.

$$\frac{75\% \text{ x Q x h x } 62.5}{33{,}000} = \frac{.75 \text{ x } 240 \text{ x } 400 \text{ x } 62.5}{33{,}000}$$

$= 130$ H.P.

The transformation of the turbine now in progress has developed within recent years to such a point that the designer of a hydraulic plant to-day has a much larger form of turbine to select from than ever before, which numbers also enlarge for him the field of possible error. In order that some of the new turbine types under an increasing range of heads may be studied, some of the high speed turbines now proposed or already applied, are shown in the three diagrams in Fig. 10. These compare the ordinary "Francis" turbine with one of the forms proposed by Dr. Kaplan of Austria, also one developed by Dr. Dubs of the Escher Wyss Co., which is an extreme development of the "Francis." The "Moody" diagonal propeller type turbine is illustrated in Fig. 11.

It will no doubt be of interest at this point to look over the general arrangement given in the illustration of the

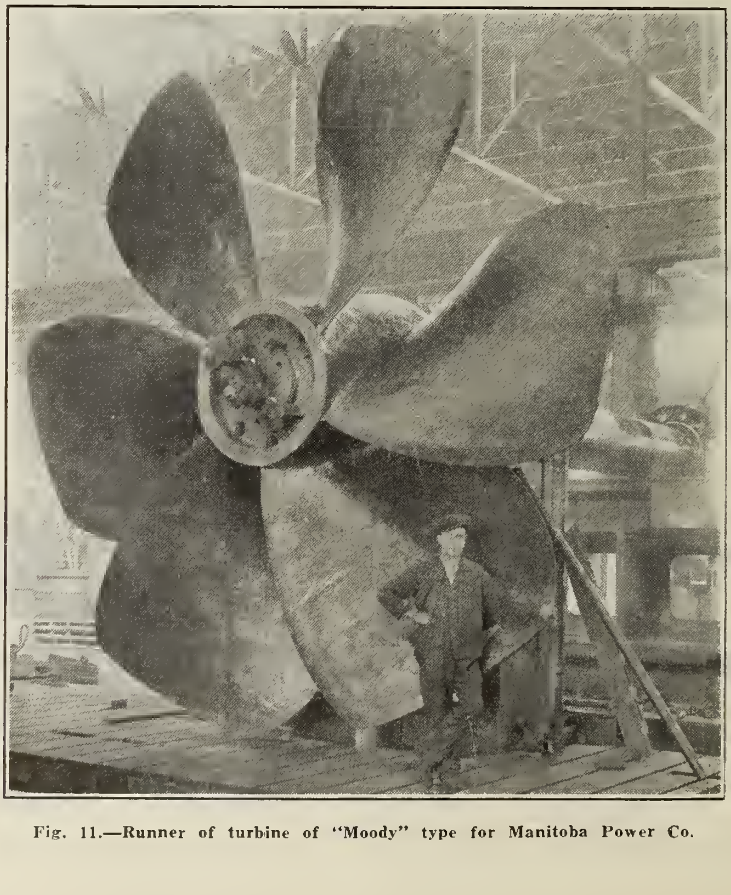


Fig. 11.—Runner of turbine of "Moody" type for Manitoba Power Co.

pump-house and turbine of the Chippawa development at Niagara which shows the practical application of a head of water and the means of converting this into useful work.

The turbines are each of 50,000 h.p. rated capacity and of the vertical spiral case, single runner Francis type and will operate at a speed of 187.5 r.p.m. This gives a specific speed of 36. The maximum guaranteed efficiency is 90%. The inlet diameter of the scroll case is 10 feet and the diameter of the runner is 10 feet 5 inches at the inlet. An open space has been left in the power house foundations below the runner so that by removing a section of the draft tube the runner can be taken out from below, thus obviating the necessity of dismantling the generator when renewal of the runner is necessary. The runner is designed for a capacity of 61,000 h.p. and is "gated back" to a maximum capacity of 55,000 h.p. The reason for this is that the turbines, which will normally operate at or near full rated load, will, therefore, also operate at their maximum efficiency. The total effective head of water is 305 feet and the installed capacity of 9 units will give a total of 500,000 h.p.

ELECTRICAL EQUIPMENT

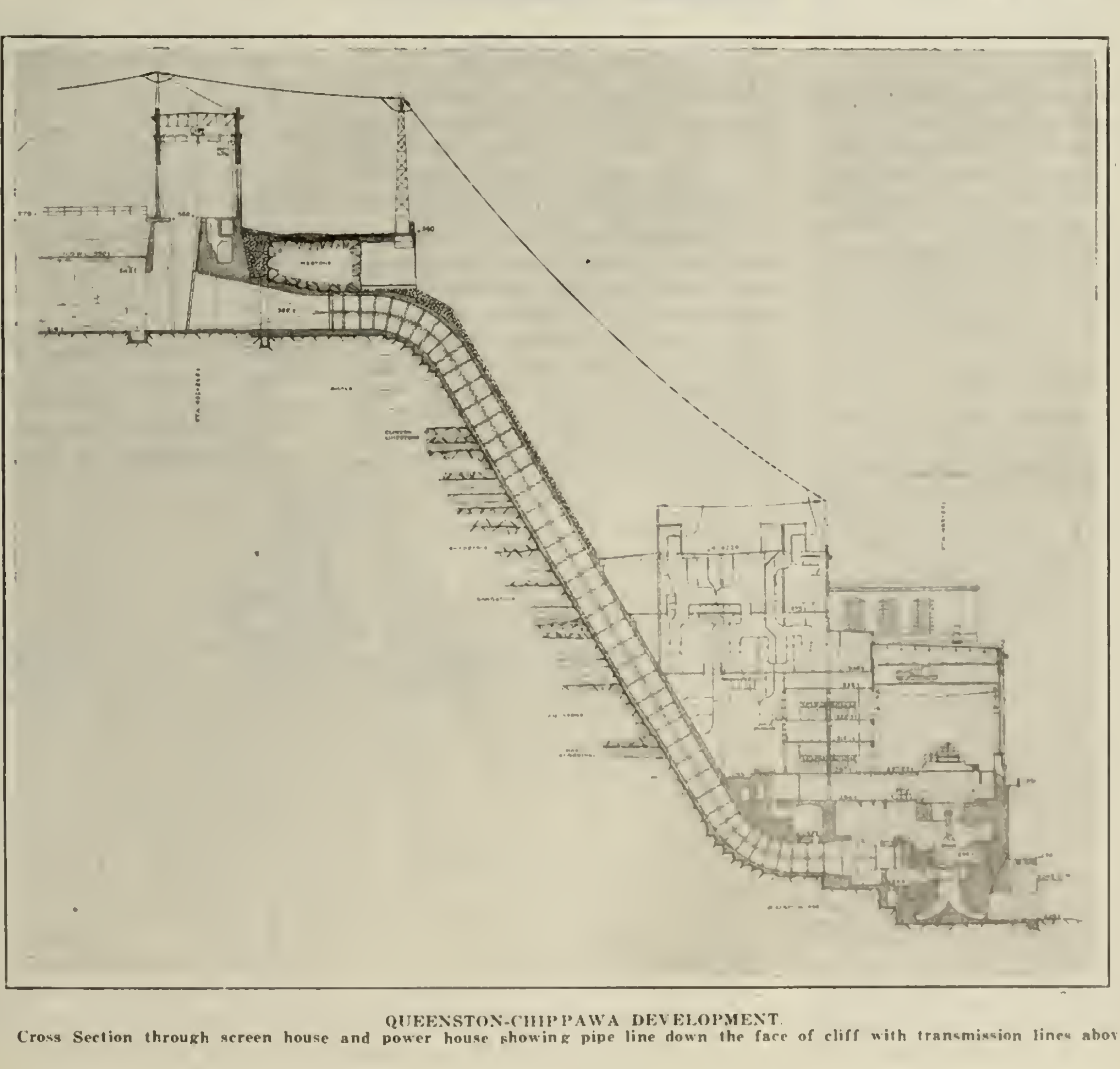
It might be of interest at this point with a view to giving a better conception of the tremendous size of each unit, to give a few particulars of the electrical equipment, the generators for which are the heaviest in the world.

The entire weight of the revolving parts of each generator and turbine is carried on a thrust bearing which is designed to sustain a weight of one million pounds. The heaviest part of the generator weighs 300 tons and its removal requires the use of two 150-ton cranes installed in the power house for this purpose. The generator is air cooled, which air may be taken either from inside or outside the generator room. It generates electric power at 12,000 volts, the frequency being 25 cycles. This is transformed to 110,000 volts before it is transmitted down the lines in the different directions.

Manitoba is also pushing ahead with the development of her natural resources in the province. Last month the Manitoba Power Co. had the official opening of the first unit of the power plant at Grand Falls. We understand the unit now completed and in operation is designed to deliver 28,000 h.p., but until the second unit is ready for operation the power actually developed falls somewhat short of the above amount as the full head of water cannot be utilized. The illustration given in Fig. 11 shows the runner for the first unit. This is a Moody diagonal type runner weighing 74,000 lbs., 15 ft. 9½ in. in diameter, and the boss or hub being 4 ft. 5¼ in. deep. This is a cast steel runner and the first of this type to be ever cast in Canada. The most striking difference between this type of runner and the Francis which has held the field for so long for medium and low head installations, is the speed. The rim speed of the new runner is about 7,000 ft. per minute, or twice the velocity of the water under a head of 56 feet, from which the units are to be worked. In comparing the r.p.m., we understand the new runner has a speed of 138.5, while a Francis runner of the same capacity and under similar conditions would run at 75 r.p.m. The greater speed means a smaller generator, smaller cranes, lighter overhead construction and a very material saving throughout the whole of the installation.

Ottawa, Ont.

Erection of civic abattoir at cost of $75,000 is contemplated by city.



QUEENSTON-CHIPPAWA DEVELOPMENT.
Cross Section through screen house and power house showing pipe line down the face of cliff with transmission lines above.

Improvements in Design of Friction Clutches

Eliminating Power Loss—Characteristic of Various Types—Cone Clutch Not Suitable for Heavy Load—Advantages of the Plate Design—Effect of Centrifugal Action

By V. R. BRUCE, Manager, Hilliard Clutch and Machinery Co.

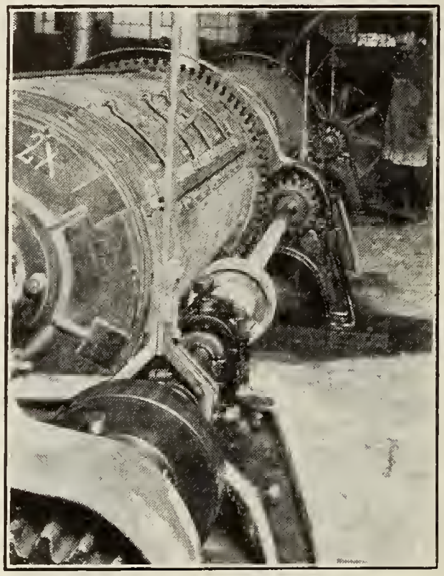
EFFECTIVE solution of power transmission is a problem that requires close attention of plant executives in order to avoid the loss incidental to poor and inefficient installations. In the accompanying article are given the relative merits of various types of clutches and what, in the judgment of the writer, are some of the installations practical with clutches which reduce the plant equipment upkeep to a minimum and place the manufacturer in a position to meet modern competition.

In the first place, it might be stated that friction clutches could be generally classified as follows: Cone, expanding shoe, contracting band and plate type clutches. Cone clutches are used to some extent by some machinery manufacturers for countershaft purposes. The characteristic of all cone clutches is that they take hold very quickly and are certainly not a type of clutch that should be used for picking up heavy loads smoothly or gradually. As a rule when applied to machine tool drives, it is a metal to metal friction.

The expanding shoe clutch is made up in a great many variations having several different methods for expanding the shoes which grip the outer driven member which is usually in unit with the clutch sleeve. The troubles characteristic of the expanding shoe clutch are also characteristic of the contracting band clutch, resulting in overstraining and breakage of the operating mechanism, grabby action, failure to properly release, and also a tendency to drag just as soon as the sleeve members are slightly worn which permits the outer friction member to drop down for the small distance allowed for the clearance between the driving and driven members. The slightest amount of wear in the clutch sleeve will permit contracting band or expanding shoe clutches to drag.

Judging from the various types manufactured, it would seem to be the consensus of opinion that the plate type clutch properly constructed, is the better unit for all practical purposes. The exceptions that we would make would pertain primarily to very heavy duty clutches, in which case contracting and expanding shoe clutches can be made up in very much larger sizes and have very much less weight to them than is possible with any kind of plate clutch. So when we get into very large horsepowers it is probably true that a clutch along the lines of the expanding shoe type might be excepted.

However, for small drives ranging from 2 h. p., say up to 100 h. p., it is our judgment that the plate type of clutch is superior. Our reason for saying it is superior is that it can be kept to smaller diameters, have greater friction area for any given diameter, permits of a type of operating mechanism, which does not involve the usual troublesome toggles and permits of a larger friction area for any given diameter, with a resultant lower unit pressure on the frictions, and therefore longer life and less frequent adjustment of the clutches.


Installation of plate type clutches on gang of foundry cleaning mills.

It is likewise necessary to make some distinction between plate type clutches.

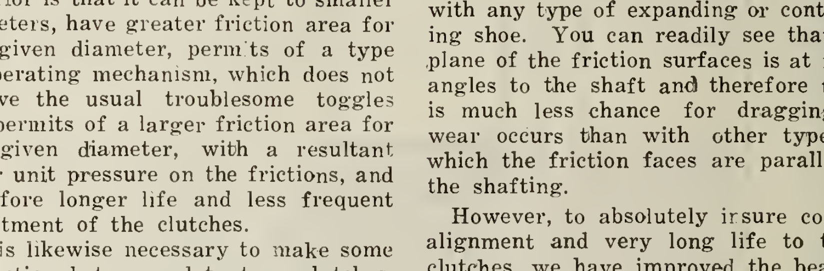
We substitute for the toggle operating mechanism three worm threaded studs which are actuated by means of a spiral gear and rack which in turn are actuated by a sliding collar, and this permits the full pressure to be exerted on the friction surface. With toggle clutches the full power is never exerted because the full pressure is used in passing the center, and it is necessary to pass the center in order to lock the clutch, and this causes a slight releasing of the clutch. This involves an overstraining and a frequent breakage of parts.

In order to get past the center with toggle type clutches it is necessary to go past quickly, with a sudden jerk, and that, of course, is disastrous to any type of delicate machinery. With worm threaded studs it is easy to pick up a load gradually and as smoothly as desired and to provide considerable reserve of travel on the operating racks; each tooth in reserve on the racks is the equivalent of an adjustment of the toggle type clutches.

With all plate clutches the sleeve bearings can stand a great deal more wear, without interference with the proper operation of the clutch, than is possible with any type of expanding or contracting shoe. You can readily see that the plane of the friction surfaces is at right angles to the shaft and therefore there is much less chance for dragging as wear occurs than with other types in which the friction faces are parallel to the shafting.

However, to absolutely insure correct alignment and very long life to those clutches, we have improved the bearing conditions in the past few years by the use of ball and roller bearings; particularly our clutches equipped with Fafnir

(Continued on page 32)



Sectional view, showing construction features of plate type clutch.

Some Hints Upon Running Oil Engines

Treating With the Care and Management of the Diesel Engine—Means of Determining Distribution of Load—Analyses of Working by Reference to Indicator Diagrams

By B. BARE

WHILE almost all the high-compression types of engines can run on anything that can be called an oil, it is a question that must be decided in each case whether it is worth while to use the low grade of fuel, or whether it is better to use what is known as a "Diesel oil." Some of the largest motor-ships that have reported perfect voyages and where these voyages have been half around the world, have used a "Diesel oil." In cases like this, where the load factor on the engines has been very high, it would be the most desirable to use the cheapest fuel. It may be that a better grade of fuel is cheap enough. It is true that the high-compression engine will give perfect satisfaction when running on the heaviest fuels, but it means that there must be extra care and attention given in such cases. It is very important to have efficient and careful engine-room personnel when these heavy fuels are used. In the future the cost of fuel will advance and it will be more economical to use the heavier fuels and pay a little more for the engineer who can keep his engine in the proper condition.

STARTING WITH HEAVY OIL FUEL

Besides heating the heavier fuels, as has been mentioned, it is particularly necessary to keep the passages clean and free from "gumming" which the heavy fuels are inclined to cause. Filters of ample capacity fitted in the fuel-section line, and of a type that allows continuous operation of the engine, are desirable. A very fine mesh screen should also be fitted in the delivery line, as the passages, especially in the mechanical-injection types of engine, are very small, and a particles of dirt in the nozzle will give trouble.

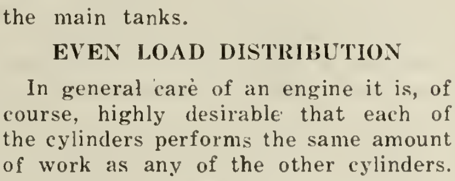
Kerosene is the engineer's best friend in the case of gumming. When starting up cold, kerosene should be used until the engine has become warmed up well and the heavy fuel ready to be turned into the line has also had a chance to warm up. Five minutes will be long enough for this, then the heavy oil can be turned into the line through any three-way-cock arrangement. Where air injection is used a little change in injection-air pressure may be needed. Increase the pressure until there is the tendency to "knock," and then reduce the pressure just enough to prevent the engine from labouring. In plants where the engine is shut down at noon, the kerosene should be used for about 5 mins. before stopping. This will give time to clean out the engine and fill all the piping and the valves with this lighter fuel. In this way there will be no sticking of the parts should the engine get cold.

Where there is continuous running it will be well to run on kerosene for about 5 to 10 mins. once each watch. The kerosene will tend to loosen any deposit that tries to form and burn it out, just as it does in the case of the gasoline engine. It will also be well to squirt some kerosene down the exhaust-valve stem to keep it from getting sticky, and to clean the exhaust valve seat. This should be done on each round of inspection. Whenever the engine is shut down for a considerable period the fuel-pump valves should be filled with the kerosene.

When using heavy fuel particular care should be taken to have the fuel as free from water as possible. It is quite sufficient to let the fuel stay in the main supply tanks, where the water can settle to the bottom and be drawn off. For this reason, as well as to allow a place for the sediment to settle, it is well to have the outlet from the main tanks at a little elevation above the bottom of the main tanks.

EVEN LOAD DISTRIBUTION

In general care of an engine it is, of course, highly desirable that each of the cylinders performs the same amount of work as any of the other cylinders. By listening to the exhaust a rough estimate of the amount of work being done by each of the cylinders can be ascertained. A favourite method with low-compression engines is to open a pet-cock, usually that used for indicating, and listen to the explosions. At first a little time must be given the communicating hole to clean itself out, and then by getting all the explosions to sound alike, a fairly good distribution of load will be obtained. This method is also a quick and positive means of identifying a "missing" cylinder.



Oil-engine Hints.—Fig. 1.

Use of the indicator card is, however, becoming more common, and will give the finer distinction as between loads. Where the engine is equipped with the mechanism for conveniently taking indicator cards, and where the installation requires the constant services of an operator, cards should be taken once a week as a matter of routine. In this way a small irregularity will be quickly detected and correction can be made before any trouble occurs. The cards must be taken when the load on the engine is constant, otherwise it will not be possible to tell whether the difference in card readings is due to the variation between cylinders or to the variation in load during the period of taking a set of cards.

Cards should be inspected first for similarity of shape. If the shape of the card is found to be good, or if it has been brought to this condition, the next thing to do is to measure the area of the card to determine the load the card represents. The area of the card represents, of course, the amount of work done by the cylinder from which the card was taken. The best way of obtaining the area of a card is by means of the planimeter. The areas of all the cards should be made equal by adjusting the fuel to each of the cylinders as provided for on the engine, either through a distributor where such is employed, or by separate adjustment where there is a plunger for each cylinder.

OVER-PRESSURE

When looking over the individual cards, the point of top dead centre should be particularly noted. The pressure at this point should not exceed that for which the engine was designed. Where the engines are subject to inspection by the insurance companies, that pressure must not be exceeded. When the engines are put out at the factories the cylinders and heads are tested at a pressure about one and a half times the maximum operating pressure, so it is important not to be operating the engines at a higher pressure than that tested for by the inspectors. Relief valves are fitted to the cylinders, but the passages are generally small and will not take care of any great volume. Their function is mainly in the nature of a warning that the pressures are being exceeded. These valves are also fitted for hand operation, and it is well to open them once a day to let any accumulation in the connecting passage blow itself out. It sometimes happens that the accumulation of deposit has become so hard that it is necessary to drill into the hole to clear the passage. Do not let the pressure cause the valve to blow out continually, because the heat from the cylinder at the time of blowing is very great, and it will not take long to burn out the valve or seat and cause trouble.

In the indicator cards where the maximum pressure is greater than the pressure at the end of compression, the explosion line is best when vertical. If this cannot be obtained it is better that the explosion line incline away from the head end of the card rather than that the fuel be injected too early (Fig. 1). In the case of air-injected fuel, the compression is also the maximum, and the proper direction for the injection line to take is horizontal. In this type of card the point of top dead centre should not show a vertical line extending above the horizontal, or nearly so, injection line. If the extension rises above the height that a compression line would show, it means that there is slight preignition, and ths should be corrected. If the injection line starts out horizontally below the point of maximum compression, it means that the injection is too late, and this, too, should be corrected.

In cases where the load on the engine is subject to large and comparatively sudden changes, and where the ar injection pressure is set for the average load, either of the above-mentioned cards would result. It should be noted, then, that when taking cards the engine should be tuned up to the average-load conditions. It would be well in such cases to fit an automatic device for taking care of the changes in load. This would avoid the knocking that occurs when the engine suddenly runs "light." By the time the operator adjusted for this condition the load may have come on again. These varying conditions do not obtain in marine practice, as the load is constant. In marine cases where it is desired to run at half-speed, a favourite method is to "cut-out" half of the total number of cylinders, thus maintaining good working loads in the operating cylinders. The number of cylinders in a marine unit is such that the engine can be started up from any position of crank angle. In a two cycle engine four are enough; in a four-cycle engine six will be required.

Use of Starting Air

In a stationary plant it is not necessary to have all the cylinders fitted with starting valves. It will then be necessary to turn the engine over to a crank position, just past top dead centre, for the starting cylinder. In this way the cylinders not equipped for air-starting can start directly on fuel, and when they carry the load the starting cylinder or cylinders can be changed over to run on fuel. The air-starting valve and the fuel-control valve are so arranged that the two are never in operation at the same time. This must necessarily be so, as the high-pressure air in conjunction with the fuel would set up pressures far in excess of that normally allowed. In marine practice all the cylinders are fitted for starting. Here it is necessary to start all the cylinders on air, and then it is usual to change three over to fuel after the engine gets turning. As soon as these three take hold the three others are changed over to fuel. When the engine is in good running order the whole operation takes less time than it does to tell about it.

As little air should be used in starting as possible, so as to conserve the supply, and also because the expansion of the air will cool the cylinders. It is particularly necessary to conserve the air supply in marine practice where the engines are subject to manœuvring.

Racing

In some cases where speed control is obtained by action on the governor spring, the engine will race when the load on the engine is taken off and the engineer has to make a dash for the control to slow down the engine. This is caused by too few coils in the governor spring. A new spring with more coils should be used, the use of a short throw for the full control of speed should be abandoned, and a number of turns of the handwheel substituted. In the larger marine engines the only time there will be a tendency for the engine to race will be when the propeller comes out of the water. Since, otherwise, speed control can be obtained by cutting out some of the working cylinders, all that is necessary is a good overspeed governor. This will completely stop the fuel, except possibly to one cylinder, immediately the engine reaches a speed 10 per cent. greater than its rated speed. In the case of oil engines this governor action is instantaneous, as the fuel is stopped immediately by a small valve. The fuel that is still being supplied to the one cyinder will be sufficient to keep the engine turning over, so that when the load comes on again the other cylinders will be in condition to resume the load.—"Power Plant Engineering."

IMPROVEMENT IN DESIGN OF FRICTION CLUTCHES

(Continued from page 30)

ball bearings which represent the utmost efficiency in clutches of this design.

It is possible to use this clutch up to rim speeds of 5,000 ft. p. m. In these clutches and friction cut-off couplings the centrifugal force, which is a big factor as high speeds are involved, does not detrimentally affect the operating mechanism. We stop at rim speeds of 5,000 ft. p. m., but this permits many of the clutches to be used up to speeds of 1,750 r. p. m. and for this purpose they are used very generally by centrifugal pump manufacturers and other jobs where direct connection to high speed gasoline engines or electric motors is desirable.

The particular advantage to the manufacturer in making installations of clutches, is that each clutch replaces one countershaft, and the cross belt for every machine driven through a clutch. It also permits the cutting off of the power closer to the prime mover than with tight and loose pulleys. This saving in countershafts, in belts and in power with the decreased amount of equipment and reduction in light and noise is a great advantage.

Many manufacturers have the notion in their heads that the real up-to-date equipment is an electric motor drive for each machine. That is false doctrine as applied to light machinery and the ordinary small equipment. We have in mind an instance in Niagara Falls where a concern had 100 5 h. p. motors direct connected to buffing lathes. The average h. p. requirement for each machine was two h. p. At very infrequent intervals it might take four or five h. p., but the majority of the times the machines were driven by motors more than 50 per cent. of excess capacity.

The upkeep on the motors, the initial investment, the uneconomical power take-off from oversize motors made it altogether a very expensive outfit. On the other hand, they decided to sell those motors, put in 100 plate type clutches and by the use of approximately 10-20 h. p. motors they drove through group drives with Hilliard clutches ten buffing lathes with each 20-h. p. motor and had still plenty of power. It will readily be seen that this reduced the number of motors to 20, the connected load to 200 h. p., and a saving in connecting loads of 300 h. p., and so far as the investment goes, the cost of the necessary clutches and the 10 20-h. p. motors was far less than the installation cost and the initial cost of the 100 5-h. p. motors.

Another interesting installation which has been in for a period of more than ten years, is some 250 to 300 clutches driving punch presses in the plant of the Eastman Kodak Co. This does away with the tight and loose pulley proposition and they stagger the machines so that they have two lines of presses driven from one main line shaft on which are mounted plate clutches with driving pulleys, driving direct to the presses. They find it unnecessary to remove their belt when changing dies, due to the special clutch made for the purpose.

Drummondville, Que.—It is reported that tenders will be called by the Southern Canada Power Company early in the spring, on a hydro-electric development located on the St. Francis River, three miles from Drummondville.

Vancouver, B. C.—The British Columbia steel works project has been temporarily abandoned. Negotiations are still going forward, but the provincial government has decided to do nothing further with proposed legislation to aid the enterprise financially.

Safe Practice in Handling Acetylene Generators

Best Housing Methods Under Different Conditions—Fire Hazard Requires Special Attention—Natural and Artificial Lighting of Buildings—Pressure in Pipe Line Important

THERE is one of three things to do with the acetylene generator—it can be housed in a separate building away from other buildings; it can be housed in a lean-to building or shed adjoining your plant; or it can be installed inside one of your plant buildings. A separate isolated gas house is the ideal method, especially so if you go to the expense of having a substantial structure with floors at truck floor level, and divide the building into three or four compartments, using one section for housing the acetylene generator, one or two sections for the housing of calcium carbide and acetylene cylinders, and another section for the storage of oxygen cylinders. The isolated generator, carbide and gas storage warehouse need not necessarily be of fireproof construction, although such construction is preferable. In the case where it is decided to house the acetylene generator in a building which is a lean-to to your main plant, it should be separated from such plant building by an unpierced fire wall.

Where it is decided to house the generator inside one of the plant buildings, as said before, it is important to be sure that your insurance companies do not object, and also to see that you are not breaking some local ordinances. However, if such is not the case and you are housing the generator inside, a special compartment or room must be constructed, and such compartment be built of non-combustible materials. The door to such a compartment should preferably open to the outside, but if it does open into the main building or shop, the door should be of the fire, self-closing type. You will readily appreciate, however, that it is far more desirable to have the door open to the outside; then if there is any leak of gas there is no chance for the gas to escape through the door into the main building or shop, with the possibility of being ignited by some heat or spark-emitting device.

In the opinion of the writer the acetylene generators should not be installed inside buildings where the building is more than one story in height, except in the case of a special generator house provided with two floors, when the second floor is sometimes used for the storage of a supply of carbide and for charging the generator. Be sure to see that the generator stands on a substantial and firm foundation. We know of cases where generators were put up on a flimsy foundation, which were later undermined by the water discharged from the generator, and as a result, the generator canted over and broke off certain piping connections, causing serious trouble.

A generator room must be protected from freezing. This is most important. Freezing up of acetylene generators is the cause of fifty per cent of the accidents that have happened with them. One should never attempt to lower the freezing point of the water by using calcium chloride in an attempt to do away with the necessity of heating, for the reason that the calcium chloride not only tends to corrode the generator itself, but will gradually permeate the whole piping system and cause serious trouble.

The recommendations here set forth are made in the hope of serving the manufacturer and user of acetylene and help him to steer clear of accidents which need not occur. Remember that safe practice does not end with the proper operation of your welding equipment. Welding must only be used for work where welding can be considered good and safe practice for construction or repair. Some users become over-enthusiastic and attempt to employ welding on certain work where it should never be attempted and, consequently, fall down badly, with the result that it tends to give welding a bad name and creates a feeling of insecurity about the process in the minds of those who are considering its use.

Generator houses should be provided with plenty of daylight illumination, and plenty of head room. It must necessarily be well ventilated, and also be provided with good and sufficient artificial illumination. This must necessarily be of the incandescent electric type, with globes properly protected and with switches outside the building. Certain existing rules call for acetylene generators to be charged during daylight hours only, but such rules are to-day obsolete and cannot be complied with for the reason that many generators are in constant use, and during the winter months it is necessary to charge in other than daylight hours. For this reason it is essential that the artificial illumination be good.

One would think to-day that any workman who could get a job would be educated sufficiently to know that you can't bring a naked flame in contact with a combustible gas without getting ignition or explosion—yet a considerable percentage of the accidents that have occurred with acetylene generators have been caused by this very thing. For this reason it is strongly recommended that good natural and artificial illumination be provided in the generator house, so that there will be no possible inducement for the thoughtless workman to strike a match or use a lantern when examining the generator. The instructions furnished by the manufacturers of acetylene generators for the installation of their machines should be followed closely, and it is advisable, when at all possible, to have the manufacturer install the machine and put it in operation.

It is quite unnecessary to say anything about the installation of acetylene gas piping, beyond stating that it should be of ample size to meet the estimated maximum demand and should be installed according to the requirements of the National Board of Underwriters. We venture to suggest that if any who have acetylene installations would secure a copy of the National Board of Fire Underwriters' rules, and would peruse these rules and observe whether the installations comply with them or not, quite a number would find that the National Fire Underwriters' rules were not followed when the installations were made. It should be appreciated that National Board rules are recommended and drawn up by the National Fire Protection Association, a body that has always made a point of consulting with the industry when preparing rules. Possibly it can be said that National Board rules are the rules recommended by the acetylene industry. You will find amongst the National Board installation rules, those calling for escape and relief pipes to be carried outside of buildings. Personal inspection has shown numerous installations where no attention was paid to this rule and safety devices, if they were called upon to operate, discharged their gas inside of the buildings. This was asking for trouble.

A considerable number of the acetylene generators in use to-day for supplying gas to shop piping systems deliver the gas to the piping system at pressures up to 15 lbs. per square inch. It is therefore necessary to have the piping systems tested after installation at a good deal higher pressure than is commonly employed for testing out city gas piping systems. Let us now deal with the installation of the oxygen supply.

In the majority of cases, oxygen is used direct from a standard oxygen cylinder, a separate cylinder being used

---

As recommended by the National Safety Council.

use. In some instances, however, a number of oxygen cylinders are manifolded together, the gas being supplied to the shops through a system of piping. In rare cases oxygen is manufactured on the premises, the gas being first collected in a gas holder and then compressed in a receiver to a pressure of a few hundred pounds, after which it is passed through a regulator and supplied to the welding stations through a system of shop piping.

In those systems where it is desired to manifold a number of oxygen cylinders and supply gas to welding stations, it is extremely desirable that the necessary manifolds be purchased from a responsible apparatus manufacturer or be made up to their specifications. Every care possible must be taken with the installation of the oxygen piping system. It should be appreciated that oxygen, when supplied in cylinders, is under a pressure of approximately 2,000 pounds per square inch, and consequently oxygen manifolds must be sufficiently strong to withstand this pressure. It must be borne in mind also, that no combustible material should be employed in making up the manifolds, for the reason that oxygen under pressure is liable to cause a spontaneous combustion of such material.

When assembling the manifolds and the piping system, great care must be taken to see that fittings, etc., are handled with clean hands. Crease on a joint or in the interior of the piping might cause serious trouble. The interior of the piping must be clear of all scale and rust, and should be thoroughly washed out with caustic soda before being put into service. It is needless to talk about the actual setting up of welding apparatus, beyond saying that the manufacturer's instructions must be followed to the letter. In those installations where both gases, oxygen and acetylene are supplied from a single cylinder of each gas, the cylinders should be so located that they cannot be knocked over or struck by passing traffic. In most cases, where the individual cylinders are employed, it is the best practice to have both cylinders mounted on a truck, so that they can be conveniently transported from point to point.

Now a few words about the operation and manipulation of the generators and other equipment. When starting up an acetylene generator the first time, the instructions of the manufacturer must be followed in detail. Where possible it is extremely desirable that the acetylene generator manufacturer should not only install the machine, but should put it in operation. After the generator is charged with water and carbide, a connection should be made at the extreme end of the piping system, so that the gas can be discharged from that point to the open air. It is most important, before starting to use the gas for welding, to make sure that all air has been purged from the generator and the piping system. Some common sense has to be used to judge when this has been accomplished, but in the average installation, the decomposition of 10 to 15 pounds of carbide will have generated sufficient gas to expel all air from the generator and pipe lines. You may possibly wonder why this is so important, and we will therefore endeavor to explain more clearly.

Under normal and proper working conditions, the pressure of the acetylene gas in your pipe lines and generator will never exceed 15 pounds per square inch. Pure acetylene gas (that is, acetylene without any air mixture) at any pressure below 15 pounds per square inch is non-explosive. It is possible to fill any empty cylinder with pure acetylene at a pressure of 15 pounds per square inch, fit the cylinder with a spark plug and make a spark, and there will be absolutely no ignition of the acetylene, but if there is a small percentage of air present, there will be a violent explosion. If the same cylinder were filled with acetylene at 30 pounds pressure, and there was no air present and the spark plug was sparked, there would be a violent explosion. The action of acetylene under pressure between 15 and 30 pounds per square inch is somewhat uncertain, but all the best authorities have definitely decided that acetylene should never be used in a free state at a pressure in excess of 15 pounds per square inch.

Now, let us assume that you failed to purge your pipe lines of air or mixtures of air and acetylene, and were to light a blowpipe that is supplied with gas from the pipe line, and then suppose that the blowpipe backfired—it would be possible for the backfire to propagate right through the piping system up to the flashback or hydraulic seal, which is necessarily attached to the discharge outlet of all generators. This backfire along the piping system might be of sufficient violence to split the pipe or loosen the joints. Cases are known where, while the generator was being purged, a cap at the end of the piping system has been removed and a match applied, under the idea that as soon as the discharge from the pipe would ignite, it would show that all air had been driven out of the pipe. In such cases, of course, an accident has generally occurred, the mixture of gas and air discharging from the pipe having ignited, and owing to the orifice being large and the velocity of the gas and air comparatively low, ignition has propagated throughout the piping system.

Oshawa. — General Motors Corporation are making additions to their power plant. Goldie, McCulloch water tube boilers are being installed. Present plant includes two Leonard boilers with Detroit stokers, and two Inglis boilers, hand fed. The new installation will be equipped with Detroit stokers.

CONDENSITE CELERON IN THE RADIO INDUSTRY

WITH the development and expanding use of radio, condensite celoron and vulcanized fibre have found many new uses. Radio transmitting apparatus often demand very high voltages and currents which, at the high rate of vibration or, in other words, "frequency" developed, would soon destroy all but the best insulation. The essential electrical qualities of an insulator are that it shall have high volume and surface resistivity; high dielectric strength, and a low power loss or "phase angle." An explanation of the above terms condenses down to the fact that the insulation must be the best non-conductor of electricity that can be had. Condensite celoron is stated to possess certain mechanical properties that are especially adapted to radio service.

Radio voltages and currents are very much more destructive to insulation than equal voltages and currents used in commercial work. This is due, as stated above, to the high frequency involved. Where very high frequencies are used even the best insulation becomes a conductor of the current. In comparing the electrical qualities of an insulator, the surface and volume resistivity, dielectric strength and phase angle are all inter-related. If the material is of such a character that part of the current will tend to flow through it, or be absorbed by it, then a power loss develops measured by the phase angle, which is another way of expressing in degrees the percentage of power lost. Therefore the resistance which the material possesses to withstand these current leakages is expressed in terms of volume and surface resistivity. Another important property of the material is its dielectric strength or, in other words, the voltage required to puncture the insulation. This last-mentioned property is somewhat dependent upon the other three.

Probably the greatest use for this material in the radio industry is in the manufacture of panels. Possessing a beautiful finish, coupled with the fact that it can be readily machined in the way of being sawed, drilled, tapped or engraved, in addition to its excellent electrical properties, make it an ideal panel material. Its use runs from the simple crystal set to panels two to three feet square and up to one-half inch thick for the ultra-sensitive receiving set with its many stages of amplification. In the construction of the receiving set it finds additional uses in the form of tubes on which to wind the wire, end plates for the condensers, vacuum tube bases, rheostat bases, terminal blocks, etc. In transmitting equipment its insulating properties make it very serviceable for mountings of inductance coils, for high voltage condensers, spark discharges, transformer housings, switchboard panels, antenna switches, relay keys and many other relative applications.

Machines Tested by Sound

Testing Devices Where Detection, Location and Comparison of Sound Are Interpreted

C. E. NOEL STORR

FOR a long time there has been an effort to build testing devices that would make it possible to determine and, in particular, locate irregularities in operation of machinery by the sound emitted.

The author developed his initial apparatus in order to locate mechanical defects in a series of very large engines which did not run quite right. To do this he devised an instrument with two ear pieces and flexible connections to the reproducer. While the device was crude and far from efficient, the difficulty in the engines was traced with very little trouble and with perfect comfort. Later on another problem arose in connection with small gear boxes which contained a double-reduction spur gear mounted on ball bearings. Some of these boxes failed to pass inspection on the ground of excessive noise. A difficulty also arose on account of the irregularity of the rejections, since batches considered noisy by the test room would perfectly pass, while nominally silent batches failed to do so, due, of course, to the entire lack of any definite standard of reference for either the inspector or the works staff. It therefore became desirable to find a way of measuring the sound of the boxes.

The construction of instruments for the detection and location of sound is complicated by the fact that in connection with mechanical work there are two distinct purposes for which such instruments may be applied, namely the detection of internal or mechanical sound and external or atmospheric sound. For example, in examination of the running condition of the balls in a journal bearing the internal sound only is of interest and not any external noise the bearing may make. On the other hand, in many forms of construction it is desired to reduce the external noise to a minimum and it is quite possible that a test of the internal sound may lead in such cases to a totally incorrect conclusion.

To deal with the two different aspects of the matter there are two different types of reproducer. In the first place, there is the tectoscope, which is arranged with a test rod and reproduces only the internal sound of the bar with which the rod is in contact. The tectophone, on the other hand, is arranged with a conical mouth and reproduces the external sound when the mouthpiece is held close to any object.

It will be noted at once that one instrument serves to check the results obtained with the other. For example, the contact breaker of a magneto will show a considerable blow from the rocker arm when tested with the tectoscope, but except on a few very silent engines the blow will not be heard externally when tested with the tectophone. In other words, the first instrument will indicate that there is a distinct mechanical blow taking place, and the second test will show that in the matter of improving the general silence of operation this blow is of small moment.

The foregoing example serves to show that the clear reproduction of even minute internal noises should enable worn or faulty parts to be located quite easily, while it also brings forward the use of the second type of instrument for checking the amount of external noise arising from a given internal source. Thus parts which may give rise to external noises may be traced, although it is more than likely that in some cases the internal cause is of small magnitude.

There are other general applications of the tectophone; for example, there may be two universal joints on a common shaft, and either or both may be dry and noisy. In some cases of this nature the tectoscope applied to the nearest bearing on the shaft might fail to give a clear indication on account of the noise of the bearing, but if the tectophone is held quite close to each joint in turn the squeak can be instantly located. The above instance applies to many similar problems and includes the tracing of gas, compressed air, and similar leaks from pipes and plant in general, the flow of a liquid in the pipe being indicated quite distinctly by the tectoscope.

The author gives descriptions of ways to proceed in testing the operation of various parts of an automobile engine, selected here as an example, by means of his apparatus. Sounds picked up by this apparatus may be compared either with each other or with a standard which is to be taken as a fixed quantity. For general shop tests a pair of reproducers are used connected to the head frame. If, for example, the left-hand reproducer is placed in contact with No. 1 cylinder, the sound emanating therefrom will be the only sound audible to the operator. On placing the right-hand reproducer in contact with No. 3, however, the relative "slap" of the two cylinders can be instantly compared, this being preferable to an attempt to remember the relative intensity of No. 1 and making a mental comparison after testing No. 3.

It should also be noted that when required the method enables the internal sound to be compared with the external; and as in some forms of construction the section or shape of the casing may cause, say, four tappets and cams which are all of equal intensity internally to give very different external effects, the combined test should enable any confusion to be avoided as to the actual cause of the defect. In fact, it should be of considerable assistance in the industry for purposes as widely different as the choice of suitable material for the exhaust pipe and the design of a gear-box lid.

Other applications of the use of this apparatus are described, from which it would appear that by these means a considerable amount of information can be obtained at a small expense in time. For example, many sources of trouble in closed bodies can be easily obviated with the aid of the tectophone which will trace body squeaks, panel drumming, and the periodic drumming of wings and undershields under actual running conditions on the road.—Mechanical Engineering.

WHAT IS METAL FATIGUE?

With repeated stress as the basis of the explanation, the old theory of crystallisation of metal as the cause of fatigue failure is now abandoned, and we are taught to view failure as the outcome of the progressive spreading of minute cracks across the metal. This, of course, is not a complete explanation, for cracks are an effect, not a cause, and the phraseology which refers to repeated stress as the primary cause leaves the reader in a rather hazy condition concerning how and why the stress acts as it does. The search for exactitude in that direction may be of more interest to the scientist than it is to the average engineer, who need not go beyond the chain of effects in order to possess all the metallurgical knowledge that his work may demand. Questions of origin may be advanced towards solution by a use of the film. In the meantime some interesting tests are reported in connection with Illinois University, where the latest reversed-bending testing machine can be run at 1,800 revolutions per minute in producing cycles of completely reversed-bending stresses. Wrought ferrous metals appear to have a well-defined failure limit, accompanied by a rise in the temperature of the metal undergoing stress. Some difference between British and American figures relating to the endurance limit of cast iron and steel castings is disclosed, and further experiments have been arranged for the purpose of verification. One of the important facts recorded is that poor surface finish may lower the endurance limit by 18 per cent. Shape also influences the result. Such facts serve incidentally as reminders that machine designers, in many cases, fail to make adequate allowance for localised stress.

Building men in Ottawa anticipate something in the nature of a boom in that city this year. Permits last year reached the exceptional record of $5,021,782. Labor is abundant except for a few skilled lines.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

S. S. MOORE - - - Managing Editor
W. B. ROBERTS - - - - - - - Editor
B. G. NEWTON - - - - - Manager
H. D. TRESIDDER - Advertising Manager

SUBSCRIPTION RATE
Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year, other countries, $3.00. Single copies, 25c. Advertising rates on request.
THE MACLEAN PUBLISHING COMPANY, LIMITED
143 UNIVERSITY AVENUE, TORONTO, CANADA
JOHN BAYNE MACLEAN, President
H. T. Hunter, Vice-President.
H. V. Tyrrell, General Manager.

Cause of Boiler Explosion

WE HAVE received a letter from a correspondent, which appears in another part of this issue, which was accompanied by a complete article taken from an American Engineering Paper relative to the explosion of a boiler of the locomotive type. Unfortunately the article is too long to publish, but our correspondent appears to thing that the report is at variance with the article appearing in the Dec. 20 issue of this paper. We are prone to think, however, that our correspondent has not interpreted our article on this subject correctly, otherwise be could not compare it with the case in the article he submits.

The Manchester Steam Users Association, as the majority of engineers know, is one of the greatest authorities on the operation and design of steam boilers in Great Britain, and C. E. Stromeyer their present chief engineer, is known the world over for his researches in boiler work and experiments on the ageing and fatigue of steels. Some years ago, however, it was thought necessary, on account of the divergent opinions upon boiler explosions, to conduct certain experiments to disprove that cold water sprayed upon a red-hot boiler plate, would cause an instant generation of steam sufficiently quick and so voluminous as to cause an explosion. We think it was generally accepted by the Board of Trade and all other engineering authorities, that the experiments conducted fully proved all they set out to prove and, therefore, it was finally accepted that explosions were not caused due to these conditions.

In reading over the extract from the articles submitted to us, we are informed "That there is no doubt at all, from the condition of the tubes, which are collapsed, and also from the condition of the crown sheet, that the disaster was caused by low water." The unfortunate part of the report, which no doubt has misled our correspondent is, that a few minutes prior to the explosion, the owner's son saw the engineer start the injector, but the report does not tell us that this caused the explosion. We are distinctly told in this report, that as a result of the investigation the cause of the explosion was fully revealed and that low water was responsible for the disaster, also that the crown sheet of the furnace was very badly burned. We think those last few words sums up the whole situation and allows us to place our finger upon the direct cause of the explosion. A boiler never explodes except due to weakness and here is the actual weakness. If the crystalline structure of a plate is destroyed due to being burnt, the strength is very materially affected and it is not at all unlikely, if that plate is in a boiler under pressure, that some form of disaster is sure to follow. In this case it did, and it is no use trying to associate the turning on of the injector with the explosion as the injector was turned on several minutes before the explosion happened. The furnace crown was burned and consequently very materially weakened. Since the shell of the boiler was intact and the explosion was due directly to the collapse of the fire-box, we see exactly what has happened and it is of little use trying to create a mystery around a situation like this, when an examination of the plates betrays the whole cause.

It was on account of this growing tendency to enshroud such mishaps with mystery, that we were prompted to publish this experiment, the main object being to disillusion those who unfortunately had come to regard such a theory as gospel, and, at the same time, to fortify all engineers against the acceptance of such a theory which must sooner or later be submitted to them.

Future of Water Turbines

IN ANOTHER part of this issue, we have dealt very briefly with the water turbine showing its application to one of the hydro electric units at Chippawa. This form of prime mover is a machine that is bound to claim very considerable attention in the future on account of the vast sources of undeveloped natural water supply we have at our disposal in this country. We are always aiming at cheaper power which must consequently resolve itself into larger and still larger power stations, getting rid of scattered and haphazard methods which have proved to be slow and costly. With a view to reducing the cost of power, the price of labor must be considered and with this in view, a special control stand is provided for each unit containing the necessary indicating instruments and control valves, so that a single operator can from one position, not only observe the performance of the turbine and all its auxiliaries, but can also start up, adjust the load, or shut down the turbine in the course of regular operation, or shut the turbine gates if required in case of emergency.

The manufacturer is, therefore, supplied with his power from a reliable source which is uninterrupted from transportation and coal strikes and which places him in that sphere where he is free from the anxieties and worries of fuel shortage.

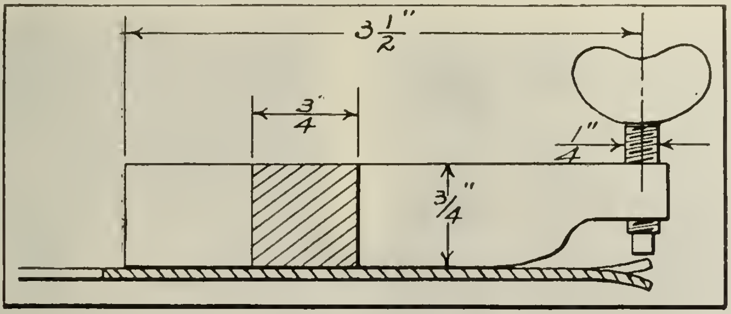
Operators' Point of View

GAUGE FOR SETTING BUZZ SAWS

By D. A. H.

Every mechanic knows that a saw must have set in it to cut freely. Saw factories set saws by machinery and there are machines used in wood working plants for the purpose; then there is the skilled man who sets saws with no other tools than a hammer and a taper block. But owing to differences in temper in different parts of the same saw as well as to blows of uneven intensities, hardly one saw in a thousand has all teeth set the same. Then, if there is one high tooth, the saw will never make a smooth cut; that tooth or a number of them will always be over-prominent and leave grooves in an otherwise smooth cut. The high tooth or teeth are almost impossible to find—they cannot be detected by eye or by laying a straightedge over the saw.

The sketch herewith shows a "tool" so simple that one wonders why it was not thought of before. It will pick out the high tooth instantly. When that has been lowered with a light blow, the gauge screw is turned a fraction and the next higher teeth can be spotted. In this way, the teeth that would positively cause scratching may be located and corrected before the saw goes on the mandrel. In construction, the gauge is a piece of ¾ in. square c. d. s. notched to let in the light and rounded a little way back to clear the tooth if its set extends back to the root. The screw is made a snug hand fit—snug so it will not jar out of its setting.



Gauge for setting teeth of buzz saw.

THE TREAT GAS PRODUCER

The chief distinctive features of this producer consist in a number of devices and power-actuated mechanisms which perform automatically various functions in relation to the fuel bed. Thus, a mechanism is provided for agitating the fuel bed and for feeding and distributing the fuel in the producer chamber. The machine to do this is located in the central circular opening of the producer top and is arranged to revolve bodily at a slow rate in a horizontal direction. The action for feeding and distributing the fuel and the agitation of the fuel bed functions in unison with the rotary movement.

The machine has a number of agitator bars extending vertically within the producer chamber so that the pair of agitator fingers of the lower ends penetrate the fuel bed. By turning adjusting screws the agitator bars may be raised and lowered at the will of the attendant. Fuel-feeding devices are provided. The blast is supplied through eight independently controlled steam-jet blowers of special design which are disposed uniformly around the outside of the producer. To each blower is connected an independt tuyere pipe which is arranged to extend through the tapering lower portion of the producer body, into the ash zone. The ashes are discharged through a water seal over the edge of the ashpan and a scraper device is employed which is designed to act against the interior surface of the ashpan.

Cleanliness is often underestimated in many factories. Superintendents, foremen and workmen should study this problem more to obtain the best results. Without cleanliness high class work is practically impossible, and it is the better class of work produced at reasonable cost that brings in and holds new customers.

Editor, Power House:

Please find attached an article and illustration from a recent issue of an American engineering journal which is quite at variance with your article appearing in "Power House" December 20th, 1922.

We would be pleased to hear what the Manchester Steam Users' Association has to say about this.

A. MURPHY,
Toronto.

Editor's Note:—

Mr. Murphy did not give us his address and we would ask him to kindly forward this to us in case we should wish to write to him personally upon this matter.

We cannot publish the whole of the article that was forwarded to us, on account of its length. The heading ran "Low Water and Removal of Fusible Plug Cause Boiler Explosion," and an extract reads:

"The 2-in. lever safety valve was found among the debris and was in good working condition and showed evidence of having been weighted to blow at 80 lb. There is no doubt at all, from the condition of the tubes which are collapsed and the condition of the crown sheet, that the disaster was caused by low water. This decision is further substantiated by testimony from witnesses who state that the 'engineer' was making an attempt to start the injector and the owner's son, who was also employed at the plant, made an effort to stop him but was unsuccessful. A few minutes later the boiler exploded."

POWER COMPANY HEAD GETS HANDSOME GIFT AT LEAVING

N. B. Ambler, superintendent of the Toronto Power Company at Niagara Falls for the past ten years, has resigned and leaves for New York. The employees of the power company presented Mr. Ambler with a handsome silver tea service suitably engraved. Mr. Stanley E. Thompson made the presentation and in a happy speech voiced the regrets of the employees in losing the genial superintendent. Mr. Ambler expressed his appreciation of the beautiful gift and thanked the employees for the splendid co-operation that he had enjoyed during his term of office. Mrs. Ambler received a huge boucuet of roses at her home.

Progress in New Equipment

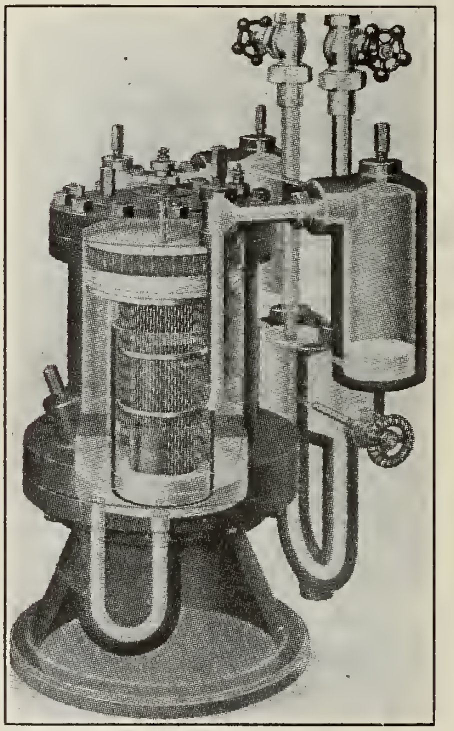
REPUBLIC FLOW METER

A phantom drawing of the meter body and seal assembly is shown on this page.

The two pipes terminating with globe valves are connected to the differential medium either a pitot tube or orifice disc by means of ⅜ in. piping. The dynamic or high pressure is admitted to the left-hand connection, when looking at the view of the meter in the drawing, and the static pressure of the right-hand connection. The dynamic connection leads to the mercury well, and the static connection to the annular space around the contact chamber.

When there is a flow in the line, the dynamic pressure becomes higher than the static. The mercury level is depressed in the mercury well and raised in the contact chamber in proportion to the impact of the flow. The rise and fall of the mercury in the contact chamber engages or disengages the successive ends of the overhanging rods, and thus adds or cuts out a given part of the resistances to which the rods are connected, regulating the amount of current flowing through the electric circuit. The resistances are so divided by the contact rods that the flow of the current in the circuit is directly proportional to the flow of fluid in the pipe. The electrical instruments, while measuring the current regulated by the flow, actually register the amount of fluid passing through the pipe.

Accordingly, the total amount of electrical energy measured by the flow integrator is the exact equivalent to the total amount of fluid passing through the pipe. The instantaneous flow of current shown by the indicator and recorder is equivalent to the instantaneous flow of fluid through the pipe. As the action of the meter depends only upon the level of the confined body of mercury, unrestricted by floats and mechanism, consequently, the slightest change in the flow of the fluid in the pipe will make an immediate change in the level of the mercury column, resulting in a corresponding immediate change in the reading of the electrical instruments.



Flow Meter.

PNEUMATIC RIVET CUTTER

A new type of pneumatically operated rivet cutter has been placed on the market recently. It has been constructed on the principle that a few intermittent heavy blows cause less vibration and therefore less distortion of steel plates than a number of comparatively light, rapid blows. The device consists of a dead handle for holding the machine, a throttle handle of crank design, taper throttle valve, a back head screwed onto the cylinder and secured by a locking device, a seamless steel tube cylinder with a cushion chamber in the rear end, a by-pass from back to front head, square coiled spring buffer, adjustable chisel lock, spade handle and chisel. The cutter is operated by moving the handle parallel to the cylinder. Both forward and return stroke is hand-controlled. Four blows, requiring about 15 sec., are said to be ample to cut off the head of a ¾-in. rivet. The device is made by the Chicago Pneumatic Tool Co., New York.

CHAIN SCREEN DOORS FOR FURNACE OPENINGS

Everyone who has had to work around ovens and furnaces knows what discomfort has to be endured by the operators from the heat and gases pouring out through the uncovered opening when the doors are thrown open and, further, what a chilling effect the cold air has upon the interior of the furnace and its contents. Doors, however, must be opened; be it to renew the charge, manipulate the contents, or study the interior conditions.

Many contrivances have been devised in connection with drop forge, steel, metal and chemical furnaces to avoid the adverse conditions arising from the opened furnace door, but these as a rule were solid, opaque and cumbersome. What was demanded was a door or shield which would permit a clear, unhampered view of the interior of the furnace or oven—would not in any way interfere with the free manipulation of the tools required to handle the charge, yet a door that would keep the heat in and the cold air out. In other words, a door was required which should possess at the same time the qualities of opaqueness, transparency and penetrability. These conditions have been met largely by the Wiegand Chain Screen Door.

Chain screen doors, in the form used mostly on steel, copper, glass and chemical furnaces, consist of a multitude of freely swinging individual strands of steel chain hanging close together from a steel bar in a manner to form a continuous sheet or curtain of chain, not unlike the familiar Japanese portiere.

This curtain of chain, hung before the uncovered opening to a furnace, and looking like a coat of mail, effectively hinders the heat, glare, gases and sparks from leaving the furnace and the cold air from entering. The loosely hanging strands of light chain with ease are parted and pressed aside by the tools or other objects projected into the furnace, only to fall together again and close the opening when entrance has been effected.

The preliminary plans have been drawn for the $7,000,000 power development at Rivieres des Prairies, Que., by the Back River Power Company.

Babcock & Wilcox Chain Grate Stoker

For Natural Draft

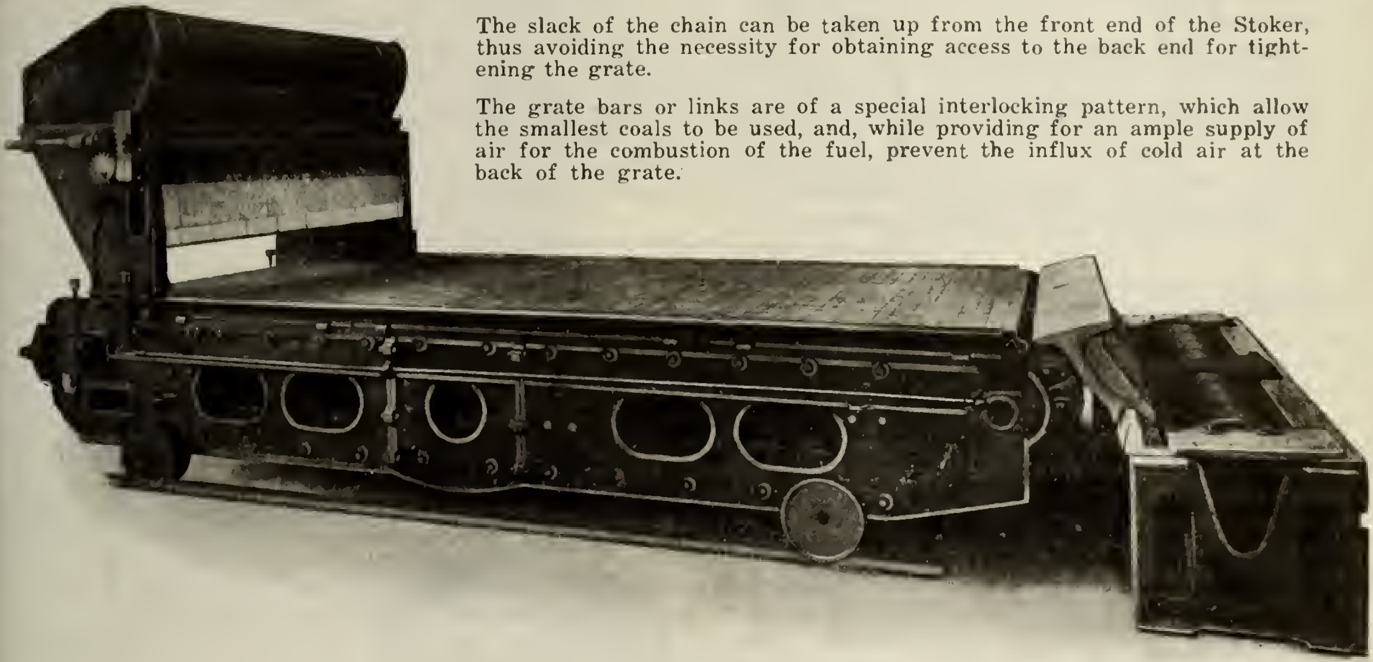
The grate consists of an endless chain of short interlocking cast-iron grate bars, linked together, running on angle irons and rollers and driven by a revolving shaft and sprocket wheels at the front end of the Stoker. The necessary power to drive the revolving drum is transmitted through a link chain and sprocket wheels from a shaft arranged either overhead or underground.

The starting or stopping of the Stoker, or the variation of speed, is effected through the B. & W. patent gear box, which can be driven at varying speeds. This box forms an oil bath in which the gear runs, and also contains an efficient clutch for putting the driving gear out of action should any unusual strain arise from an obstruction on the grate.

Any small repair, such as replacing a link, can be carried out with the Stoker in place under the boiler; but in case of need the whole Stoker can be brought out clear of the boiler, the frames being provided with wheels running on rails placed at the sides of the ashpit.

The slack of the chain can be taken up from the front end of the Stoker, thus avoiding the necessity for obtaining access to the back end for tightening the grate.

The grate bars or links are of a special interlocking pattern, which allow the smallest coals to be used, and, while providing for an ample supply of air for the combustion of the fuel, prevent the influx of cold air at the back of the grate.



The coal is fed over the whole width of the grate, and the depth of the fire is regulated by the adjustment of the vertically lifting fire door.

THE FEED OF THE COAL IS SLOW and the gas evolved from the fresh fuel as it drops on to the grate readily perfects its combustion by passing over the incandescent fuel further on.

The depth of the fire being regulated by a vertically lifting fire door, the Stoker CAN BE ADJUSTED IN A MOMENT to suit the class of fuel to be consumed and varying demands for steam, both by the depth of the fire and the speed of the grate.

The Stoker is easily manipulated and so simple that any fireman can understand it. It is the only form of stoker in which the undue admission of air at the back of the grate is prevented and with it THE HIGHEST EFFICIENCY is obtained.

The Stoker ultimately proves itself the embodiment of economy because it is efficient and saves coal over any other method of firing and the cost of upkeep is low compared with any other type.

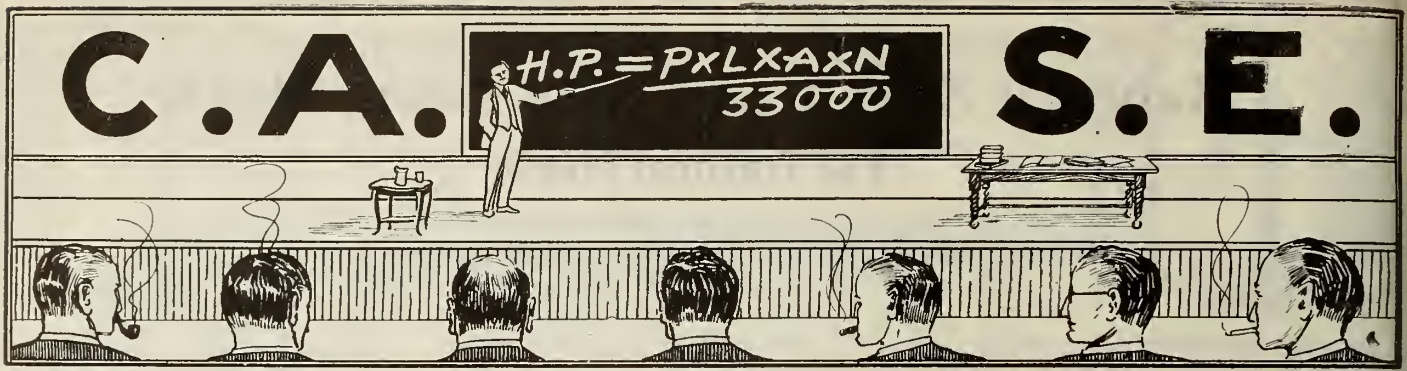
The first cost of some other makes may be less, but consideration must be given to whether they have the necessary metal in them to stand up under the work they are intended to do. By reducing the weight of metal the price can be lowered but only at the sacrifice of the durability, consequently the cost of repairs will be great. Due consideration should also be given to whether by any other method of firing the price of the Stoker can be recovered in the amount of coal saved in a given period.

Full information given on request.

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE: BANK OF HAMILTON BUILDING



Toronto.—The 34th annual convention of the C. A. S. E. will be held in the Central Technical School on Lippencott St., Toronto, on June 25, 26, 27 and 28 this year. Judging by the amount of interest shown by the engineers and some of the supplymen, this convention promises to surpass anything previously held by the C. A. S. E.

Arrangements have already been made to secure the co-operation of the Canadian Manufacturers' Association, the Board of Trade and the Toronto Publicity Bureau.

Mr. Gordon Keith, of the Commercial Press, 51 Richmond St. W., Toronto, was elected general secretary of the joint committee.

At the joint executive meeting held January 30 at the residence of Mr. C. B. Turner, 894 Bathurst St., all the necessary arrangements were completed for the success of the convention.

Mr. R. McLaren, president of Toronto No. 1 C. A. S. E., is chairman of the joint committee and chairman of the convention committee.

The directory which Toronto No. 1 have had under way for some time will be ready for distribution before this issue goes to press.

Nearly all of the manufacturers of power plant equipment have representation or membership in the Supplymen's Association.

Officers ,of Exhibitors' Association

Past president—Grant E. Cole, G. E. Cole Co., 21 River St., Toronto.

President—J. Thompson, Dearborn Chemical Co., 2454 Dundas West, Toronto.

1st vice-president—H. G. Fletcher, Garlock Packing Co. Ltd., Continental Life Bldg., Toronto.

2nd vice-president — Earl Gordon, Thompson-Gordon Co., Ltd., Hamilton.

Secretary—Gordon C. Keith, The Canadian Manufacturer, 51 Wellington St. W., Toronto.

Assistant secretary—Geo. W. Wilkinson, Quaker City Rubber Co., Rochester.

Treasurer—Lloyd M. Archibald, Dart Union Co. Ltd., 93 Niagara St., Toronto.

Exhibition committee—C. B. Turner (chairman), 894 Bathurst St., Toronto.

Entertainment committee — E. F. Hetherington (chairman), Goldie & McCulloch Co. Ltd., Galt.

Reception committee—H. H. Gee (chairman), Jenkins Bros., Ltd., 48 Colborne St., Toronto.

Next exhibition will be held at Toronto, June 25, 26, 27 and 28, 1923.

Kitchener.—Lodge No. 9, C.A.S.E., at their last regular meeting on January 12th, had their annual installation, when Past President Bro. F. Pflug installed the following officers for the present year:—President, Bro. Chas. Merreth; vice-president, Bro. E. Klein; rec. sec., Bro. Con. Ott; fin. sec. and treas., Bro. C. Emmrich; conductor, Bro. J. Luft; door keeper, Bro. J. Ransch.

There was a fairly good attendance of members.

Considerable work upon educational matters will be effected during the year.

A stereopticon lantern has been bought which will considerably help in promoting greater interest with the engineers at their meetings. The Kitchener lodge intends holding an at home in the very near future and a very strong committee was appointed at the last meeting to insure its success.

POWER COMPANY HEAD GETS HANDSOME GIFT AT LEAVING

N. B. Ambler, who has been superintendent of the Toronto Power Company, Niagara Falls, Ont., for the past two years, has resigned and leaves for New York. The employes of the power company presented Mr. Ambler with a handsome silver tea service suitably engraved. Mr. Stanley E. Thompson made the presentation and in a happy speech voiced the regrets of the employes in losing the genial superintendent. Mr. Ambler expressed his appreciation of the beautiful gift and thanked the employes for the splendid co-operation that he had enjoyed during his term of office. Mrs. Ambler received a huge bouquet of roses at her home.

Dales Conservatories, Brampton, Ont. will erect 5 new greenhouses in spring approximately 40 x 400 ft. each. This will necessitate the erection of 2 new 200 H. P. boilers for heating them. A tunnel 600 ft. long will be made of concrete extending from power plant to the new houses. The total transaction will approx. $100,000. They have at present 4 Murphy Stokers with Inglis boilers.

IS SIR ROBERT HORNE CLOSING BALDWIN DEAL?

Sir Robert Horne's visit to Toronto has revived speculative interest in the future of Baldwin's Canadian Steel Corporation plant in Ashbridge's Bay, Toronto.

Sir Robert, formerly Chancellor of the Exchequer, is vice-chairman of the English Baldwins, parent of the Canadian concern. While no confirmation is available, it is understood that, since his arrival in America, some progress has been made in negotiations looking to disposal of the plant here to Bethlehem Steel Co.

The plant closed down early last fall as the result, it was stated at the time, of difficulties growing out of the coal rail strikes in United States. Materials were held up to such an extent that the plant could not be operated on a profitable basis. Another problem, which had been partly solved, had to do with the development of a working force. Production of tinplate in Canada was a new industry, for which there was no class of experienced help available. Labor of all kinds was high and the wage proposition was a very large item in an industry operating on a somewhat competitive basis. Nevertheless, it was felt that Canada offered a positive market for products of the plant.

It is understood that the Bethlehem Steel Co. are desirous of securing a plant in Canada that would serve as an adequate link in the chain of plants that they have been organizing to better serve their marketing purposes.

At the Baldwin plant it was stated that, as yet, nothing was available for publication. Capt. Hugh E. Poynter, president, is in New York.

Fuel authorities report that instances are known in which manufactuers have had to curtail, if not suspend, operations, owing to shortage of coal. This, it is claimed, is the result of failure to take advice offered some weeks ago to lay in stocks of coal while there was a limited quantity available. A temporary embargo went into effect subsequently and supplies have reached low levels. Coke which is now selling at from $9 to $10, could have been purchased two months ago at $7.70, at which price demand was inclined to hesitate, in anticipation of better prices. These, however, have not materialized.

Tested Efficiency and Tested Strength

—*proof that this insulation saves more heat*

A LENGTH of pipe insulation can save more heat in two ways: by its greater efficiency, and by its greater strength which increases its working life.

The greater efficiency of Asbesto-Sponge Felted Insulation has been proved by frequent tests—In a test of 26 insulations at the University of Wisconsin, it showed the highest efficiency.

The greater strength of Asbesto-Sponge is obvious—hit it with a hammer or test it in any way you please. It has lasted well over twenty years on hard service—a record that will be exceeded as the passage of time permits.

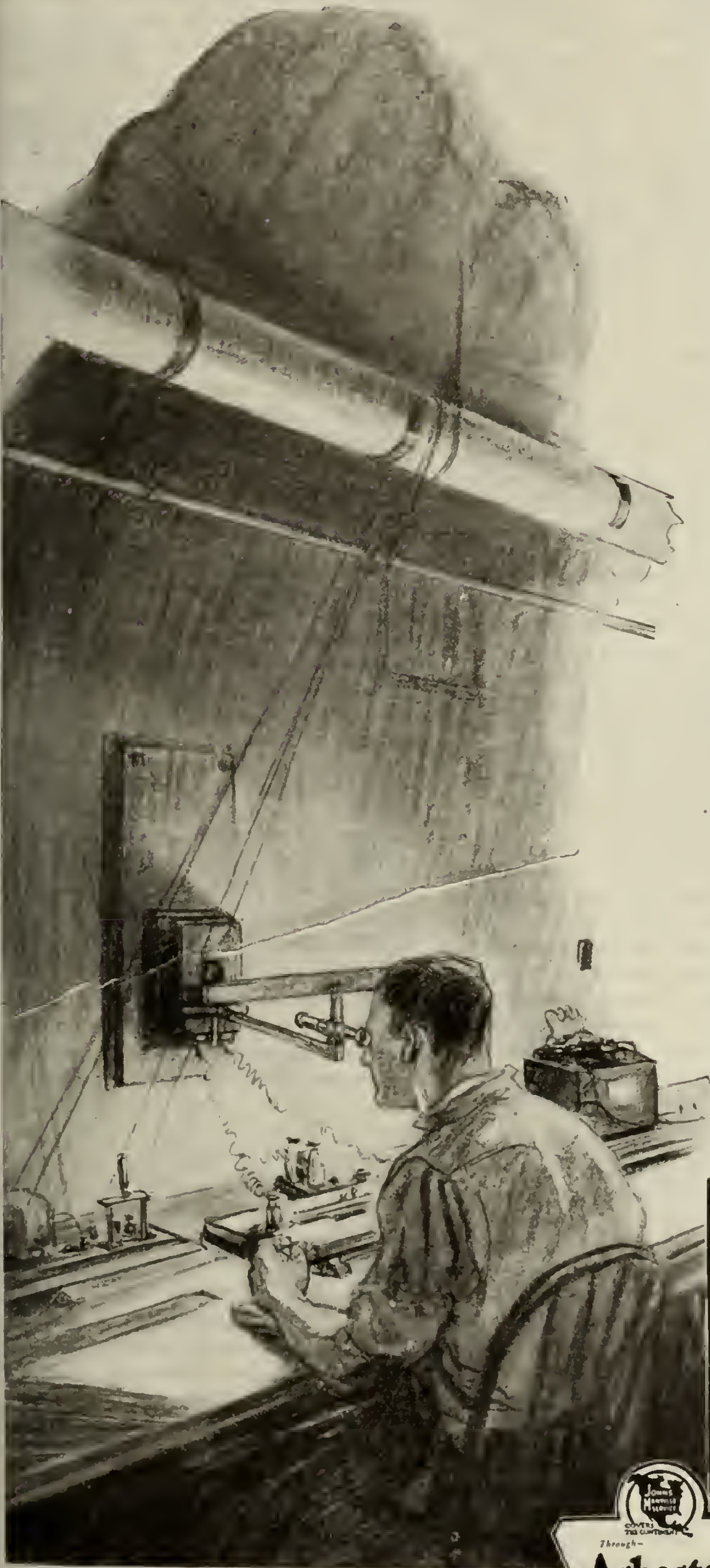
These tests prove the ability of Asbesto-Sponge Felted Insulation to save more heat in *both* of the ways such saving is possible—higher efficiency and longer life. Naturally, it is more economical.

CANADIAN JOHNS-MANVILLE CO. LIMITED

Toronto Montreal Winnipeg Vancouvre
Windsor Ottawa

JOHNS-MANVILLE

Power Plant Materials



Testing pipe insulation by the electrical method—an accurate test that has repeatedly demonstrated the greater efficiency of Johns-Manville Asbesto-Sponge Felted Insulation. The electrical heating input necessary to keep the pipe at a given temperature measures the heat loss.

Johns Manville Service
Covers the Continent
Through—
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

You can hit Asbesto-Sponge Felted Insulation with a hammer—a test that has an important bearing on the life of an insulation in service.

EXPERIMENTS ON ICE MAKING

DESCRIPTION of what appears to be a novel method of ice manufacture in which an attempt it made to make a practically continuous cake of ice from which pieces may be cut off as desired. The method is based on the use of supercooled water. It is known that strongly agitated water may be cooled below its theoretical freezing temperature without solidifying. In tests made by the author, water strongly agitated and surrounded by a 14-deg. fahr. brine was reduced to 26.8 deg. fahr. before it flashed and ice crystals were formed. In other experiments water was not agitated but covered with a film of oil and a temperature of 25 deg. fahr. was reached without crystals forming. A piece of ice was dropped into the water and crystals slowly formed. The peculiar thing in the formation of these crystals is that they formed in laminated sheets. After proving that water could be supercooled, a plant was built with the idea in view that if ice crystals could be made in sufficient quantities and the ice cans filled with a concentrate of ice crystals and water at 32 deg. fahr., a marked step in the development of a more commercial method of manufacturing ice would be obtained. Notwithstanding all efforts made it was found impossible to use this plant on a commercial scale as the equipment would work only a few minutes, when the cooler would freeze up. This happened even when high back pressures from 42 up to 100 lb. per sq. in. were used. The apparatus, it seems, was provided with screens of 200 mesh in the bottom of the tank to prevent the crystals from being carried to the cooler. As a matter of fact, however, the crystal formations break up into such minute particles that they readily pass through eight to ten thicknesses of 200 mesh screen reinforced with cheesecloth, and these minute crystals once in the cooler cause the flashing.

A device was then developed for separating crystals by gravity. After the separator was connected between the tank and the cooler, supercooled water could be made and maintained for an indefinite period at temperatures below 32 deg. fahr., and it was believed that by introducing the supercooled water into a refrigerated can or receptacle the water coming in contact with the refrigerated surface would deposit lamination of ice thereon, thus removing the heat through water instead of through ice. Numerous experiments were made but without satisfactory results on a commercial scale at first. Thirty-seven forms of cans of various types and shapes were made. In all of these absolutely clear ice was made but in no case was it possible to deposit crystals that would adhere to the refrigerated surface or to the ice formed. This led to further experiments to determine the relation between supercooled water and ice crystals.

In the course of these experiments another means was employed in the hope of solving the problem. A large cast-steel ammonia-jacketed can, weighing 7,000 lb., was made in two sections, machined inside and bolted together. This can was 6 ft. 9 in. long and the ammonia-jacketed section 6 ft. long. It was open at the ends and the front end was provided with a cover and an inlet and outlet; in the center an agitator was provided. The idea was to admit supercooled water into the can through the top inlet, agitate it in the can, and discharge it from the lower outlet. The object of the agitator was to mix the supercooled water and crystals so that the entire mass would be of one temperature and the crystals would be deposited on the refrigerated surface of the can and thus make ice. Means were provided to lubricate the inner surface of the can, the intention being to make ice continuously, allow it to slide out of the can as made, and then saw it off into standard lengths. The system was not a success.

Experiments are now being conducted in an attempt to make ice in an open tank, separate the crystals in the water by a centrifugal separator and then press them into a cake by means of hydraulic pressure. The crystals made from supercooled water are so minute that they can hardly be distinguished from water when in a glass, being so clear. By subjecting them to pressure, however, they can be compacted so that solid ice can be made.

In the course of these tests an endeavor was made to stabilize the crystallization point by catalytic action. Various acids and alkalies were added to the water with a view of decreasing the freezing point and with the hope of discovering some means whereby the crystal formation would be retarded. Certain dyes were used, as well as starch, glycerine, and other chemicals. A thorough study of the crystal formation of sugar, salt, glycerine, and various chemicals was made and a number of very interesting experiments were conducted with electrical apparatus. Glass containers were made surrounded by coils of wire through which both alternating and direct current were applied with a view to stimulating or directing crystallization by magnetic lines of force.

It would appear, therefore, that while no commercial result has yet been obtained from the work of the writer, some facts of considerable scientific interest have been established.—Refrigerating Engineering.

The Eureka Planter Co., Woodstock, Ont., will start work early in the spring for an addition to its foundry, in which a considerable amount of new equipment will be installed. H. C. Norry is vice-president.

RECOVERING FUEL FROM ASHES BY MAGNETIC SEPARATOR

The presence of coke and unburnt coal in ashes often constitutes a considerable loss of fuel, and up to the present there has been no very effective method of recovering the combustible matter from the refuse. We are informed that Messrs. Fried Krupp, in Germany, have devised a magnetic separator for the purpose and that many of such machines are now in successful use. Practically all coals contain iron in the form of pyrites, which has no magnetic properties. The burning of the coal, however, converts the pyrites into oxides which are magnetic, and as the whole of the iron passes away with the slag the metal exists there in a very much more concentrated form than in the original coal. These facts are taken advantage of to effect the separation. The machine employed consists essentially of a magnetic drum over which the furnace refuse is passed. The drum rotates slowly about a horizontal axis, just as in the case of an ordinary magnetic separator. The ashes to be treated are delivered by a bucket elevator to a vibrating screen which separates them into various sizes. Each size is passed separately on to the circumference of the drum. The slags containing iron are held magnetically to the surface for a portion of the revolution, and then drop off into small wagons or other receptacles as the current exciting the portion of the drum which held them, is automatically broken. The coal and coke which may be present do not adhere to the drum, but leave its surface directly after contact with it, and fall into their own receptacles. It is said that lumps of slag up to 3-in. mesh will adhere to the drum and thus be eliminated from the fuel.

The magnetic separators are built in sizes capable of dealing with quantities of ashes ranging from ½ ton to 2 tons per hour. The fuel recovered by these machines can either be burnt under boilers by means of forced draught or it can be briquetted, both methods being in use. We are informed that about 90 magnetic ash separators are now in use in Europe and elsewhere, and that 50 more are on order. Among the users may be mentioned the Hungarian State Railways, who treat locomotive ashes by the method described. The agent is Mr. W. Stamm, 63 Queen Victoria-street, London, E. C. 4.—Engineering.

Cobalt:—H. H. Sutherland, promoter of the Great Northern Power prospect at Indian Chutes, said they fully expected to be putting on extra 8,000 horse power into Porcupine by July next, and furthermore, if the Hollinger wants it, they might increase this to 12,000 or 14,000 H. P.

"SAFETY" PLASTIC METALLIC PACKING

This packing is made of an alloy of the FINEST ANTI-FRICTION METALS combined with the BEST LUBRICATING MATERIALS, which always remain in the packing, making it practically Self-Lubricating and Frictionless. It is

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL

In fact there are many Engines, Pumps, Compressors, Expansion Joints, Valves, etc., on which this packing has been in use for over 12 years with the very best satisfaction.

Let us send you further particulars also about our "Safety" Superheat Sheet Packing.

STEEL MILL PACKING CO. - WINDSOR, ONT.

AGENTS WANTED

Packing in bulk.

Packing in Cotton Tubes.

Established 1899

2

AGAIN TESTING COPPER TUBES

The use of copper for locomotive firebox plate and boiler tubes in the United States was abandoned many years ago, but the metal is likely to be tested again to determine whether it is cheaper than steel under present conditions. Copper is cheaper than it was in 1914, whereas steel is 50 per cent. dearer. One of the circumstances which caused the American railroads to discard copper was the high cost of the material, but the scrap value recovers a great deal of the original cost. In a paper by Mr. P. C. Dewhurst (Jamaica Government Railways) the author states that he does not see sufficient justification for the use of copper tubes unless it is on account of better conductivity. Owing to the high co-efficient of expansion of copper the tube sheets are distorted more between the cold and working temperatures than when steel tubes are used. Moreover, Mr. Dewhurst argues that steel tubes do not suffer from eroding at the fire-box end, just inside the tube sheet.

Cobalt.—Canadian Associated Goldfields will start operations, as soon as the winter breaks, on completing the development of its Windego Falls power scheme on the Blanche River, south of the Kirkland field. A preliminary development of 2,500 horsepower will be ready this summer, this amount of energy being available without damming. By building a dam and otherwise providing storage, this power position is stated to be good for 6,000 horsepower. The preliminary development will provide more power for the Associated Company's own operations, Crown Reserve, Argonaut and other possible users in the eastern end of the Kirkland Lake field. The company has had several requests for power from small developers. It has also been asked to consider transmitting power, from its Raven Falls plant, to new gold properties in Quebec.

OXIDIZED KEROSENES AS FUELS

The solution of still another industrial problem has been undertaken at the research laboratories of Carnegie Institute of Technology, Pittsburgh, in experiments to determine the relative efficiency of kerosenes and oxidized kerosenes as fuels.

In accordance with the policy of the Institute to link up its educational facilities with modern industry, the department of chemical engineering has been conducting a series of tests to determine the relative merits of various oils as usable fuels. The completion of this important work should go a long way toward solving the problem of oil conservation, by the possible development of a new fuel.

According to a report by Dr. J. H. James, head of the department conducting the experiments, oxidized kerosenes cause less "knocking" tendencies than straight kerosene when used in a kerosene engine. The tests also showed that oxidized kerosenes have approximately the same power development as ordinary kerosene, in spite of the fact that their thermal value is one-eighth less. Dr. James attributes the efficiency of the oxidized kerosenes to the better "clean up" in the combustion of these partially oxidized fuels.

The success of the experimental work at Carnegie at this stage gives promise that oxidized kerosene, which is manufactured by catalytic oxidation from low grade petroleum, may become a useful fuel in the future. Its properties may cause it to be used industrially in kerosene engines or blended with gasoline for use in gasoline engines. Although it has a somewhat lower fuel value than ordinary kerosene, one of the most favorable features of its effectiveness is that it undergoes much better combustion in the internal combustion engine.

The town of Kincardine, Ont., will install an auxiliary gasoline waterworks pump to cost $7,000. J. H. Scougall is clerk.

THE WEAR OF STEELS

Several tests have been conducted to determine the resistance to wear of hardened and tempered chromium steels. It was noticed that while the so-called standard hardened specimen, which was run on the upper shaft of the testing apparatus, invariably had a polished surface at the conclusion of every test, the bottom specimen, especially the tempered specimens, presented a dull appearance which was presumed to be caused by abraded particles sticking to the specimen. It seemed, therefore, that specimens with this dull mottled appearance would show a loss of weight less than the actual loss. To prove this several tests were made of Ketos steel running the standard hardened specimen on the lower shaft and the tempered specimen on the upper shaft. The curve of rate of wear versus tempering temperature obtained was similar to the previous curve but showed a greater rate of wear. The tempered specimens under the last-named conditions were free from abraded material at the end of the tests. Efforts will be made to prevent the adherence of the abraded metal particles to the specimen.

It is reported that the Back River Power Co., Riviere Des Prairies, Que., is having plans prepared for power development to cost $7,000,000.

Construction has been started on the foundation for the Belleview Pumping Station, Brantford, Ont., and bids for equipment will be received by F. Adams, engineer, March 1.

F. I. Fox, manager Ford Motor Co., of Canada, Toronto, is receiving tenders for the erection of a plant on Danforth Avenue, Toronto, between Luttrell and Victoria Park Avenues, at a cost approximately $1,500,000. The plant will cover an area of 15½ acres and is expected to be completed and in operation by next summer.

Bearing Metal
plus Service

Ordinary bearing metals may look quite similar to Magnolia Metal, weigh the same, and cost even a trifle less. But when you buy Magnolia Metal, you get the assurance of long and efficient service as well as just so much metal. U.S. and other government tests have proven Magnolia Metal to have the lowest frictional coefficient of any known bearing metal and to have every other requirement for its purpose besides. Magnolia Metal melts and pours well, is easily peened and scraped in, and is always uniform in composition. It is perfectly adapted to a wide range of speeds and pressures, quickly adapts itself to inequalities in the shaft and embeds the grit that might score the shaft or increase friction. Try Magnolia Metal on one of your bearings and test its superiority to your own satisfaction. 19

Magnolia Metal Company
113 Bank Street, New York

Chicago	San Francisco	Montreal
Fisher Building	Pacific Building	37 Shannon St.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK

This Booklet is FREE

Less Work — More Wear

THIS plastic furnace lining, in unbaked form, is pounded into place by anyone who can use a mallet. When vitrified, it forms a jointless, air-tight, gas-tight lining that resists temperatures to 3,100 deg. F. and that outlasts ordinary fire brick two to four times.

Plibrico is delivered only in steel containers of distinctive appearance as shown below. Warehouse stocks in principal cities. Write to the Jointless Fire Brick Co., 1142 Clay Street, for your copy of the free fifty-page booklet shown above.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B. C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's Ltd., Calgary, Alta.

JOINTLESS
FIRE BRICK CO.

We make quality indicating and recording thermometers, pressure, liquid level, vacuum, and draft gauges, automatic temperature controllers, CO2 recorders, especially for Power Plants. Write for Bulletin CF-115.

The Foxboro Co., Inc., Foxboro, Mass., U.S.A.

FOXBORO
TRADE MARK
118-112

INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE

OF POWER HOUSE

MONCRIEFF'S "UNIFIC" WATER GAUGE **GLASSES**

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary, glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

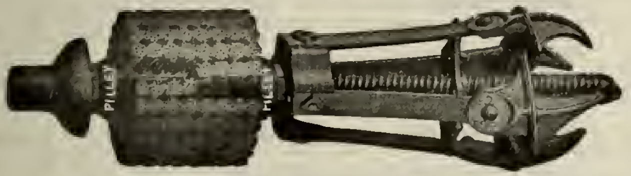
Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

A Striking Message

A STRIKING message to manufacturers of power-house equipment is derived from a letter written by a "Power House" reader in reply to a request for a criticism of the paper and for suggestions as to how it could be improved. Here is the letter:

"I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. This is a mistake on their part, but for all I know to the contrary it may be due to the lack of energy on the part of the Power House ad. manager in getting after them. It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages so much as on the ADVERTISEMENT PAGES."

HINTS TO BUYERS



The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send O

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street.-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

"Pop Off" Steam
Carries Ashes Away

"Into the hole and away they go" describes ash removal with a Green Steam Jet System. At the Kewanee Boiler Co., they use "Pop off" waste steam to do the work.
Write to Dept. X for descriptive literature.

GREEN ENGINEERING COMPANY
175 Kennedy Avenue
EAST CHICAGO INDIANA

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T.J. CUNERTY** Company
Room 240 17, Queen St, East Toronto

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE
MEANS ECONOMY

Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd
Sun Life Building, Hamilton, Ont.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we willtell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

AMMONIA PLANT EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
Under-feed Stoker Co. of Canada, Ltd. Toronto.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn,
Jamieson Cold Storage Door Co., Hagerstown, Md.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co.,: Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd., Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. McLaren Limited, Montreal, Que.

BELT HOOKS
Bristol Co., The, Waterbury, Conn.
D. K. McLaren, Limited, Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, FABRIC
D. K. McLaren Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. McLaren, Limited, Montreal, Que.

BELTING, SOLID WOVEN
D. K. McLaren, Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

CORD CLOTHING
D. K. McLaren Limited, Montreal Que.

CHAIN WHEELS
The Mason Regulator & Eng, Co., Ltd., Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Suply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co. Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co, Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont,

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren, Limited, Montreal, Que

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H, Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

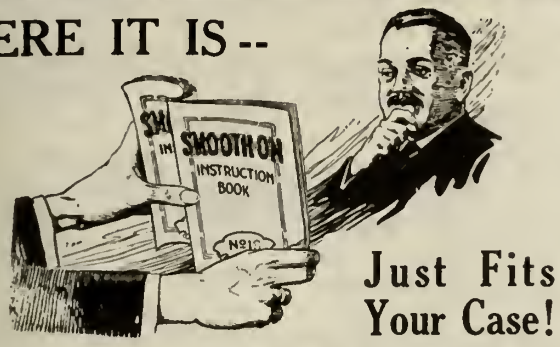
CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

SMOOTH-ON IRON CEMENTS

HERE IT IS--



Just Fits Your Case!

Many engineers have learned from experience not to say, "That will have to come down for repairs," until after they have tried Smooth-On Cements. For Smooth-On saves dismantling in a large proportion of cases.

SMOOTH-ON
Instruction Book No. 19

just off the press, contains 144 pages of engineering information and shows many instances of how time and money were saved by engineers through the use of Smooth-On Cements for making power plant repairs. This book shows you "how it is done"—quickly and economically—without dismantling machinery or pipe lines. Write today for your copy—IT'S FREE.

Smooth-On Cements are sold in 5-lb., 10-lb., and 25-lb., tins; also in larger sizes.

THE CANADIAN ASBESTOS CO.,
Dept. 52-B, 36-48 Youville Sq., Montreal, Que.
If your supply house cannot supply you, write us direct.

This ANDERSON Steam Trap

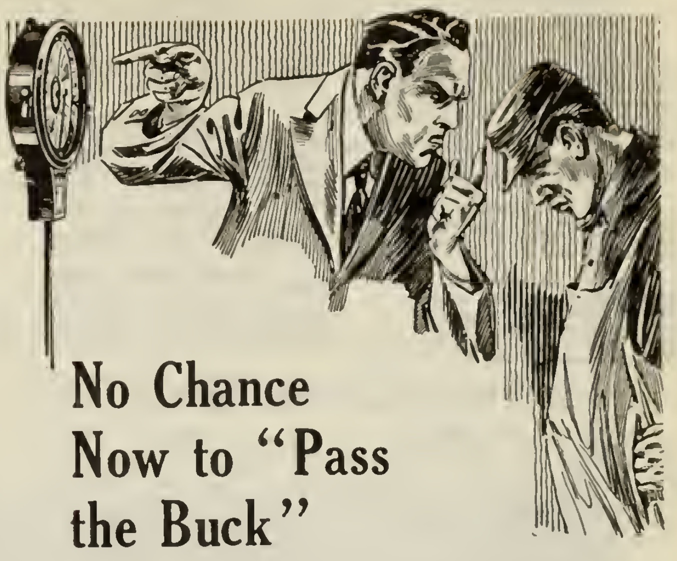
Positively
Prevents
Wasted
Steam

Use it on any Line

Wherever there is condensation the Anderson Model "D" Trap will give you economical service. Because it absolutely prevents loss of steam some odd thousands of users are "strong" for this trap. It is the most effective trap because it automatically adjusts itself to any pressure within its capacity. Valves are built of wear-proof, rust-resisting materials. Equipped with a removable strainer which prevents scale, packing, etc., from entering the valve.

Write for Catalogue

THE V. D. ANDERSON CO.
1935 West 96th St., Cleveland, Ohio.



No Chance Now to "Pass the Buck"

You can now place the blame on the exact man who makes the mistake when goods are ruined or other damage occurs as a result of not maintaining correct temperature. For, by installing a Columbia Recording Thermometer with the new **Time Punch** attachment, you have an automatic watchman that not only unerringly points out any carelessness or neglect, but also **pins down the responsibility and leaves no loophole for alibis or excuses.**

The chart gives a continuous day-and-night record of the temperature itself. But that alone isn't enough—you also want to know whether the temperature has been regularly inspected and undue variations promptly and properly corrected. And this the Time Punch attachment tells you when you use

Columbia Recording Thermometers
With Time Punch

The operator simply pushes a button when making each inspection, and the exact time of the inspection is immediately recorded on the edge of the dial, while the temperature chart shows the temperature at that particular minute. Thus, you get the whole story in an indisputable form.

If the operator fails to make an inspection at proper intervals, then the failure is shown by a blank.

Columbia Recording Thermometers (also Recording Gauges and Tachometers) with the new Time Punch attachment cost no more than an ordinary recorder alone—you get an extra check on temperature control at no extra cost. And it's a check that works both ways — the conscientious operator will take pride in having the record of his faithfulness always in evidence, while the careless or lazy operator will immediately brace up and try to avoid a bad record.

Catalog H-33 gives full information.

A copy free on request.

The Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO. DIVISION
Brooklyn, N.Y.
Canadian Agency
THE CANADIAN FAIRBANKS-MORSE CO., LTD.
Montreal Toronto

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Wateroue Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal,

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Northern Crane Works, Walkerville, Ont.
Wateroue Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CARBONIC ACID GAS
Laurie & Lamb, Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro. Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Worke Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLINGS
Can. Fairbanks-Moree Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Worke, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal,
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb. Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injetor Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd,, Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can, Link-Belt Co., Toronto, Ont.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal,
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR DRIVES
Sterling Engine Co., Buffalo, N. Y.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N. Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER HEATERS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., Erie, Pa.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.

FILTERS, WATER
Frick Co., Waynesboro, Franklin Co., Pa.
Graver Corp., East Chicago, Ind.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane, Limited, Montreal.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N. Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FUEL ECONOMY DEVICES
The Boiler Repair and Grate Bar Co., Toronto, Ont.

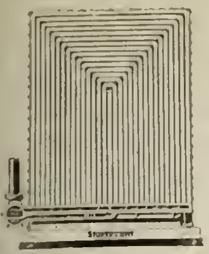
FURNACES
Under-feed Stoker Co. of Canada, Ltd., Torento.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome, N, Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Johns-Pratt Co., The, Hartford, Conn.



Sturtevant fuel economizers are cutting the fuel bills in hundreds of paper mills from 10 to 20%. Ask for folder 607 and invite Sturtevant engineers to solve your operating problems.

B. F. Sturtevant Co.
of Canada, Ltd.
Montreal Galt Toronto

Sturtevant
PUTS AIR TO WORK

Read "Power House"
for
Articles of Merit on
Refrigeration, Equipment
and Management

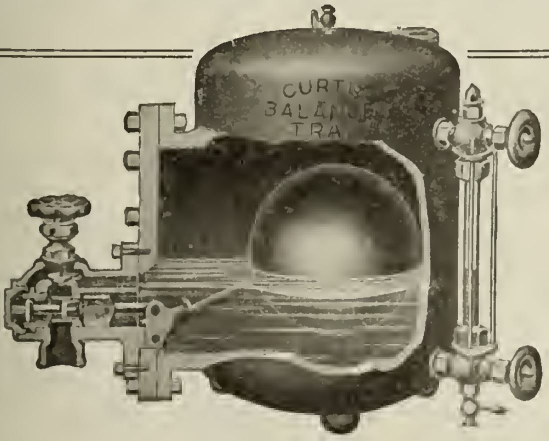
De Laval Oil Purifiers

are maintaining the efficiency of lubricating oil and the dielectric strength of transformer oil in power plants—large and small—throughout the United States and Canada. They effect instantaneous removal of water and sludge from used oil by means of centrifugal force. They occupy small space and require but little attention.

Write for Bulletin No. 105, which gives detailed information.

The De Laval Company, Ltd.
Peterborough - Ontario
Montreal Winnipeg Edmonton Vancouver

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

Write for our No. 50 Catalog of Curtis Engineering Specialties.
Sole Distributors: DARLING BROTHERS, Montreal, P. Q.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.

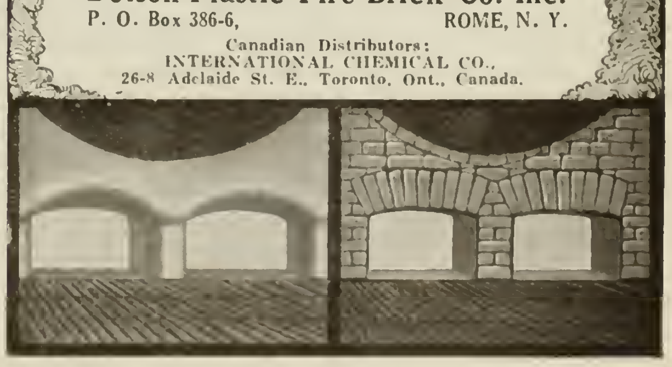
BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

ELIMINATE LOOSE BRICK
and FALLEN ARCHES

by using BETSON PLASTIC FIRE BRICK for repairs and for building complete, seamless, monolithic furnace linings, including front and rear arches, side walls, bridge walls and baffles.
No more fallen arches—no more in-leakage of cold air. But more power with less expense.
Shipped either mixed ready for use or dry to mix with water (the cost is the same) from warehouse stock in principal cities.

Write for valuable booklet.

Betson Plastic Fire Brick Co. Inc.
P. O. Box 386-6, ROME, N. Y.
Canadian Distributors:
INTERNATIONAL CHEMICAL CO.,
26-8 Adelaide St. E., Toronto, Ont., Canada.



GAS ANALYSIS INSTRUMENTS, ETC.
Penherthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HAND-HOLE
Canadian Rayhestos Co., Ltd., Peterhorough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Peldam Aahestoa (Canada) Co., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durahla Mfg. Co., New York, N. Y.
Frick Co., Wayneshoro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.

GASKETS, LEAD, COPPER AND SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar, Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairhanks-Morse Co., Ltd., Montreal.
Laurie & Lamh, Montreal.

GAUGE COCKS
Can. Fairhanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penherthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penherthy Injector Co., Windsor, Ont.

HANGES, GAUGES, AMMONIA, OIL, GAS, AIR
Schaffer & Bundenhurg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.

GAUGES, DRAFT
Bristol Co., The. Waterhury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Bristol Co., The, Waterbury, Conn.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Div-Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock &, Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penherthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morae Co., Ltd., Montreal

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal
Canadian Steam Boiler & Equipment Co., Toronto.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E. London, Ont.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRATE BARS, FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.
The Boiler Repair and Grate Bar Co., Toronto, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamh, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Can. Fairhanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Galt.
Laurie & Lamh, Montreal.
B. F. Sturtevant Co., Boston, Masa.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicago, Ind.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Bahcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Ruhher Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Ruhher, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairhanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Graver Corp., East Chicago, Ind.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Wayneshoro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Wayneshoro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairhanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INDICATING THERMOMETER, SARCO
Sarco Co., Inc,, New York.

INJECTORS
Bahcock & Wilcox, Ltd., Montreal.
Jaa. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Bristol Company, The, Waterbury, Conn.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LACE LEATHERS
Can. Johns-Manville Co., Ltd., Toronto.
D. K. MacLaren Ld., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairhanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LINK BELTING
Can. Link-Belt Co., Toronto. Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penherthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
Penherthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penherthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penherthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mo.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MARINE CASTINGS
Muelier Mfg., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Montreal.

MECHANICAL STOKERS
Bahcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

METERS, F.M.
Canadian General Electric Co., Toronto.
The Bailey Meter Co., Cleveland, Ohio.
Can. Johns-Manville Co., Toronto.

MILL AND MINING MACHINERY
Can. Fairhanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairhanks-Morse Co., Ltd., Montreal.
Gelinas & Peunock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penherthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penherthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co,, Ltd., The, Montreal.
Bahcock & Wilcox, Ltd., Montreal.
Can. Fairhanks-Morse Co., Ltd., Montreal
Direct Separator Co., Syracuse, N. Y.
Jaa. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.

OILING SYSTEMS
Lunkenheimer Co., Cincinnati, Ohio.

PACKING, AMMONIA, STEAM AND WATER
Beldam Ashestos Canada Co., Toronto.
Beveridge Suppy Co., Montrea.l
Canadian Rayhestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexihle Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Ruhher Co., Limited.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC
Canadian Rayhestoa Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexihle Metallic Packing Co., Windsor, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexihle Metallic Packing Co., Windsor, Ont.

PACKING, H. P. ROD
Canadian Rayhestos Co., Ltd,, Peterhorough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Rayhestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont.

PENSTOCKS
W. M. B. Scarfe & Sons, Pittsburgh, Pa.

PIPE COILS
Frick Co., Wayneshoro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tuhes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
The Superheater Co., Limited, Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tuhes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE STEEL
Page-Hersey Tuhes, Ltd., Toronto, Ont.

PIPES, WATER
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane'a Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Wayneshoro, Fraoklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Bahcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co.. Cincinnati. Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairhanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Wateroua Engine Works Co., Brantford.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W

VICTORIA FOUNDRY COMPANY LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations
Write for our latest catalogue
Patterns Machine Work

When Answering Advertisements Mention
POWER HOUSE

FOR SALE

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas. McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

SITUATION VACANT

SALESMAN WANTED FOR STEAM SPECIALTIES, power house and heating equipment; State age, education received, and previous experience if any. Box 101, Power House.

FOR SALE
Fuel Oil Storage Tank
10,000 GALS. CAPACITY
This is a new tank. We have not yet taken delivery of it, and offer it at a very attractive price.
MR. VOGAN, The MacLean Publishing Co., Ltd, 143 University Ave., TORONTO.

"Power House" Guide To Buyers
PAGES 46 - 54

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES
4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE
These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator--Lubrication--PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught--HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers--Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

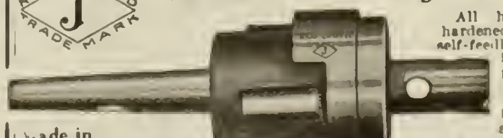
Signature ______
Occupation ______
Employed by ______
Residence ______
Reference ______

THE VENTURI METER
Measures hot and cold water, sewage, brine, chemical solutions, oil, gas, air and steam. Bulletin on request.
BUILDERS IRON FOUNDRY, PROVIDENCE, R.I.
Canadian Representatives: General Supply Co. of Canada, Ltd., Ottawa, Montreal, Winnipeg, Vancouver: Allen General Supplies, Ltd., Toronto, Ont.

NORTHERN

CRANES
NORTHERN CRANE WORKS, LTD
Walkerville, Ont.

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING
Oil Burning Systems Installed
Full line of Power Plant Equipment and Supplies.
LAURIE ENGINE CO.
The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL.

Jardine's Self-feeding Tube Expanders
REGISTERED J TRADE MARK

All have properly case hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander
Made in Canada
A. B. Jardine & Co., Ltd
Hespeler, Ont.

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Pratt & Cady, Hartford, Conn.
Smart-Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, GAS
Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co., (Inc., Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

OIL PUMPS FOR FUEL OIL BURNING SYSTEMS.
Albany Pump Co., Toronto, Ont.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMP TANK, RECEIVER
American Steam Pump Co., Batle Creek.
The John H. McGowan & Co., Cincinnati Ohio.
Smart-Turner Machine Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Bristol Co., The, Waterbury, Conn.
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Tayor Instrument Co., Toronto, Ont.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamieson Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co, of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester Mass.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.

Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch, Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox. Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOIST
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM ENGINES
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM JETS
Green Engineering Co., East Chicago, Ind

STEAM SPECIALTIES
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
The Reliance Gauge Column Co., Cleveland, Ohio.
Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM CALORIMETERS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Divisio Brooklyn, N.Y.
Division, Brooklyn, N. Y.
Sarco Co., Inc., New York.

STEAM TRAPS
American Steam Gauge and Valve Co Division, Brooklyn, N. Y.
Julian D'Este Co., Boston 14, Mass.
Sarco Co., New York, N. Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa

STEEL DRUMS
Smart-Turner Machine Co., Hamilton
Scaife & Sons, Co., Wm., Pittsburgh, Pa

STEEL, CONTRACTORS' STRUCTURA
Can. Fairbanks-Morse Co., Ltd., Montrea

STOKERS
Canadian Planet Engineering Co., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd., Montreal.
Green Engineering Co., East Chicago, Ind
Underfeed Stoker Co., of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
Sturtevant, Co., B. F., Toronto and Boston

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co, Pittsburg, Pa

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

What Kind of Reading Matter Do You Like Best?

Henry Ford with one of his favorite business newspapers. He considers it part of his business to read them and moreover finds pleasure in doing so.—By courtesy of the North American Newspaper Alliance, New York.

An entertaining story of Henry Ford and of his personality has lately appeared in serial form in daily papers throughout Canada, the United States and Great Britain from the pen of the Rev. F. F. Marquis, D.D., a former pastor of Mr. Ford's. This has been generally regarded as the most intimate sketch of him and his habits that has appeared.

In one of the chapters the question of what Mr. Ford reads is discussed. He is, we are told, not an extensive reader, but there is one type of literature which he on no account neglects to read and that is his trade newspapers. In the illustration above we see him with one of his favorite business newspapers.

This is typical of the average business man of to-day—the man whose attention you are anxious to secure by your advertisements. Whatever else he may or may not read, he will not miss the paper which gives him all the news concerning his own business.

You can send your message to the leading business men in Canada by means of the following MacLean publications, all of which are members of the Audit Bureau of Circulations, the hall-mark of Quality Circulation. Information regarding rates, and fields covered, will be furnished on application to

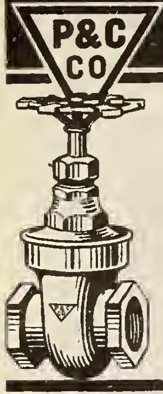
The MacLean Publishing Company, Limited

153 University Ave., Toronto

PUBLISHERS OF:-

- Canadian Grocer
- Hardware & Metal
- Druggists' Weekly
- Dry Goods Review
- Men's Wear Review
- Printer & Publisher
- Bookseller & Stationer
- Canadian Machinery
- Power House
- Sanitary Engineer
- Canadian Foundryman
- Canadian Shipping
- Canadian Automotive Trade
- Financial Post
- MacLean's Magazine

PRATT & CADY VALVES



Pratt & Cady Bronze and Iron Valves are made for all purposes and pressures. They give long and satisfactory service.

Reading Steel Casting Co., Inc.
Pratt & Cady Division
Bridgeport, Conn.
Canadian Representatives:
CANADIAN FAIRBANKS-MORSE CO.,
Montreal.

READING STEEL FITTINGS

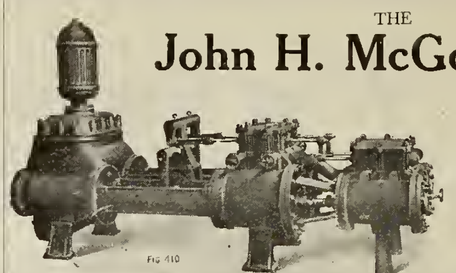
Reading Open Hearth Fittings come in all shapes and sizes—flanged and screwed — for oil, water, gas and steam lines.

Reading Steel Casting Co., Inc.
Reading Valve & Fittings Division
Bridgeport, Conn.
Canadian Representatives:
CANADIAN FAIRBANKS-MORSE CO.,
Montreal

THE
John H. McGowan Co.

Builders of Pumping Machinery

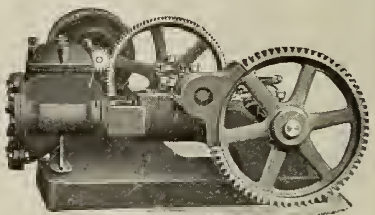
Cincinnati Ohio, U.S.A.

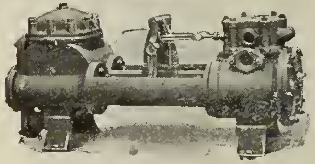


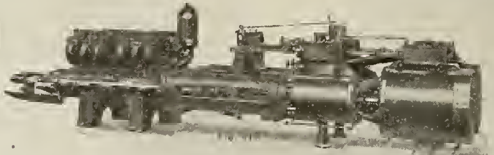
We are frequently in receipt of inquiries calling for pumping machinery built for continuous operation.

All McGowan Pumps are built for continuous operation.

Try a McGowan the next time you purchase.







For All Conditions of Service

SUPERHEATER, STATIONARY
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, LOCOMOTIVE
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STEAM SHOVEL
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N. Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Canadian Johns-Manville Co., Ltd., Toronto.
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co. Brantford.

TANKS, OIL, KEROSENE, GASOLINE
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

TANKS, WATER
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

TACHOMETERS
Bristol Company, The, Waterbury, Conn.

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

THERMOSTATS
Sarco, Inc., New York, N.Y.

TOOLS SMALL
J. H. Williams & Co., Brooklyn, N. Y.

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Sarco Co., Inc., New York, N.Y.
Wason & McDonald Co., Philadelphia
Taylor Instrument Co., Toronto, Ont.

TACHOSCOPES
The Reliance Gauge Column Co., Cleveland Ohio.
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS
Canadian Sirocco Co., Ltd., Windsor, Ont.
American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Schaeffer & Budenburg Mfg. Co., and Am-
Sarco Co., Inc., New York, N.Y.

TRAPS, PUMPING
Grant E. Cole Co., Toronto, Ont.

TACHOMETERS
Bristol Company, The, Waterbury Conn.,

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Sturtevant Co., B. F. Toronto and Boston.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal.
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES OF ALL KINDS
Reading Steel Casting Company, Inc.
  Pratt & Cady Division,
    Bridgeport, Conn.
Reading Steel Casting Company, Inc.
  Reading Valve and Fittings Division.
    Bridgeport, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass
Jas. Morrison Brass Mfg. Co., Toronto
H. Mueller Mfg. Co., Limited, Sarnia, Ont
Shell Bar Boico Supply, Ld., Toronto
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.

Tycos
and the
Economizer

Tycos Temperature Instruments Indicating, Recording and Controlling installed on Economizers give accurate records. Economizer efficiency is thereby maintained because it checks the ingoing and outgoing water temperatures.

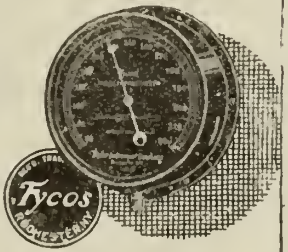
Tycos Index Thermometers bring readings out of dark corners.

No matter what the temperature problem in your power plant *Tycos* Temperature instrument will do the work completely. Request our general industrial catalog.

Tycos
Temperature Instruments
Indicating, Recording
Controlling

Taylor Instrument Companies
ROCHESTER, N.Y.

There is a *Taylor* or *Tycos* Temperature Instrument for Every Purpose.



B CO. LTD.

FIBRICO
JOINTLESS
FURNACE LINING
for
Complete Furnace Linings

Will outlast ordinary
fire brick two to
four times.

JOINTLESS - MONOLITHIC

Beveridge Supply Co., Limited
628-630 St. Paul St. West
Montreal, P.Q.

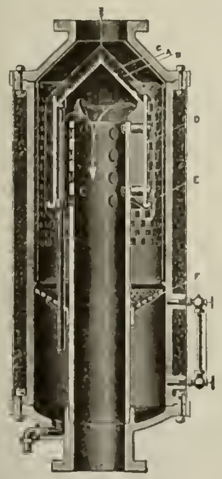
Stocked also in Toronto, Winnipeg, Vancouver.

10,000 Sweet's Separators are serving discriminating steam users around the world.

Half of them sold on repeat orders. This record is backed by authentic tests, copies of which are mailed on application. For live steam mains or exhaust lines made in sizes from 25 pounds in weight to 25,000 pounds.

Read our story before buying.

Sweet's Separators



DIRECT SEPARATOR COMPANY
218 South Geddes St. - Syracuse, N.Y.

General Sales Agents

Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton,
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

A COMPLETE SERVICE IN
"John Crane"
FLEXIBLE METALLIC PACKING

STYLE 100.

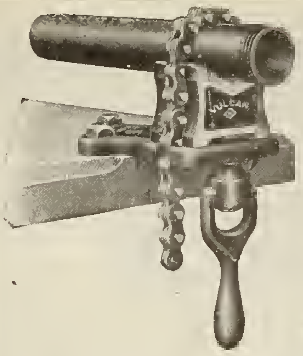
Uses the Principle of the Piston Ring

- Minimizes Friction
- Non-Abrasive
- Use Fluid Seal
- No Disintegration
- Flexible
- Compressible
- Economical
- Long Life
- Convenient.

Send your name for this book.

"Metallic Packing" (now in its third printing) is the most thorough piece of modern literature on the subject of packing. It is interesting and constructive - "food for thought" on lowering maintenance and labor costs and reducing annoyance of leaky packings. Let us send it to you free.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS PACKING & GENERAL MFG. CO., LTD.
Toronto and Montreal.
H. E. CARMAN. 334 Cordova St., Vancouver, B. C
"MADE IN CANADA"



Williams' "Vulcan" Chain Pipe Vise

UNBREAKABLE, compact, rapid in action and positive in gripping pipe. Attachable anywhere—any handy bench, post or other support will serve.

Made entirely of wrought steel; the drop-forged jaws are saw-tempered for file sharpening and the hand-made chains are of the same superior quality as those of our well-known "Vulcan" Chain Pipe Wrenches.

Vises in 3 sizes for ⅛ to 8-inch pipe. Booklet on request.

J. H. WILLIAMS & CO., Limited
"The Drop-Forging People"
78 Thorold Road - St. Catharines, Ont.

REPAIRS

NOW is the ideal time to have your pumps and general machine equipment put into first-class shape to stand up to the strain of increased business during the coming months.

Our corps of experts with every facility at their command can perform this work at an unusually reasonable figure.

John T. Hepburn, Ltd.

Engineers and Iron Founders

18-40 Van Horne St. Toronto, Ont.

Index to Advertisers

A
Albany Pump Co. 47
American Steam Gauge & Valve Mfg. Co. 47
American Steam Pump Co...... 12
Anderson Co., V. D. 47
Armstrong Cork and Insulation Co., Ltd. 11
Audel Co., Theo 51

B
Babcock & Wilcox 39
Bailey Meter Co. 6
Betson Plastic Fire Brick Co... 49
Beveridge Supply Co............ 55
The Bristol Co. 13
Builders Iron Foundry 51
Buyers' Directory....48, 50, 52, 54

C
Canada Cement Co., Ltd.....Front Cover
Can. Fairbanks-Morse Co....... 38
Canadian Sirocco Co., Ltd.,.... 19
Canadian Ingersoll-Rand Co.... 15
Can. Johns-Manville Co........ 41
Classified Adv. Section 51
Cole Co., Grant E............. 12
Counerty, T. J. 45
Crane Packing Co. 55
Crane, Ltd. 14

D
DeLaval Steam Turbine Co..... 2
DeLaval Co., Ltd., The......... 49
Dart Union Co. 4
D'Este Co., Julian 49
Diamond Specialty Ltd. 17
Direct Separator Co. 55
Durabla Mfg. Co. 2

E
Elk Fire Brick Co. 45
Engineering & Machine Works of Canada 7

F
Foxboro Co. 44
Frick Company 11
Flexible Metallic Packing Co. .. 55

G
Garlock Packing Co.........Inside Back Cover
Garth Co,. The 45
Goldie & McCulloch Co. 20
Greene, Tweed & Co. ......Inside Front Cover
Green Engineering Co. 45
Gutta Percha & Rubber, Ltd.... 3

H
Hints to Buyers 45
Hepburn, John T. Co. 56

J
Jamieson Cold Storage Door Co. 12
Jardine, A. B. 51
Jenkins Bros. 8
Jointless Firebrick Co. 44

K
Kerr Engine Co. 6

L
Laurie Engine Co. 51
Laurie & Lamb 17
Linde Can. Refrig. Co......... 10
Lunkenheimer Co. 5

M
McLaren, D. K. Co. 9
McGowan, Co., John H......... 54
Magnolia Metal Co. 44
Moncrieff Ltd., John 44
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Mueller Mfg. Co. 18

N
Northern Crane Works 51

P
Pilley Packing & Flue Brush Mfg. Co. 45
Pratt & Cady Co. 54

R
Reading Steel Casting Co...... 54
Refrigeration Dept. 10
Reliance Gauge Column Co., The —

S
Schaeffer & Budenberg Mfg. Company 47
Smart Turner Machine Co. ... 45
Smooth-On Mfg. Co. 47
Superheater Co. 56
Sturtevant & Co., Ltd., B. F.. 49
Steel Mill Packing Co. 43

T
Taylor Instrument Co.......... 55

U
Underfeed Stoker Co., of Canada, The..... 16

V
Victoria Foundry Co. 51
Vilter Mfg. Co. 10

W
Wall, W. J. 44
Waterous Engine Works Co.... 1
Watson, M. Barry 51
Watson & McDaniel Co. 45
William & Co., Ltd., J. H...... 56

Y
Yarnall-Waring Co. 4
York Mfg. Co. 13

SUPERHEATERS
ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS
OF ELESCO STEAM SUPERHEATERS AND
PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR
LOCOMOTIVE SERVICE; BOILER FEED PUMPS
FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

WESTERN REPRESENTATIVES:
THE TAYLOR ENGINEERING CO., LTD.,
VANCOUVER, B.C.

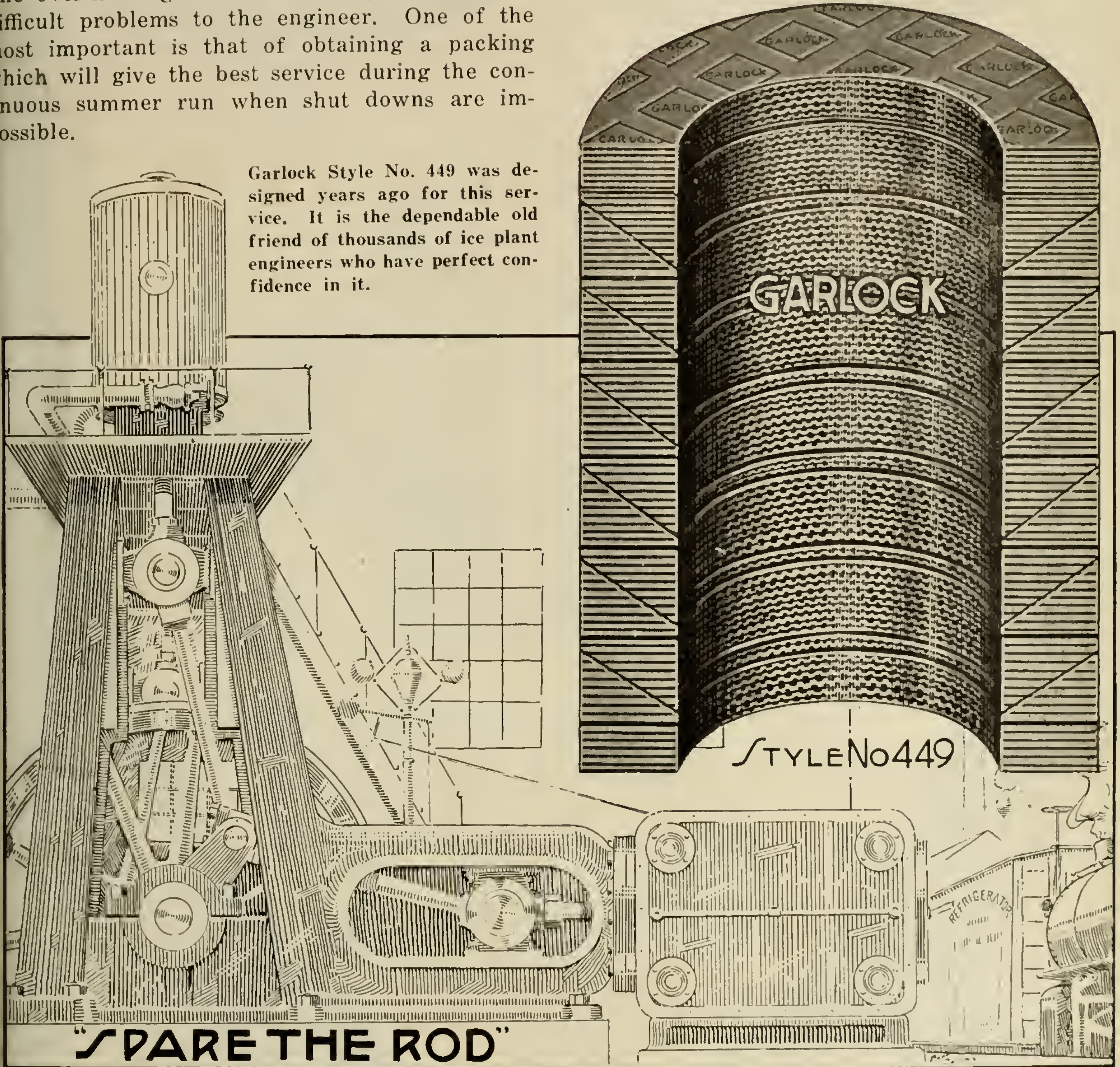
THE SUPERHEATER CO., LIMITED.
Transportation Bldg., Montreal

MADE IN CANADA
WORKS AT SHERBROOKE, QUE

CONSERVING AMMONIA

The over-hauling of ice machinery brings many difficult problems to the engineer. One of the most important is that of obtaining a packing which will give the best service during the continuous summer run when shut downs are impossible.

Garlock Style No. 449 was designed years ago for this service. It is the dependable old friend of thousands of ice plant engineers who have perfect confidence in it.



GARLOCK PACKINGS

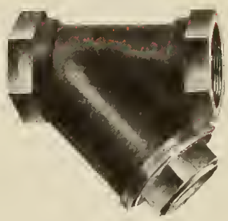
THE GARLOCK PACKING COMPANY
HAMILTON, ONTARIO

BRANCHES:

Montreal, Que.
Calgary, Alta.
Winnipeg, Man.
Vancouver, B. C.
Toronto, Ont.
St. John, N.B.

MORRISON

Strainers



For Use

on

All Pipe Lines

By preventing sediment, scale, or particles of foreign matter from passing into valves, regulators, cylinders, etc., Morrison Strainers constantly save considerable repair work, loss of time, annoyance and expensive shut-downs.

The construction is such that the flow is not obstructed through the strainer. All particles caught by the screen fall into the large chamber in the cap, out of the way of the flow. By unscrewing the cap all internal parts are removed, the screen can be lifted out of the cage which is cast solid with the cap and all parts easily cleaned and replaced.

Thousands of these strainers are in use, effecting a saving many times the installation.

Our Monthly Bulletin will interest you. Shall we put your name on our mailing list?

The James Morrison Brass Mfg. Company, Limited
93-97 Adelaide Street West, Toronto, Canada

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission and Application of Steam, Gas, Electric Air and Water Power ; the operation of Refrigerating Machinery ; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street, E. C. NEW YORK, BOSTON, CHICAGO.

Vol. XVI—No 4. Publication Office, Toronto—February 20, 1923

Published Semi-Monthly.
Canada, $2; U.S. $2.50 a year

A Time and Labor Saver—

JENKINS RAPID ACTION VALVE

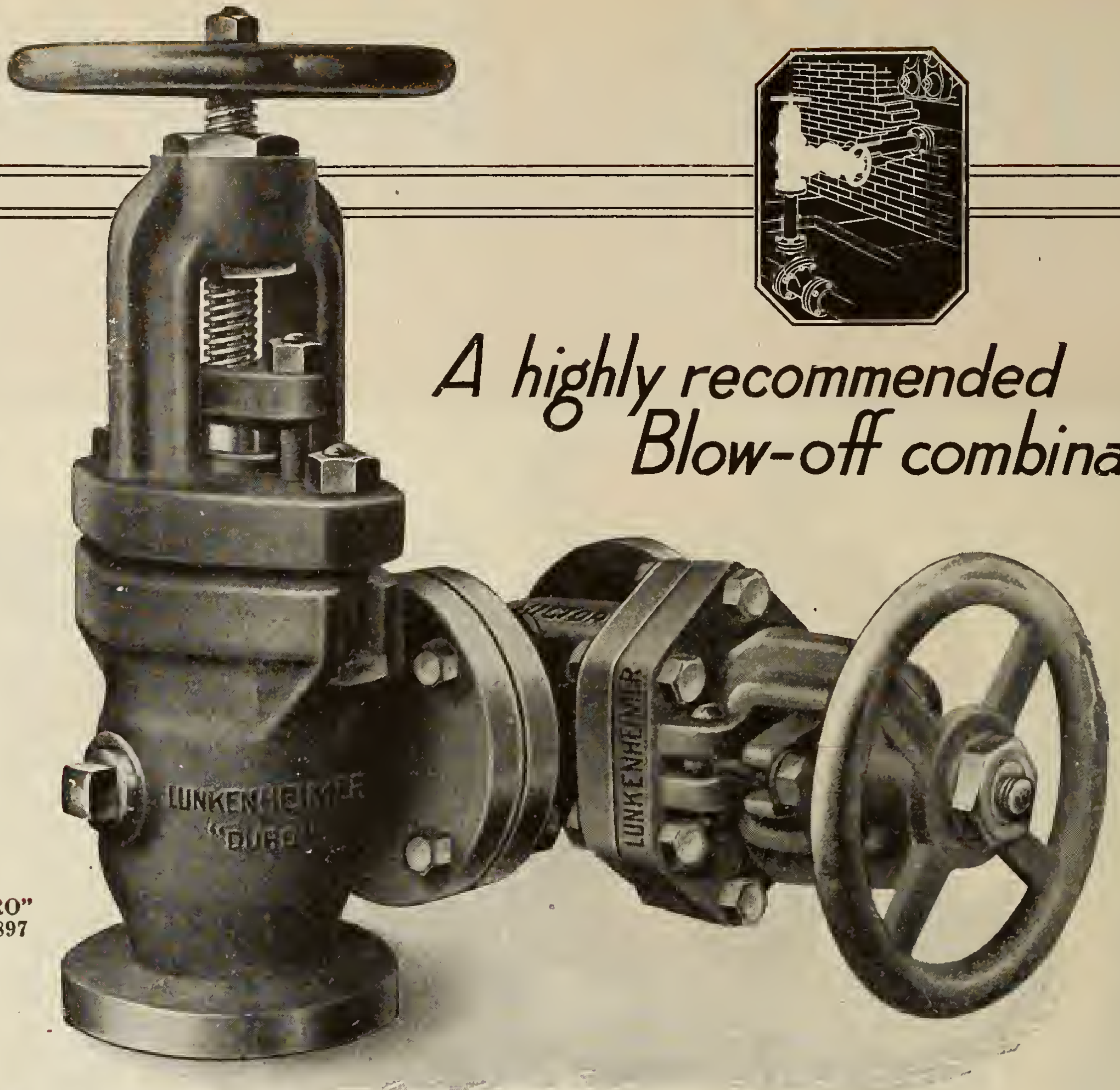
Wherever an easily operated quick opening valve is desired there's a need for a Jenkins Rapid Action valve like that shown here.

This Jenkins model meets the need for a quick action valve that **can be opened instantly without water hammer**. This objectionable feature has been entirely eliminated through skilful designing and workmanship and because every valve is fitted with a Jenkins Renewable Composition Disc suitable for service required.

An ideal valve for Laundries, Creameries, Shower Baths, etc.

Write for full details of this time and labor saver.

JENKINS BROS. LIMITED
103 St. Remi St., Montreal
TORONTO VANCOUVER
European Branch—6 Great Queen St., Kingsway, London, W.C. 2.
England.



A highly recommended Blow-off combination

"DURO"
Fig. 897

"VICTOR"
Fig. 892

LUNKENHEIMER
Blow-off Valves

Remain tight in service, prevent waste through boiler blow-off lines, and thereby turn to a profit the losses caused by leakage, which frequently occurs at this point.

In Lunkenheimer Blow-off Valves the water is released gradually, due to the peculiar construction of the seat and disc. This virtually makes them safety devices, since they eliminate the dangers incident to undue agitation within the boiler or severe shock in the discharge line which result when Blow-off Valves are opened suddenly.

Lunkenheimer design and construction reduces wear to a minimum. When wear does appear the renewal of the parts affected is easily accomplished. The installation of Lunkenheimer Blow-off Valves is the solution of your boiler blow-off problem.

Descriptive literature on request.

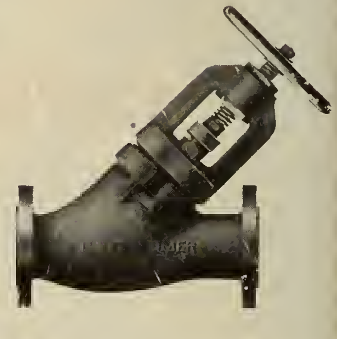


Fig. 1352.
Straightway or
Y Pattern

THE LUNKENHEIMER CO
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

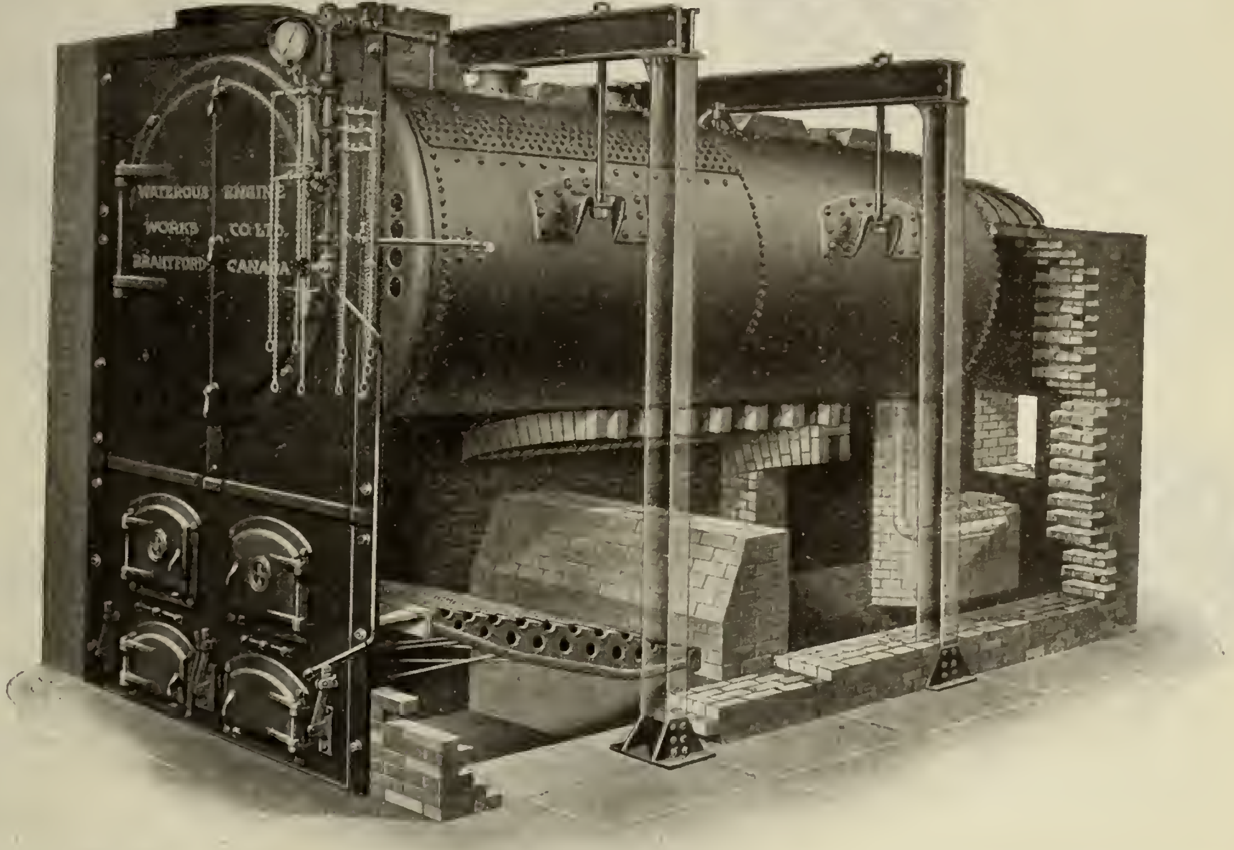
CINCINNATI, U.S.A.
NEW YORK BOSTON
CHICAGO LONDON

1606-24-43

"America's Best since 1862"

Files Stokers

Hand Operated



"Are Giving Absolute Satisfaction"—

S. KANN SONS COMPANY, Washington, D.C.

"In answer to your communication of Aug. 1st in reference to our **Files Stokers,** will state that they are giving **absolute satisfaction.** We have them installed under two 250 H. P. Heine Boilers.

"While we have not made a test of the actual saving in coal, would judge from 10 to 15% as our load increased 25%. We were able to carry steam without difficulty, which we could not do when our boilers were equipped with the down-draft furnaces.

"Our smoke laws in this city are very strict and with one or two exceptions we have always been able to comply with same. With careful firing there should be very little smoke. Our expense for upkeep has been very reasonable.

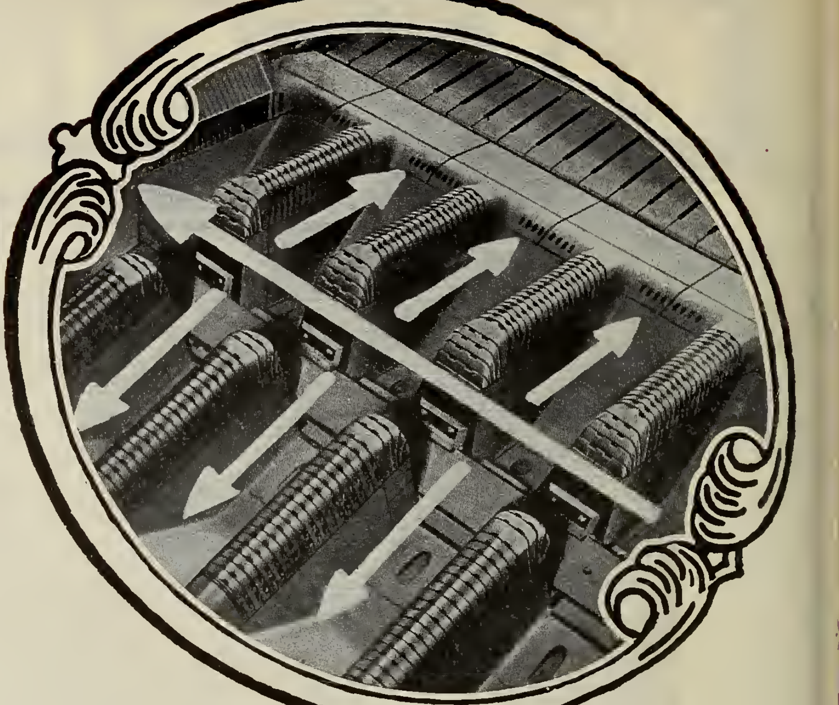
"Hoping this information is what you desire, we remain,

"Yours very truly,

"THE S. KANN SONS COMPANY."

Waterous

BRANTFORD, ONTARIO, CANADA



The arrows in the illustration opposite indicate the path of fuel travel in the *"Lateral Retort"** Stoker.

**"Lateral Retort"* is a trade mark.

Trade Mark

Trade Mark

Discard your old conception of single-retort stoker-firing

HERE is a stoker that has revolutionized single-retort underfeed stoker firing—one that retains the single-retort stokers high efficiency, ease of installation and low maintenance cost and yet one that combines the high capacity of multiple retort stoking.

As shown in the illustration above, the *"Lateral Retort"* Stoker has one main retort. Coal, following the path of the arrows, is underfed to this retort by successive strokes of a steam driven ram; it is then moved—still underfed—through the *"lateral retorts"* which branch off from the main retort. Finally the ash is deposited on the side dump plates from where it is dropped to the ash pits below.

One simple moving unit distributes the coal to the *"lateral retorts."*

The fuel feed to the main retort and to the *"lateral retorts"* is controlled independently; consequently ideal distribution is secured. A trench six to eighteen inches below the floor line is sufficient expansion for ash pits. This reduces the installation cost and makes the stoker adaptable to boilers already in service.

How the *"Lateral Retort"* Stoker brings the advantages of multiple retort stoker firing to plants that would otherwise install an inferior stoker is the story of the new bulletin.

RILEY JONES

The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.

MURPHY

Trade Mark

The Under-Feed Stoker Co. of Canada, Ltd.
146 King St., West, - Toronto

Sales agents for : Jones Stokers, Riley Stokers and Murphy Automatic Furnaces

Alta. & West. Sask.:	Man. & East. Sask.:	British Columbia:	Quebec:
Mr. J. Twomey,	W. W. Hicks & Co.,	E. A. Earle, Ltd.,	The Cleaton Co. (Can.)
Camrose, Alta.	Winnipeg.	Vancouver, B.C.	Ltd., Montreal, Que.

The "Lateral Retort" Stoker

TRADE MARK

GUTTA PERCHA & RUBBER, LIMITED
TRADE **PMS** MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

"Proven"!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO :: CANADA
Sales Offices - - Coast to Coast

The Safe and Certain Boiler Cleanser

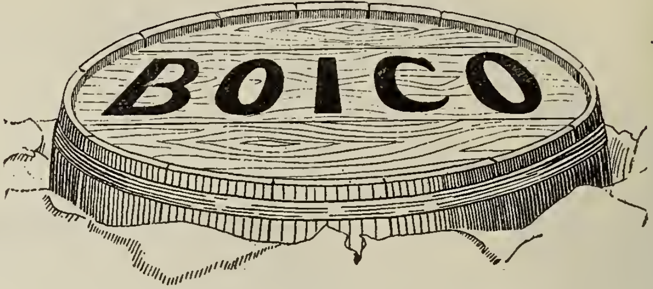
PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., **Toronto**

Sales Agents: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.

DURABLA

TRADE MARK REGISTERED

Strength; Goodness; Quality—these features distinguish durable Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

DURABLA is not affected by vibration or condensation. It will not burn out, blow out or pulp at the points. Let us send you a trial sample. Made in stock sizes 36 in. wide x 144 in. long, and 48 in. wide x 144 in. long, in thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Orders Filled Promptly.

Made in Canada by Canadian Durabla, Limited

and sold on a service basis by

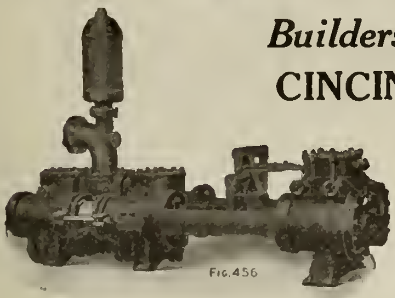
THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

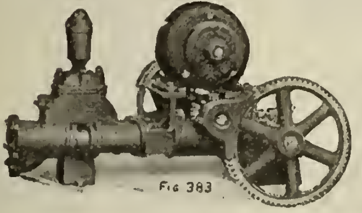
Sales Offices in all leading Canadian cities

DURABLA

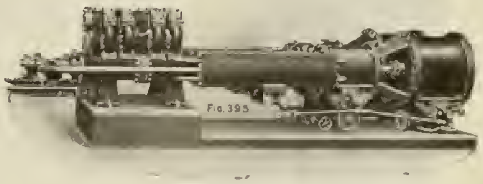
The John H. McGowan Co.

Builders of Pumping Machinery
CINCINNATI, OHIO, U. S. A.

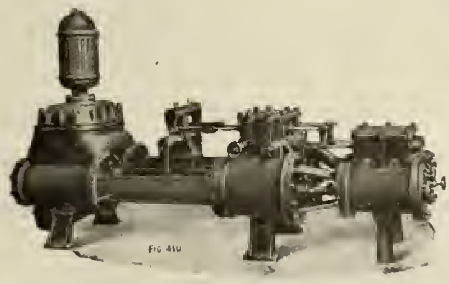




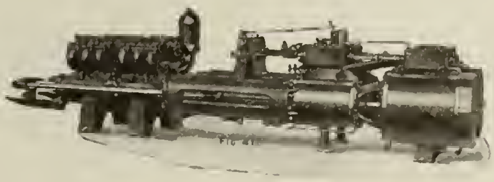
SIMPLE
DUPLEX
STEAM
POWER



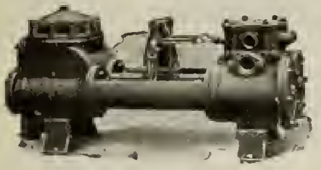
Semi-Corless
Piston Valve



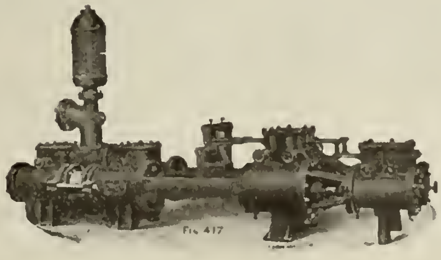
Condensing
Non-Condensing



Compound
Triple
Expansion



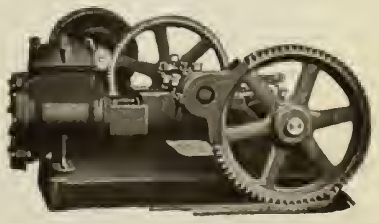
Pressure Patterns
Packed Pistons



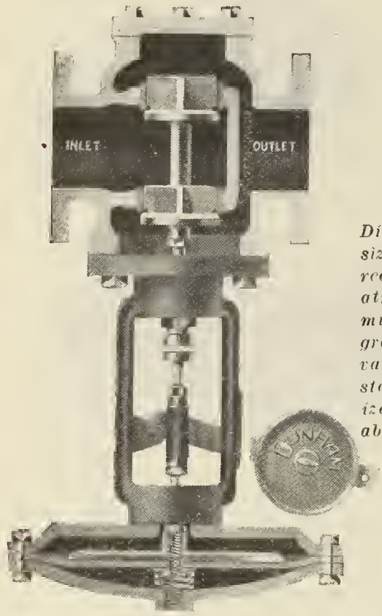
It is possible that the failure of your water service in the plant may bring about a critical condition.

The installation of a McGowan will safeguard you in this respect.

For
All Conditions
of Service



The DUNHAM
REG. TRADE-MARK
HEATING SERVICE
(Made in Canada)
Reducing Pressure Valves
Straight Pattern—Sectional View



Diaphragms of various sizes are furnished for reduced pressures, with atmosphere as minimum. Castings of best grey iron. Seats and valves of non-corrosive steam metal. Standardized and interchangeable parts.

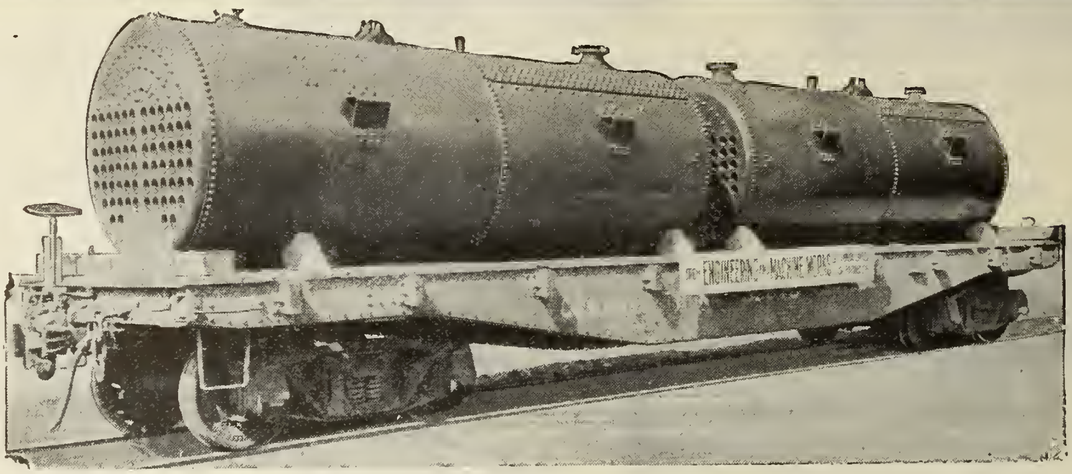
Steam, Water, Air Pressure Control

The Dunham Reducing Pressure Valve automatically reduces steam, water, or air from an initial high pressure to any lower delivery pressure. It affords adjustable control that secures an accurately fixed and noiseless low pressure delivery no matter how much the high pressure side of the valve might vary.

Dunham Reducing Pressure Valves are made in both Straight and Expanded Outlet types. They are scientifically designed and built of the finest selected materials to insure dependable and lasting service.

Complete data on request.

C. A. DUNHAM Co., Ltd.
TORONTO - ONT.
HALIFAX VANCOUVER WINNIPEG OTTAWA MONTREAL
CALGARY
London, Eng., 18 St. Thomas St., S. E. I.
Also manufacturers of a popular line of heating specialties.



Buy new Boilers now—while they are cheap

Second-hand Boilers, like second-hand motor cars, are always a gamble. We can deliver new, up-to-date Boilers, built to Interprovincial Code, at such moderate prices that it doesn't pay to take a chance with used Boilers.

Engineering and Machine Works of Canada, Limited
ST. CATHARINES, ONT.
Eastern Sales Offices :
HALL MACHINERY CO., Sherbrooke, Que., and Birks Bldg., Montreal

ALLIGATOR

TRADE MARK REG. U.S. PAT. OFFICE

STEEL BELT LACING

Why Men Change to ALLIGATOR

Strength comes first in belt lacing. Then follow: durability, ease and speed of application, efficiency in service, range and cost.

Alligator is the Strongest Belt Lacing on Earth—and the most permanent. It is applied with a hammer in an average time of only three minutes.

Mechanically perfect because it binds the long burden bearing belt fibres in equal service. "Every Tooth A Vise." Rocker steel hinge pin endures in any service where the belt will run. The finished joint is flexible, separable and smooth on both sides.

There is a size for every thickness of belting and the price is so reasonable that **its use immediately becomes an economy.**

If you are not using Alligator now, write us for sample and our interesting book "Short Cuts to Power Transmission." A trial of Alligator will be no less convincing than an analysis of its points.

Sold through "Jobber-Dealer" trade channels the world over.

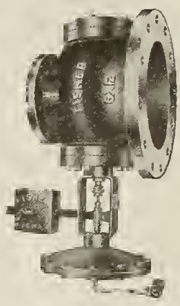
Flexible Steel Lacing Co.

4657 Lexington Street Chicago, Ill.

In England at 135 Finsbury Pavement, London, E. C., 2

"JUST A HAMMER TO APPLY IT"

"Never Lets Go"



Your Two-Fold Duty

Steam should be saved for your employer's sake as well as for your own. For steam is coal and coal is money. When you waste you increase the cost of your work and you will eventually pay for this waste out of your own pocket in the form of higher prices all along the line.

Fisher Reducing Valve

(Type 11-A)

is a reliable aid to steam economy. It is obedient. Adjust it to deliver any desired reduced pressure and it will deliver that pressure—automatically—exactly—with no further attention on your part.

Put it to any test. It's a winner—every time.

Fisher Reducing Valve is carefully built by men long trained in their work. It is a valve that will last for many years with but little attention and repair.

Lever and weight control makes it sensitive to the slightest change in pressure.

These reducing valves are made in a wide variety of outlet and inlet size combinations. We are quite sure to have a valve in stock exactly suited to your purpose.

Write for our book, "POWER PLANT SPECIALTIES." It tells all about the complete Fisher Line.

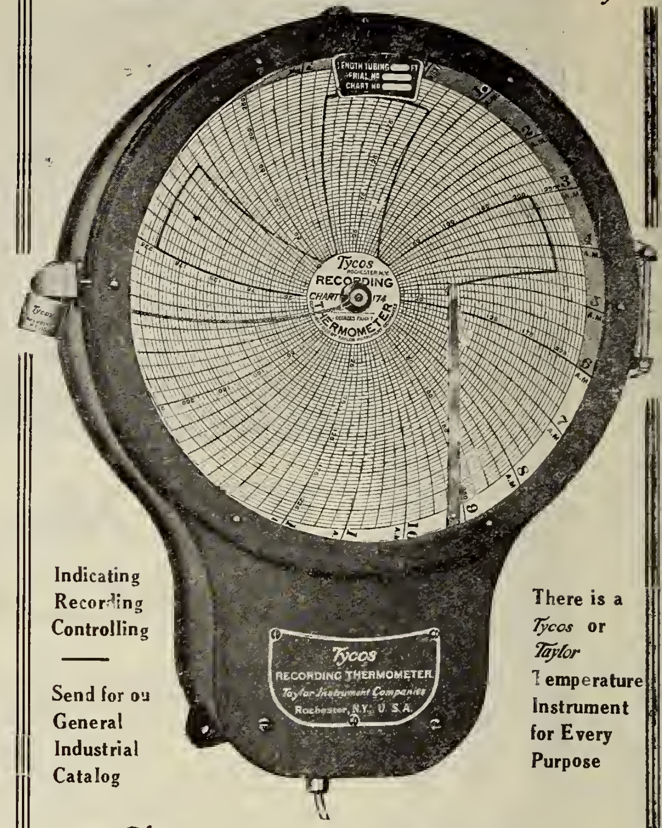
The Fisher Governor Company

943 Fisher Avenue Marshalltown, Iowa

Agencies in all principal cities

FISHER
TRADE MARK
REGISTERED

Tycos *Tycos*



Indicating
Recording
Controlling

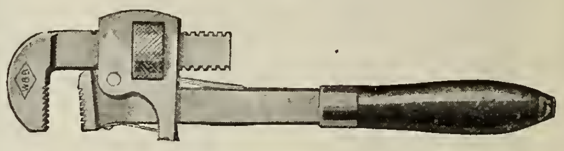
Send for our
General
Industrial
Catalog

There is a
Tycos or
Taylor
Temperature
Instrument
for Every
Purpose

Taylor Instrument Companies

Tycos Building, 110-112 Church St., Toronto, Ont.

W



Williams' Stillson Wrenches

Are sturdy and dependable—well balanced—positive in grip—powerful in action.

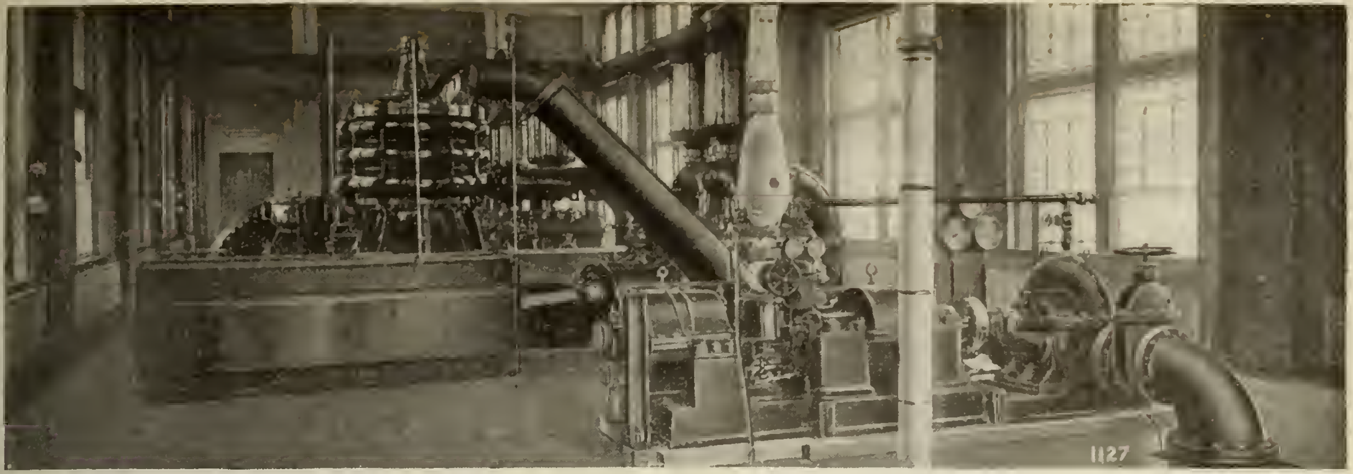
The tough teeth retain their sharpness; they "bite" instantly, yet release readily.

Wood and Steel Handle Patterns—eight sizes, 6 to 48 inches. Ask for booklet.

J. H. WILLIAMS & CO. Limited.

"The Wrench People"

78 Thorold Road, St. Catharines, Ont.



De Laval Steam Turbine for Standby at Peterborough

WATER for the City of Peterborough, Ont., is normally provided by pumps driven by hydraulic turbines, but when the water wheels are fouled by anchor and frazil ice, as frequently happens, a De Laval Geared Steam Turbine Driven Centrifugal Pump insures an uninterrupted supply, delivering 6,000,000 gal. per day against 228 ft. head for domestic service or against 274 ft. head for fire service.. The return tubular boilers are fitted with a mechanical draft fan driven by a gasoline engine, so that the steam plant can be put into service quickly.

If you will state your conditions and requirements, our engineers will supply plans and estimates. Ask for Catalog B-100.

De Laval
Steam Turbine Company

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto
THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

261

MACLEAN STOKERS

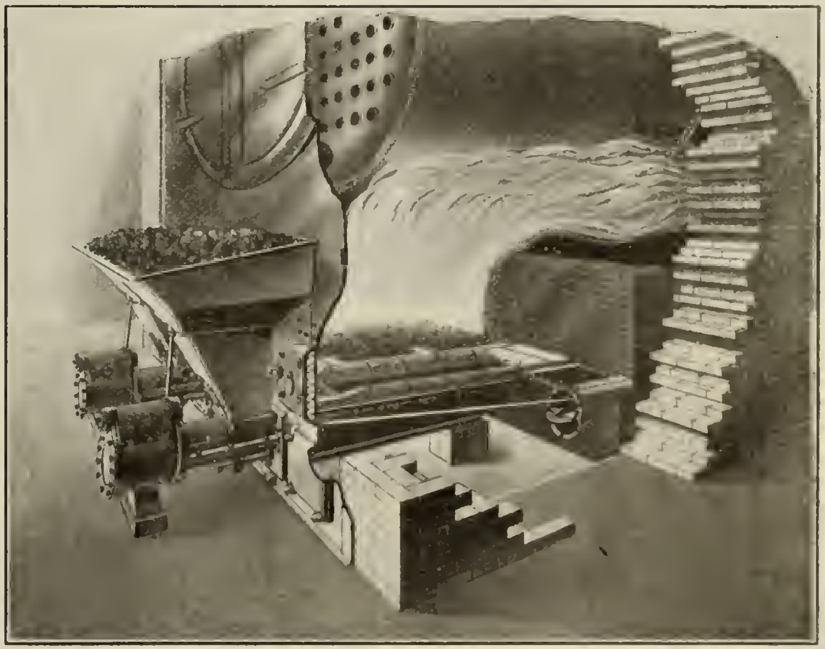
Take Care of Your Biggest Problem

It's impossible to waste coal where **MacLean Underfeed Stokers** are installed because they automatically feed both air and coal in proportions that result in complete combustion of every pound of fuel. In addition they respond instantly to variable demands by the boilers.

They are adaptable to every type of boiler, are easy to install and cost little for upkeep.

Let us estimate what they will save in your plant.

MacLean Underfeed Stoker Co.
Limited
95-97 King Street East,
Toronto - Ontario



The Coal It Saves Soon Pays Its Cost.

Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

MAPLE LEAF BELT DRESSING
CONTAINS NO ACID OR ALKALI
MAKES BELTS WATERPROOF
DOES NOT STRETCH THE BELTS
PREVENTS SLIPPING
SAVES TIME AND TROUBLE
SAVES WEAR AND TEAR
MADE BY
DOMINION BELTING CO.,
HAMILTON, ONT.

The demand for our products has steadily increased because the standard of quality has been maintained.
We make only one grade, the best that can be produced.

MAPLE LEAF

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility

DOMINION BELTING CO., Ltd., Hamilton, Canada - Quebec Branch: 51 Duluth Bldg., Montreal

WROUGHT PIPE BENDS
AND FLANGED PIPE JOINTS
ALL KINDS AND SIZES UP TO 10" DIAMETER
MADE IN CANADA BY
PAGE-HERSEY TUBES, LIMITED
Head Office: 100 CHURCH STREET, TORONTO, ONT.

"The Seal of Satisfaction"

BETTER REFRIGERATION

JAMISON
HAGERSTOWN MD., U.S.A.

To all the varied interests so vitally concerned in "Better Refrigeration"—architects, engineers, contractors, owners, and superintendents of cold storage plants—please note the significance of the symbol as shown above. This emblem is representative of "The Seal of Satisfaction" and reflects seventeen years of study and effort devoted to the betterment of insulating and refrigerating efficiency.

Since it is now generally recognized that "Your plant can be no better than your door;" and since the House of Jamison may rightfully claim premiership in the development of better cold storage doors, this company has adopted the above symbol and had it registered as our individual mark of merit. Hereafter the "Seal of Satisfaction" will appear upon all Jamison Products—cast in metal and firmly attached.

Let us explain the purpose and ideals of this business. If you have an interest, in any capacity, in the subject of cold storage, write for "Jamison Booklet No. 10."

JAMISON COLD STORAGE DOOR COMPANY
Hagerstown, Maryland, U.S.A.

FLAME BRAND

HIGH TEMPERATURE CEMENTS

RED FLAME
PLASTIC CEMENT
WHITE FLAME
INSULATING CEMENT
BLUE FLAME
FIRE BRICK CEMENT

"MONO" TRADE MARK
REG U.S. PAT. OFF.
BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE

KING REFRACTORIES CO. INC.

Represented in
VANCOUVER, WINNIPEG,
MONTREAL, HALIFAX

SOLE CANADIAN REPRESENTATIVES:
GRANT E. COLE CO.

21-23 River St.
TORONTO, CANADA

How Much Coal Are You Wasting?

Blindfolding yourself to the fact that your boiler room is different, because you can see no pipe line leaks, or the water alarms don't blow very often—doesn't help to pay for the needless fuel waste caused by the invisible losses within the boiler furnaces.

Get at the REAL FACTS and at the same time give your men a positive and simple guide that will enable them to keep the plant at top notch efficiency—by installing the

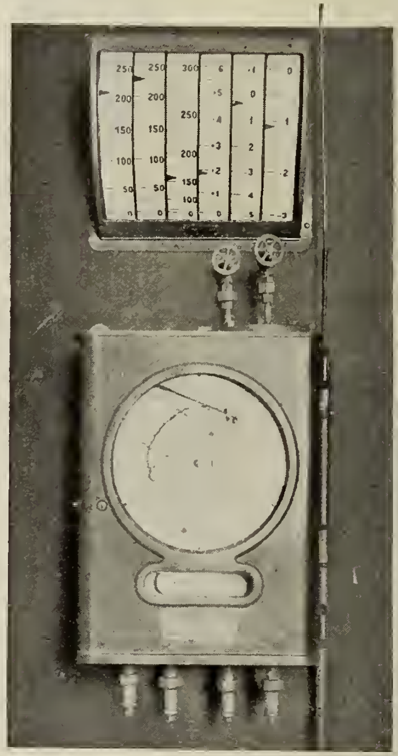
BAILEY BOILER PANEL

The Bailey Boiler Panel is a combination of the Bailey Multi-Pointer Gage and Bailey Boiler Meter.

It shows, almost immediately, the effect of improper furnace adjustment and enables the men to make the necessary correction before a large amount of preventable fuel waste has taken place. Good work on the part of the men is shown up by the charts as well as any inattention. The engineer can check the efficiency of his men as well as that of the individual boiler.

Let us send you fully descriptive Bulletins.

BAILEY METER COMPANY Limited
177 DELORIMIER AVE. - MONTREAL, QUE.



MAGNOLIA

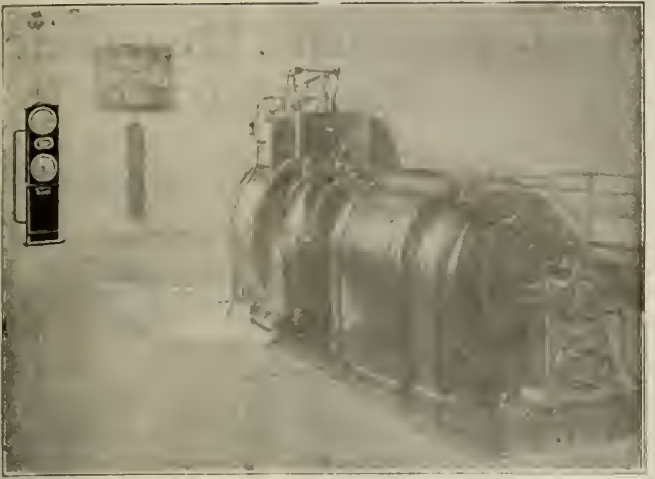
Magnolia Anti-friction Metal is the choice of thousands of engineers and machinists because it is always uniform in composition, dependable in service, melts and pours well, is widely adaptable, and assures cool-running, efficient and economical bearings. Government tests prove it to have the lowest frictional coefficient of any known bearing metal. Write for test data.

Magnolia Metal Company, 113 Bank Street, New York
CHICAGO SAN FRANCISCO MONTREAL

REG. U.S. PAT. OFF.

ANTI-FRICTION METAL

THE VENTURI METER GROWS
WITH THE PLANT



Turbine Room, D. Goff & Son, Pawtucket, R. I.

When new boilers are added to the power plant old auxiliaries often have to be scrapped and new ones purchased. Not so with the Venturi Meters.

The measuring capacity of a Venturi is easily changed, at slight expense, by substituting a new throat section in the Meter Tube and new dials in the Register-Indicator-Recorder. Some Venturi Meters have been altered several times during their long term of service without impairing their accuracy to the slightest extent.

The Venturi Meter is used to measure boiler feed water, steam, condensation from heating systems, circulating water to condensers, etc., in the modern power plant. It is accurate, durable and positive; behind it is an enviable record of 30 years and thousands of successful installations.

Shall we send you Bulletins ?

BUILDERS IRON FOUNDRY, PROVIDENCE, R.I.

Canadian Representatives :

GENERAL SUPPLY CO. OF CANADA
LIMITED
Ottawa Montreal Winnipeg Vancouver

ALLEN GENERAL SUPPLIES
LIMITED
Toronto, Ontario

Jacksonville's Remarkable Fire Boat
GASOLINE

ENGINE Sterling DRIVEN

THE ENGINE OF REFINEMENT FOR THE FINEST BOATS THAT FLOAT

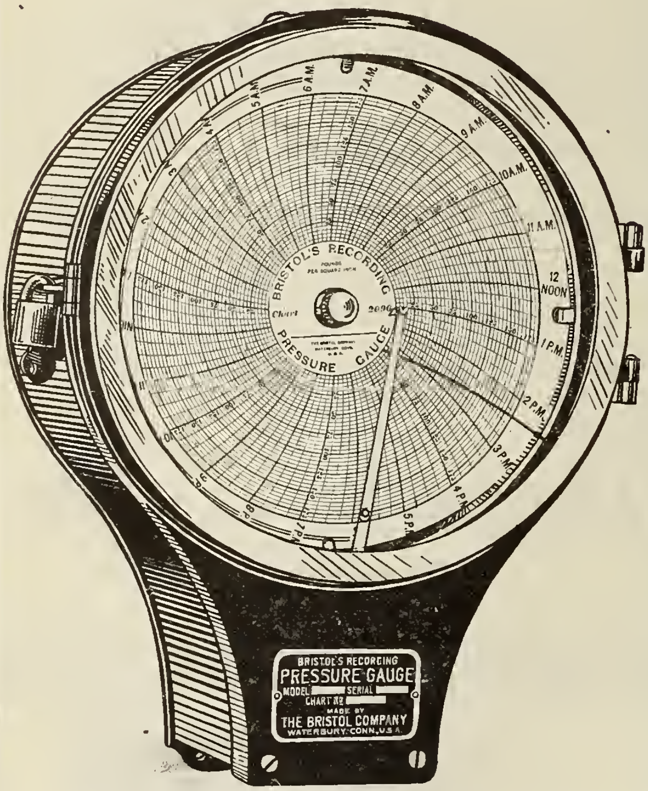
LIKE LAND fire fighting apparatus, Jacksonville has a gasoline engine driven fire boat. Norfolk, Virginia, is so equipping a former mine sweeper, also using four STERLINGS. The boats are procurable from the Navy Department at a very low price and assure a fire boat at $100,000, which, if steam equipped, would cost over $250,000 and thousands of dollars annually to maintain. If you have a water front you need a fire boat.

Use STERLINGS on your land fire pumps and standby electric generators.

A converted 110 ft. sub chaser pumps 6,000 G.P.M. at 150 lbs. pressure using four of the highly developed STERLING engines on De-Laval Centrifugals at 1250 R.P.M. (4760 G.P.M. at 256 lbs. at 1195 R.P.M.)

Sterling Engine Co., Buffalo, N.Y.
(Dept. C-4)

A Necessity For Every Power Plant



Pressure fluctuations on your steam, water and air lines are sure to result in cost in economy.

Protect yourself against this unnecessary loss with the continuous day and night records obtained in the use of

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

Recording Pressure Gauges

They show every rise or fall in pressure and are a direct check on how well the men are holding the specified pressure.

Thousands of the best operative power plants find them of invaluable assistance in maintaining economical operation. Bristol's Gauges afford lasting service without constant attention.

Catalog 1006-A mailed on request.

The Bristol Company

Waterbury, Conn. - U.S.A.

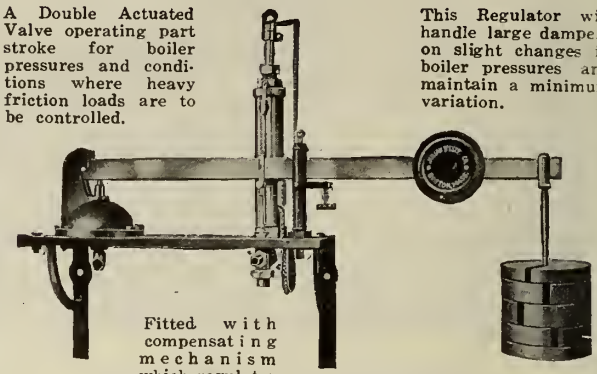
Canadian Distributors:
Eastern Territory—A. H. Winter Joyner, Toronto and Montreal.
Western Territory—Gorman's Ltd., Edmonton.

D'ESTE

Hydraulic Damper Regulator

A Double Actuated Valve operating part stroke for boiler pressures and conditions where heavy friction loads are to be controlled.

This Regulator will handle large dampers on slight changes in boiler pressures and maintain a minimum variation.



Fitted with compensating mechanism which regulates opening and closing.

Our Catalogue No. 50 of CURTIS ENGINEERING SPECIALTIES sent on application.

Julian d'Este Company

Main Office: 26 Canal St., Boston 14, Mass.

Even if you put

A water tender on every boiler—

—every man working his best to feed only one boiler—even then you could not get the safety, and the fuel savings, that are assured by the COPES System of Boiler Feed Regulation.

Careful tests between COPES feed and hand feed, in actual practice—have proved again and again that the fuel savings and labor savings of the COPES pay back its cost many times over.

The COPES varies the feed water instantly, according to every change in load conditions.

It is simple and strong with no uncertain features of construction—no springs or diaphragms, no floats or displacement bodies. The only parts are a sturdy expansion tube and a balanced valve. There is no chance for sticking or lag.

Its **reliability** has made the COPES the standard—it is used by 98 per cent. of the leading Central Stations.

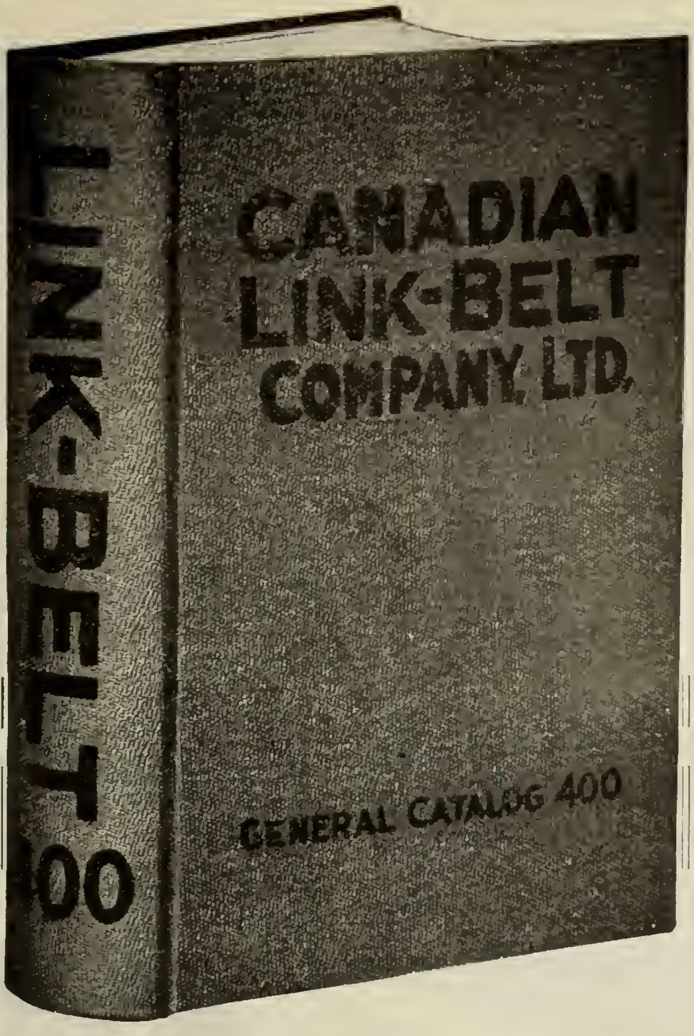
Our new booklet "Regulating Boiler Feed Water" shows how marked savings in fuel—2% to 8% ordinarily—can be effected by COPES Regulation.

Write for Catalog. D.

NORTHERN EQUIPMENT CO., 112 West 11th St., ERIE, PENN.

Branch Plants:
Hamilton, Ontario, Canada; Croydon, England; Paris, France; Cologne, Germany.

COPES
SYSTEM OF BOILER FEED CONTROL



NOW READY FOR DISTRIBUTION

THE new Link-Belt General Catalog No. 400 contains 832 pages of practical mechanical information on elevating, conveying and power transmitting machinery and accessories — chains, sprocket wheels, buckets, gears, screw conveyors; in fact, it combines the complete Link-Belt products with those of our H. W. Caldwell & Son Co. plant, now owned by our Company.

It is the most complete catalog we have ever issued. Use it as your guide in preparing plans for your material handling and power transmission equipment.

Engineers, architects, superintendents, purchasing agents, and those responsible for production, should have a copy. We shall be pleased to send the book to the right man in your organization, if it can be used to our mutual advantage. Address our nearest office, on your letterhead, giving your name and position.

CANADIAN LINK-BELT COMPANY, LIMITED 1063-A

TORONTO—Wellington and Peter Streets
MONTREAL—10 Gauvin Lane

LINK-BELT

Is Canada Going Back?

John A. Stevenson analyses our Immigration and Emigration problems in a carefully thoughtful article entitled

"Is Canada An Immigration Sieve?"

Every Canadian should read this authoritative pronouncement on this subject of such intensive national interest. You will find it in our issue of

February Fifteenth

Other Features of This Interesting Number are:—

FRANK L. PACKARD'S fine serial
"The Four Stragglers"

"BEFORE THE RED COATS CAME"
by Chief Buffalo Child Long Lance

"THE KING'S BRAHM"
by Edgar Wallace

"HIDDEN FIRE"
by Laura Goodman Salverson

THE REVIEW OF REVIEWS

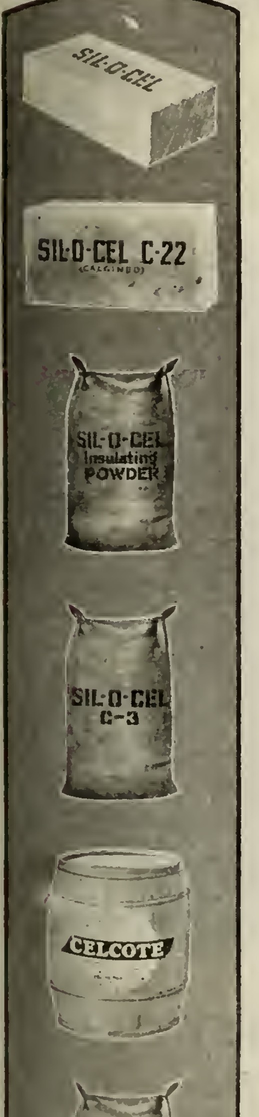
NOW 15¢ Pre-War Price

MACLEAN'S
"CANADA'S NATIONAL MAGAZINE"

Our advertising pages provide a wealth of information on the products of progressive and reliable manufacturers.

On Sale at All News Stands

CELITE PRODUCTS
—Barriers to Industrial Waste


SIL-O-CEL
SIL-O-CEL C-22 (CALCINED)
SIL-O-CEL Insulating POWDER
SIL-O-CEL C-3
CELCOTE
SIL-O-CEL Insulating CEMENT
FRAXITE High Temperature CEMENT

SIL-O-CEL INSULATING BRICK— prevent heat loss through furnace walls and on all types of high temperature equipment. An effective and economical insulation with an exceptionally low heat conductivity. Easily applied; low in cost; a permanent insulation.

SIL-O-CEL C-22 (Calcined) BRICK— a semi-refractory type of insulation free from shrinkage at temperatures in excess of 2000° F. Used as an insulating backing in high temperature zones of oil fired boilers and other equipment operated in excess of rating.

SIL-O-CEL INSULATING POWDER— less than one-tenth as conductive of heat as an equal thickness of fire brick or red brick. Used between fire brick and steel shells or red brick walls: is sufficiently elastic to absorb expansion and contraction strains; does not settle out or shrink.

SIL-O-CEL C-3— a calcined insulation in granulated form especially adapted for use in hollow wall spaces, foundations, pans or other parts of high temperature equipment. May be used alone, or bonded with 20 per cent. by volume of Portland cement to produce SIL-O-CEL C-3 Concrete.

CELCOTE— a plastic, bitumastic compound, especially prepared for application to the brick surfaces of heated equipment, to prevent air infiltration, and also as a waterproofing. It adheres firmly to the brick and mortar, remaining permanently elastic; expanding or contracting with the surface to which it is applied. CELCOTE will not dry out, become brittle or lose its effectiveness with age.

SIL-O-CEL INSULATING CEMENTS for insulating irregular surfaces where SIL-O-CEL Brick or Powder cannot be used. These cements have great covering power and can be applied to any character of surface; they possess the insulating properties of SIL-O-CEL and are unaffected by temperatures which ordinarily destroy other forms of plastic insulation.

FRAXITE— (High Temperature Cements)—a bonding cement scientifically compounded for setting and facing fire brick work of all types of furnace construction. Furnished in three grades of various temperature ranges. Fraxite prevents fire brick from cracking or spalling and greatly lengthens the life of the entire refractory structure.

Detailed information, samples and installation blue-prints on any or all Celite products gladly sent on request. Check the coupon or ask for Insulation Folder W-6.

*Warehouse and
Complete Stocks
in Montreal*

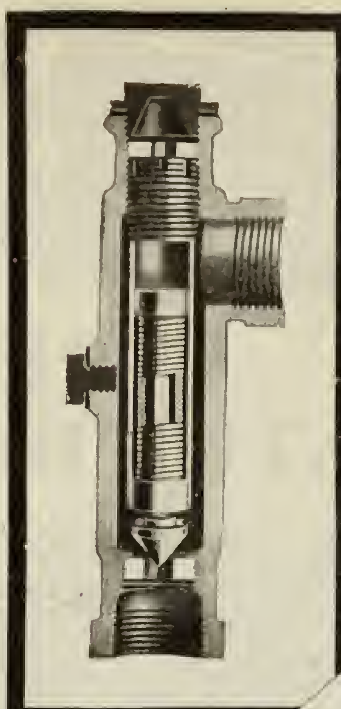
CELITE PRODUCTS Limited
New Birks Bldg.
MONTREAL, QUEBEC

CELITE PRODUCTS, LIMITED, Dept. W-6.
Gentlemen: Send, without obligation, detailed information regarding the application of the material checked below on

(Give type of equipment)

☐ Sil-O-Cel Insulating Brick.
☐ Sil-O-Cel C-22 (Calcined) Brick.
☐ Sil-O-Cell Insulating Powder.
☐ Sil-O-Cel C-3.
☐ Celcote
☐ Sil-O-Cel Insulating Cements.
☐ Fraxtite (High Temperature Cements.)
☐ Send samples of materials checked.
☐ Send installation blueprints.

Name ....
Company ....
Address ....



Steam Trap SARCO

—Try a—
Sarco Steam
Trap
30 Days Free

Write for Booklet J-30

Sarco Co., Inc.

239 Broadway
New York City

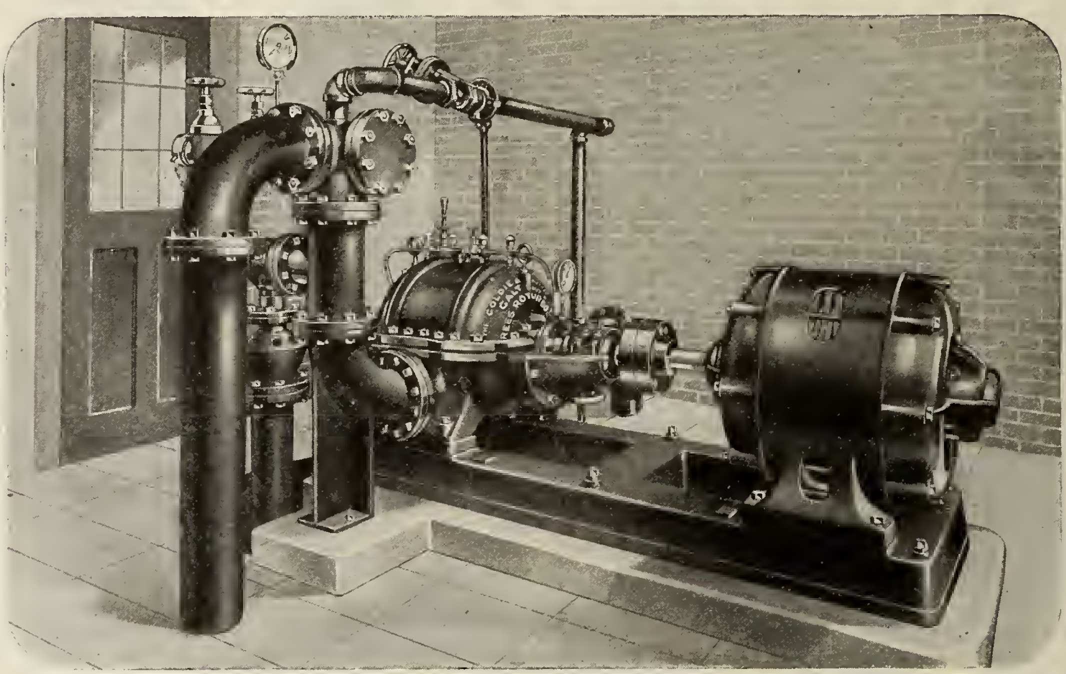
Buffalo Chicago
Detroit Cleveland
Philadelphia

Peacock Bros., Ltd., Montreal

GOLDIE & McCULLOCH

Dependable Power Plant Equipment

REES
RoTURBo PUMPS



Showing a REES RoTURBo Fire Pump recently installed by us at the Shaughnessy Military Hospital, Vancouver, B.C.

For High and Sustained Efficiency

Reports from plants where Goldie & McCulloch Rees RoTURBo Pumps have been installed leave no doubt as to their economy and efficiency. Their self-regulating features assure the maximum of high and sustained efficiency over a wide range of duties.

Catalog, prices and expert engineering advice promptly furnished.

THE GOLDIE & McCULLOCH CO.,
LIMITED.

Head Office and Works: GALT, Ontario, Canada

Toronto Office
Suite 1101-2,
Bank of Hamilton Bldg.

Quebec Agents
Ross & Greig
400 St. James St., Montreal

British Columbia Agents
Robt. Hamilton & Co.
Vancouver, B. C.

Western Branch
248 McDermott Ave.,
Winnipeg, Man.

POWER HOUSE

Members of the
Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Parliament Buildings, Regina, Have Model Plant

Designed for Maximum Efficiency—R. H. Blackburn, Chief Inspector of Boilers in Saskatchewan, Also Responsible for Lighting, Heating and Maintenance of Power Equipment

By Special Correspondent

THE power plant of the legislative buildings of Saskatchewan is certainly a model of what such a plant should be, yet at the same time it does not present any extravagant waste of public money as the maintenance and efficiency have been a dominating consideration in carrying out the design. In this case the designers have not been actuated by the principle that to obtain the maximum of efficiency the maximum of ugliness must of necessity pervade the design.

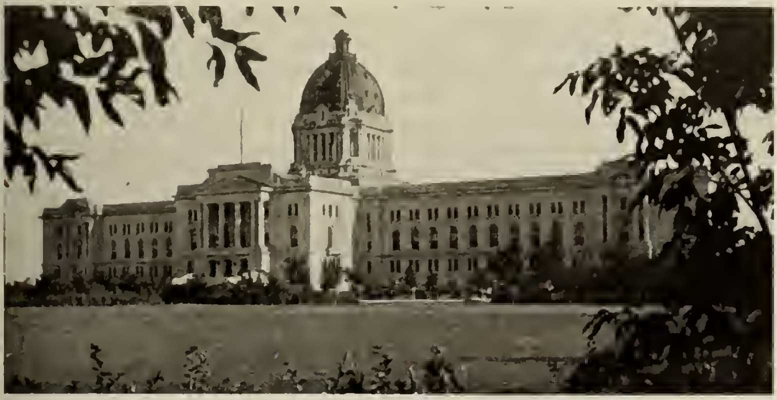


Fig. 1—Parliament Building, Regina.

R. H. Blackburn is chief engineer for the Department of Public Works, Saskatchewan, and although Chief Inspector of Boilers, he is also responsible for the lighting, heating and general maintenance of the power plant at the Parliament Building.

Mr. Blackburn who was born in Liverpool, England, in 1866, took up his scientific studies at the Liverpool School of Science. Here he won the Lord Derby Prize in 1886 for the highest marks in the South Kensington Examination. This he quickly followed up in the same year, winning the Thompson Exhibition for Mathematics and Science for Lancashire and Cheshire. Not being satisfied with these results, Mr. Blackburn also won the Whitworth Scholarship in 1887, thereby earning the title of Whitworth Scholar (Wh. Sc.) one of the most highly prized titles in the engineering profession in Great Britain.

Following upon these scholastic triumphs, Mr. Blackburn served four years aprenticeship in the workshops of George Forester & Co. Ltd., Vauxhall Foundry, Liverpool, followed by one year in the drawing office. Leaving his old firm, Mr. Blackburn took a position as draughtsman with Thornwell & Warham Ltd., Burton-on-Trent, and subsequently became chief draughtsman and designer to the company, acting in this capacity from 1891-1896.

Resigning his position in 1896, he started business for himself as consulting engineer in Liverpool. In this capacity he made quick headway when his health failed him in 1903. Acting upon medical advice, he gave up the engineering profession and came out to Canada with the object of going in for farming out West. Regaining his health, Mr. Blackburn began to again take an interest in engineering matters, and frequently gave the local community the benefit of his wide experience and knowledge. The Government in 1908 finally attracted him into their service, and in 1911, be assumed the duties of his present office.

In Saskatchewan the water conditions mitigate very materially against the efficient operation of boilers. These conditions have had Mr. Blackburn's special attention, which he felt was necessary for the benefit of the boiler owners. He consequently made a profound study of the water supply, and has upon several occasions, read papers before the Engineering Society of Saskatchewan University, and also the local branch of the Engineering Institute of Canada.

The water supply (for boiler purposes) is frankly bad. Here is given a sample of Mr. Blackburn's findings:

R. H. Blackburn, Wh. Sc.

Classification of Water

Good	—Less than 8	grains per gal.	of incrusting	solids	....	3.30%
Fair	—From 8 to 15	"	"	"	....	9.00%
Poor	— " 15 " 20	"	"	"	....	13.90%
Bad	— " 20 " 30	"	"	"	....	18.00%
Very bad	— " 30 " 40	"	"	"	....	9.00%
Very bad	— " 40 " 50	"	"	"	....	7.40%
Very bad	— " 50 " 100	"	"	"	....	23.80%
Very bad	— " 100 " 200	"	"	"	....	11.50%
Very bad	—Over 200	"	"	"	....	4.10%
						100.00%

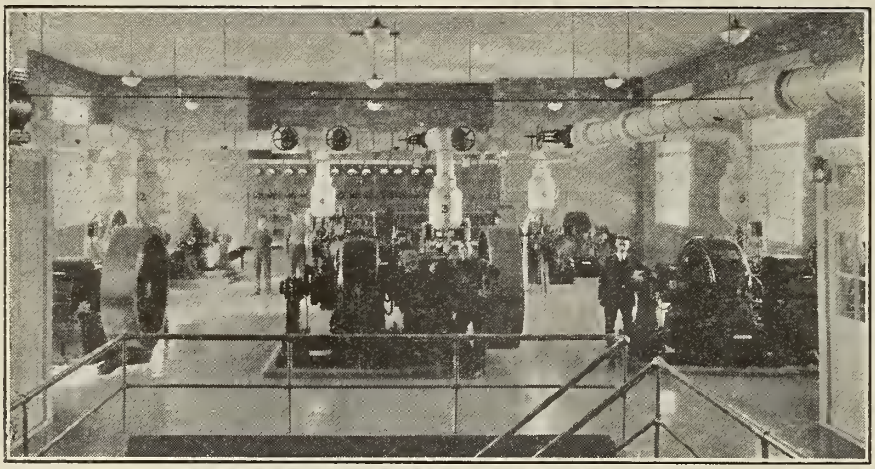


Fig. 2—Engine Room.

Mr. Blackburn is also Chief Examiner of Engineers for the province of Saskatchewan, and apart from the examination of boilers, has also under his jurisdiction the examination of gas tanks, reservoirs and compressed air tanks, all of which must be annually inspected by the Government Inspectors.

It will, therefore, be seen that independent of being chief engineer of the steam plant at the Government Building, Mr. Blackburn is also responsible for a very big department which must entail no small amount of work. Mr. Blackburn is a "big man" with a "big job" and it will be generally admitted that he handles it in a "big way."

The power house is situated some two hundred yards between the Parliament Buildings connected by a tunnel which is about six feet deep and four feet wide, this being constructed of wood and finished with cement. The electric cables are arranged in wide open steel troughs, about 4 ft. from the ground level, running down one side of the tunnel whilst along the opposite side are arranged the steam pipes supplying the steam for heating the main buildings. The tunnel is well drained and lighted with numerous bulbs suspended from the ceilings. In the event, however, of any repairs being necessary to either cables or steam pipes, there is ample working space and splendid illumination which considerably facilitates the labors of the men engaged in such repairs. This arrangement also tends to reduce the liability of breakdown, since the system permits the further inspection of these parts under the most ideal working conditions and furthermore, the economy resulting from this arrangement amply repays for the extra cost.

The general appearance of the exterior of the power house is that of a trim, clean, well designed, brick manufacturing plant, with numerous wide and lofty windows on all sides. It is a single story building about 125 ft. long and some 55 ft. wide. The first impression that one receives upon entering the engine room is the smart cool appearance and secondly the absolute freedom from noise, vibration and odour. The walls are finished in dark olive green bricks which from the floor to a height of 6 ft. these bricks are glazed and above this level they are of the usual finish. The flooring is cement finished and painted, and with the steam pipes lagged and white enamelled, the whole present a very clean and pleasing appearance.

One of the features of this power house which is much appreciated by the whole of the staff is a fully equipped bath room with full sized porcelain bath and overhead shower, with the usual hot and cold water and hand wash bowls. These are arranged in a spacious private room of white enamel finish located in one corner of the engine room.

The engine room consists of the following units:

6—100 K. W.—D. C.—compound wound dynamos. These machines generate 300 amperes at 250 volts and 275 revolutions per minute. As they operate on a three wire system of distribuion which necessitates a system of balancing the circuits, they are provided with slipperings in addition to the commutator. Special tappings are taken from the armature of these slips, the current so collected being passed to special compensating coils and so controls the out-of-balance current, without the necessity of employing either storage battery or motor generator balancers.

The engine attached to each dynamo is of the horizontal non-condensing type provided with the flywheel governor, operating a balance regulating valve which provides a very delicate regulation and is most sensitive to any fluctuation of load. The lubrication system is very complete and efficient, the whole of which being completely enclosed. The lubrication is effected by means of an oil tank fixed in a room adjoining the engine-room and elevated about 25 ft. A large oil level indicator is mounted on the wall inside of the engine-room which can be seen from all parts. From this tank the oil is distributed to each engine, passing through a system of pipes

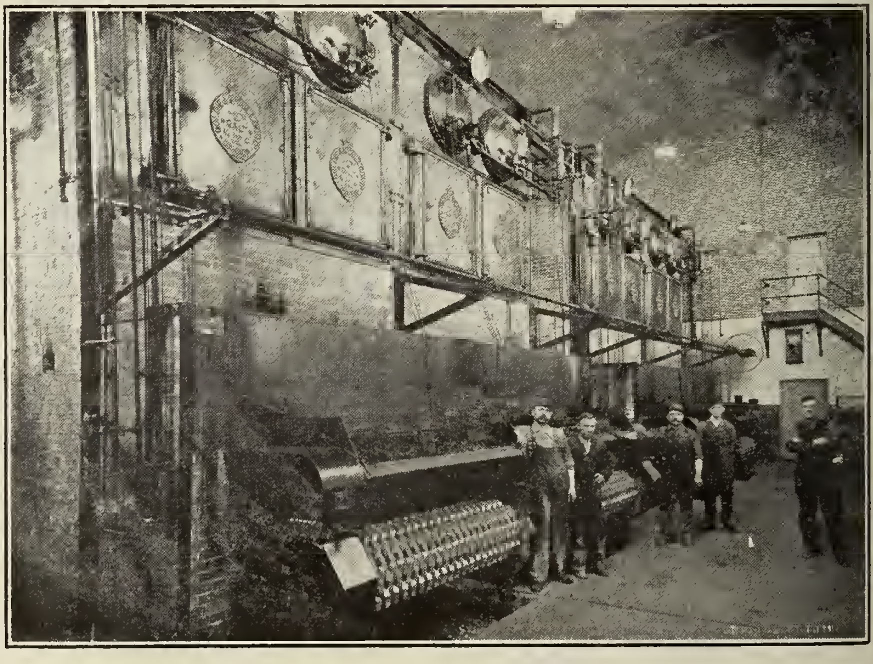


Fig. 3—Boiler Room.

to the necessary parts of the engine, and finally falling into the crank case. When the oils reach a certain level in this crank case it overflows through a pipe into a separating and cleaning tank in the basement and from there is pumped back into the tank above the level of the engine-room.

The switchboard is one of the main features of the engine-room, it being about 30 ft. long and 7 ft. high. It is mounted upon a gallery about 3 ft. above the engine-room floor. The board itself being made of unpolished black marble and consisting of 6 generator and 3 feeder panels. Each generator panel consist of two integrating kilo-watt hour meters, one being connected between the positive main and the neutral, and the other between the negative main and neutral.

2 automatic circuit breakers connected in a similar manner to the meters. These circuit breakers will open automatically, either on overload, or no-load and are "set" to open at 450 amperes.

1 shunt rheostat is provided to regulate the voltage of the dynamo.

2 double pole knife switches, one for each side of the 3-wire system.

1 single pole knife switch in the neutral wire.

1 four socket plug switch for connecting with the main station voltmeters.

2 main volmeters, one for each side of the 3-wire system are mounted about 2 ft. above the centre of the main switchboard and can be easily read from all parts of the engine-room.

The feeder panels contain the main double pole switches for controlling the feeders on each side of the system, the fuses controlling these circuits being mounted at the back of the board such that in the event of one of them "blowing" no damage can result to the operator on the switchboard gallery.

Access to the rear of the switchboard can only be obtained by passing out of the engine-room to an adjoining room, unlocking a door, and walking up 3 steps into a bricked passage some 30 ft. long, and about 6 ft. wide. Care and forethought is in evidence by making this provision, since not only is it a sound safety device, but it also provides ample space for the operators who may have to make adjustments at the back of the board whilst the plant is in operation and the board is "alive."

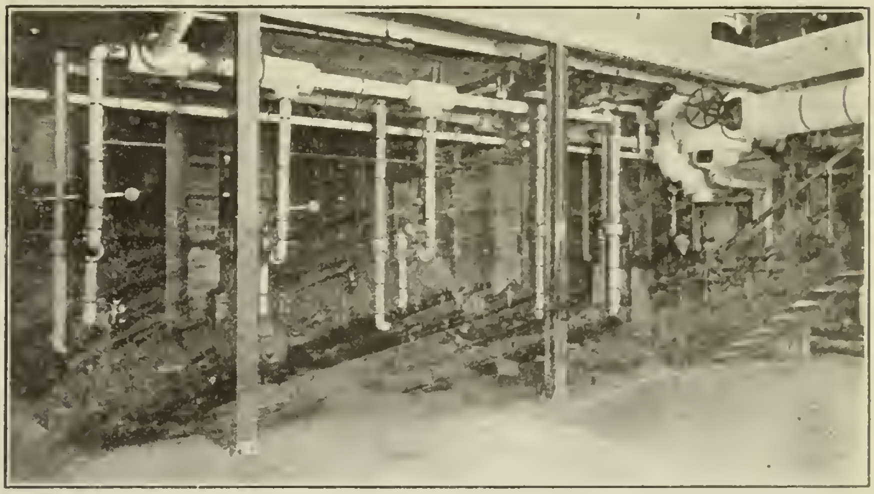


Fig. 5—Feed Pump Room.

At the end of the room opposite to the switchboard is a small chart room. In this room is mounted a water recorder of the "V" notch type for keeping a continuous record of the water consumption. There is also a steam pressure and feed water temperature recorder, a heating range vacuum gauge, heating range exhaust and 2 water pressure gauges.

These instruments are all nickel plated and mounted on polished hard wood board.

In this room the records are kept with sets of hourly and daily readings entered in the log.

These records showed a wonderful regular and even series of results. The amount of water evaporated per day was very regular running about 27,770 gals. per day, whilst the coal consumption was remarkable in its regularity which was about 27,980 lbs. per day. From this it will be observed that the evaporation runs steadily in the neighborhood of

$$\frac{27{,}770 \text{ gals. per day} \times 10}{27.980 \text{ lbs. of coal}} =$$

9.99 lbs. of water per lb. of coal.

Another interesting feature was the constancy of the steam pressure. Several charts were shown with only a variation of about 3 per cent, during the 24 hours, and one chart in particular shown only a variation of 1½% in the steam pressure during a period of 24 hours.

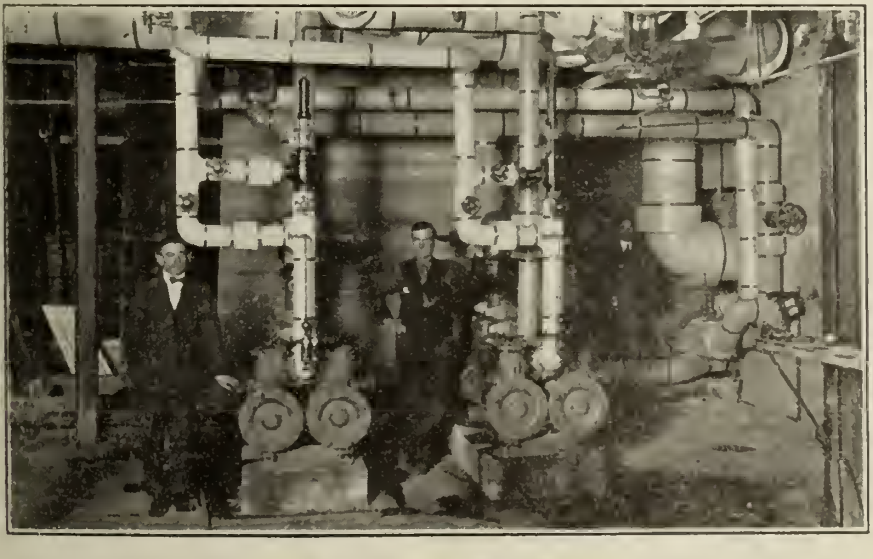


Fig. 4—Service Pump Room.

Boiler House

This is the department where some of the greatest of the economies of the plant are to be effected and if not, it would be useless trying to effect economy in other ways. Here we have two boilers of the Goldie-McCulloch type, each with two steam drums 36 in. diameter by 21 ft. 6 in. long, 112 tubes 18 ft. by 4 diameter where with a working pressure of a 100 pounds. These boilers are fitted with chain grate stokers operated with a 4 horse power motor, the shaft of which working the adjustable feed bar through an eccentric upon a ratchet. The ashes are handled through a tunnel and lifted by an ash hoist operated by the 3 h. p. electric motor.

The boilers are operated on the induced draught principle, the hydrostatic gauge usually indicating 1 in., whilst the dampers are automatically regulated by the steam pressure. The engineer claims he obtains almost smokeless combustion, although the coal is of the lignite variety obtained from Drumheller and is one of the most difficult problems to be solved. By having induced draught it obviates the necessity of spoiling the landscape by having a tall chimney stack.

Pumps

The pumping system is very complete and is divided into sections as follows:

2 duplex double ram service pumps, supplying water to all the buildings at 45 lbs. There is no tank or reservoir, and these pumps "cut in" automatically.

2 duplex double ram pumps are used for supplying the feed water to boilers.

3 air pumps in operation on the heating system for clearing the system of excess air.

Feed water heater takes in the water at 160 F. with an outlet temperature 208 F.

Water Softening

On account of the local conditions and the extremely hard water employed it is necessary to pay particular attention to this section of the plant.

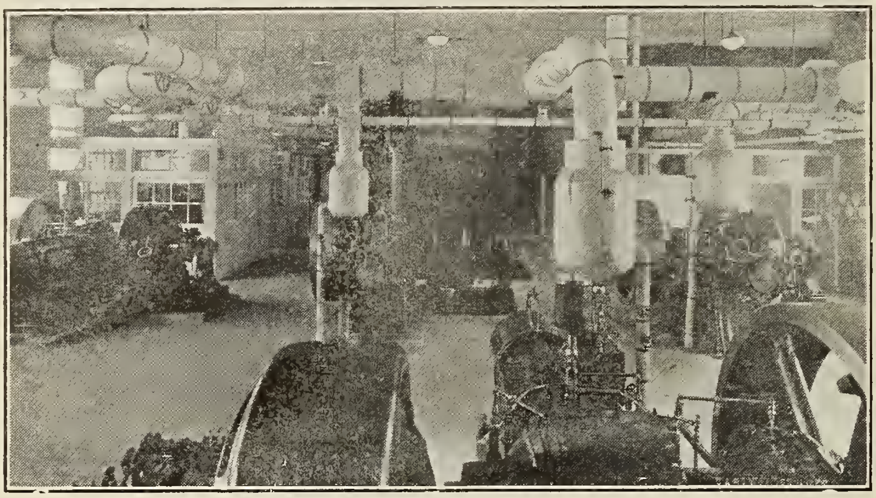


Fig. 6—Engine Room.

The water softening plant consists of 2 units and each consisting of a softening tank 60 in. diam. containing refinite.

Refinite is a trade name and is a natural double silicate of aluminum and soda. After the refinite has served its purpose in softening the water, it can be regenerated and used over again. For the purpose of regenerating the refinite there are provided two brine tanks, one for each unit. These brine tanks are 66 in. in diam. and 38 in. deep. The process is as follows: The raw water in passing through the bed of refinite in the softening tank, converts the carbonates and sulphates of calcium and magnesia into carbonates and sulphates of soda. This action is continuous until the sodium in the refinite is replaced by the calcium and magnesia when the refinite must then be flooded with a strong solution of common salt for 8 hours. This salt solution converts the calcium and magnesia into chlorides, which are soluble, and the calcium and magnesia are replaced by sodium. This is then washed free of all the salt solution and then used again.

Each unit is used alternately, one unit softening, whilst the other unit is regenerating. In this plant 150 lbs. of salt are required to 310 gals. of water for the regeneration process and every 6th regeneration it is necessary to increase the strength of this brine bath to 280 lbs. of salt to the same quantity of water.

Each unit will soften 7,000 gals. of water with one regeneration and each unit also will soften 12 gals. of water per minute.

The chemical composition of refinite is as follows:

$2SiO_2 - Al_2O_3 - Na_2O - 6H_2O$

Chemical process in softening:

Na_2 R(sodium refinite)+$Ca SO_4$=Ca R (calcium refinite)+$Na_2 SO_4$

Chemical process in regeneration:

Ca R+2Na Cl = $Ca Cl_2$+Na R.

Heating

This is provided by the exhaust steam from the main engines in the power house, and is conveyed by 16in. steam mains via the underground tunnel from the power house to the Parliament Buildings 200 yards distant.

This is accomplished by an air washer, humidifying and ventilating system, the equipment consisting of:

4 plenum fans 6 ft. diam. driven by an electric motor 20 h. p.

4 exhaust fans 6 ft. diam. at top of the buildings.

There are 4 electric elevators (passenger).

There is 1 electric elevator (freight).

On account of the pump room being at a lower level than the sewer it is provided with two vertical centrifugal pumps directly connected to two small 2½ h. p. electric motors. These are worked by a float which rises as the water rises in the well and which float lifts a plunger which operates a starting switch, which, in turn, starts up the motor. When the water has fallen back to the normal level this plunger drops, knocking out the switch and so stops the pumps.

Mr. W. Buttrey is the engineer in charge of the power house. He holds a first class certificate, and is an ardent student of engineering science, judging from the display of high class technical books in his bookcase at his office in the power house.

Summing all up, one can only say that the power plant of the legislative buildings of Saskatchewan is a credit to all concerned, and reflects in every apparatus the interest that is taken by the "man at the top."

EFFECT OF NICKEL ON STEEL

The addition of nickel to steel produces a number of improvements in its properties by reason of certain specific effects which it exerts on the structure of the steel:

1. Nickel dissolves in solid solution in the ferrite of steel and thus increases its hardness and strength without corresponding loss of ductility. Nickel steels, of all alloy steels, are unique in that they are used both in the heat-treated and in the unheat-treated state.

2. Nickel depresses the critical temperature or heat treatment range of steel.

3. Perhaps partly by reason of (2) the presence of nickel in heat-treated sorbitic steel increases the elastic limit and hardness without decrease of ductility; in other words, nickel increases the toughness of heat-treated steel.

4. Nickel exerts an influence on the grain size of ferrite and pearlite, tending to produce a finer grain structure and finer pearlite, shading into sorbite. In the same sense it diminishes the rate of grain growth within the heat-treatment temperature ranges and thus minimizes the danger of overheating during heat treatment.

These properties, both singly and in combination, are taken advantage of in several ways in metallurgical design. The depressed critical range enables the use of lower temperatures in the heat treatment of nickel steel. This, of course, means conservation of fuel and longer life of the heat-treating equipment.

It is also well recognized that the lower quenching range induces less warpage. The low hardening range of nickel steel in part explains its great popularity as a gear steel in these days when the requirements for quietness in transmission and rear axles are very exacting.

Since nickel increases the strength of steel without corresponding loss in ductility in the annealed or in the rolled or the drawn state, it is especially suited for difficult and important stampings to be used either as drawn or in the heat-treated condition. This feature also makes its use popular in the cold-drawn condition for important bolts used without heat treatment in order that the threads may be left in perfect condition, as well as for studs, nuts, keys, etc., and in the form of 3½% nickel tubing for propeller shafts, axle tubes and other structural parts.

In the heat-treated condition its superiority is well recognized for use in difficult construction where high physical properties are required. It is in this state that the high nickel content steels, and those with nickel in combination with various other alloys, give the en-

(Continued on page 36)

System of Pulverized Coal Meets Specific Needs

Twelve Million Tons of Coal Burned Annually in Pulverized Form—Many Advantages Claimed Apart From Actual Economy —Description of Equipment Used in Different Processes

By W. B. Roberts

THE application of pulverized coal to boilers and the progress made of late years has been primarily due to the great effort that has been made to obtain a more complete understanding of the subject, more particularly in respect to the preparation and handling of the fuel to meet with certain specified needs. It has been the slow development of a process of furnace firing that practically had its inception more than thirty years ago when powdered coal was utilized in the manufacture of cement. To-day there is upwards of twelve million tons of coal burned annually in powdered form. Its application to steam boilers, however, has demanded somewhat radical changes in the design of the furnace and combustion chamber, to meet with certain requirements of the boiler room. The original crude equipment has gradually been superseded by specially designed appliances with a view to promoting greater furnace efficiency, reduced fuel consumption and lower cost of operation.

The principle advantage of pulverized coal is that the coal particles are so finely divided that they readily mix with the oxygen for combustion, thereby only requiring the minimum amount of air. With large pieces of coal on the grate, as in ordinary firing, a large excess of oxygen is required to pass through the fuel bed as only a part of the oxygen can come in contact with the coal. This oxygen carries along with it four times its volume of inert nitrogen, which along with the unused oxygen, must be heated to the temperature of the furnace. The effect of this is to reduce the flame temperature, and as the gases have a large heat carrying capacity, they carry off as waste, to the atmosphere, large quantities of heat. Powdered coal when mixed with the proper proportion of air, burns without smoke and in many ways resembles the flame from ordinary gas, either the reducing or oxidizing flame being obtainable.

Apart from the actual economy effected in combustion, there are other advantages claimed, some of which are: ability to use coal of low grades and to take care of peak loads instantaneously; ease in removing ash without interruptions and losses due to opening the furnace door to clean fires; absence of moisture from the fuel as fired. Due to the reduction of air excess, there is also the saving in stack losses and power consumed by the fans; the ability to utilize 98 per cent. of the total combustible matter in the fuel, even in small installations. The experience gained at the Atlantic Steel Co. showed that a boiler efficiency of 85.22 per cent. was obtainable, of 79.22 per cent. after deducting 6 per cent. for cost of coal preparation, whereas the highest net efficiency they had obtained with stokers was 78.04 per cent. In general, the use of pulverized coal has established itself in a system as clean and flexible as oil or gas fuels, and it furthermore can be adjusted to any uniform rating that the power of the factory demands.

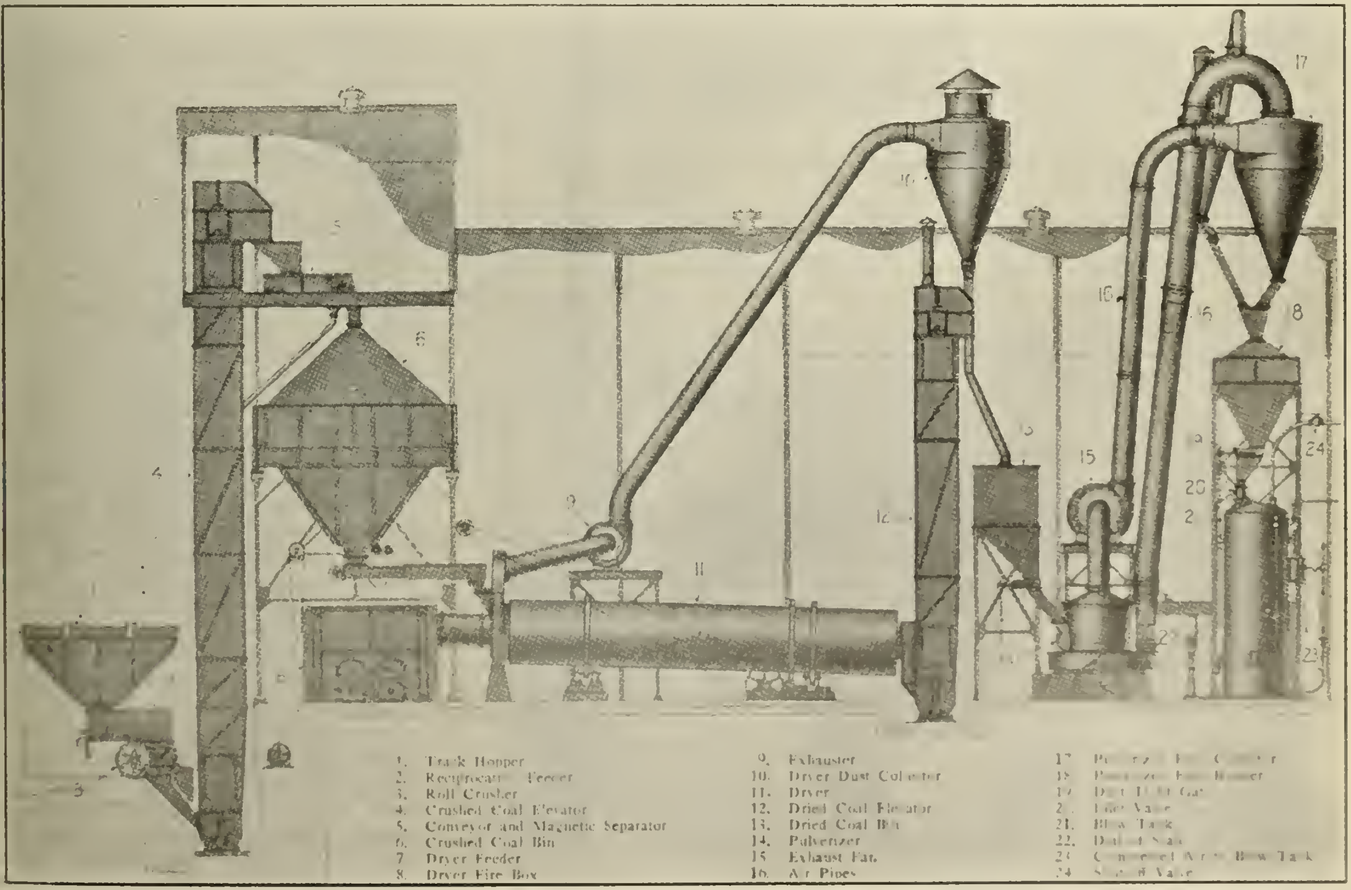


Fig. 1—Quigley Pulverized Fuel Equipment.

Against these apparent advantages must be considered the cost of preparation of the coal. One authority calls attention to the fact that various units or installations may operate at almost double the estimated cost of preparation of pulverized fuel, whilst there are forms of stokers that operate at 1/10 of 1 per cent. He also states that pulverizing equipment should be in duplicate, to avoid shut-downs; that original moisture may possibly run as high as 40 per cent. thereby increasing the cost of drying, and that fuel costs would have to be 50 to 100 per cent. higher, or pulverizing costs less to justify the use of the system. Other difficulties are the possible dissemination of fine dust over the neighborhood; trouble from slag on tubes or in ash pit; the necessity of large combustion chambers; damage to linings from high temperatures produced and the scouring action of the fuel ash; and the space required for the machinery in preparing the powdered coal.

Most Suitable Coals

It is generally understood that the greater the amount of volatile matter that is of a combustible nature in the coal, the more readily will it ignite and burn, and the less dependent will the process be upon the proportions and size of the combustion chamber. As the volatile contents decrease, greater attention must be placed upon the proportions and design of the surrounding brick work, such that the temperature of ignition can be maintained and depended upon. For instance, when anthracite coal is used, it has to be very finely ground and burned in a very confined space so that the nearby brick-work very materially aids in insuring prompt ignition. Coals giving the most satisfactory results have been found to be those with less than 10 per cent. of ash, which was of high fusing point, volatile matter 30 to 40 per cent., fixed carbon from 40 to 50 per cent., and sulphur, not only 50 per cent., but preferably much lower.

The average analysis of coals good for pulverizing is:

Volatile matter	39 per cent.
Fixed carbon	53 per cent.
Ash	8 per cent.
Sulphur	2 per cent.
B. t. u., per lb.	13,600

In Fig. 1 we illustrate the Quigley Pulverized Fuel Equipment which is a system complete with appliances for preparing, distributing and burning powdered coal. The system will be better understood by referring to the description of the diagram.

This system includes complete equipment for the preparation, transporting and burning of powdered coal and other fuels. It has been developed as the result of 25 years' specializing in the selection and application of fuels, and in furnace design, construction and operation.

The equipment used for preparation of fuel, crushing, drying, pulverizing, etc., is, in the main, standard equipment as used for this purpose in many plants now burning coal in pulverized form. The system of distribution from milling plant to furnaces, however, differs from the screw conveyor and high pressure blast system, in that the fuel is transported in bulk from the pulverizing plant through a small diameter standard wrought pipe to bins located at the furnaces. Delivery is being made by this method for distances exceeding half a mile; the extreme distance is dependent only on the capacity of the equipment used.

The pulverized fuel is fed into a blowing tank which rests on a scale. This automatically weighs the amount in the tank. Compressed air is then admitted to the blowing tank with the result that the fuel flows in bulk along the transport line and is switched from this line by means of specially designed switching valves to the furnace bins. By reading the blowing-tank scale before and after the sending of fuel to any particular bin, the amount of fuel transported can thus be recorded and charged against the operation of the furnace or furnaces which this bin supplies.

From the furnace bins, the fuel passes through a dust tight gate into a specially designed fuel feed regulator or controller, by means of which the operator has immediate and absolute control of the fuel fed to the furnace. The mere turning of a hand-wheel, the operation of which is like that of an ordinary valve, enables very close adjustment of fuel fed to the burner and the operator can, in an instant, secure any condition of flame desired.

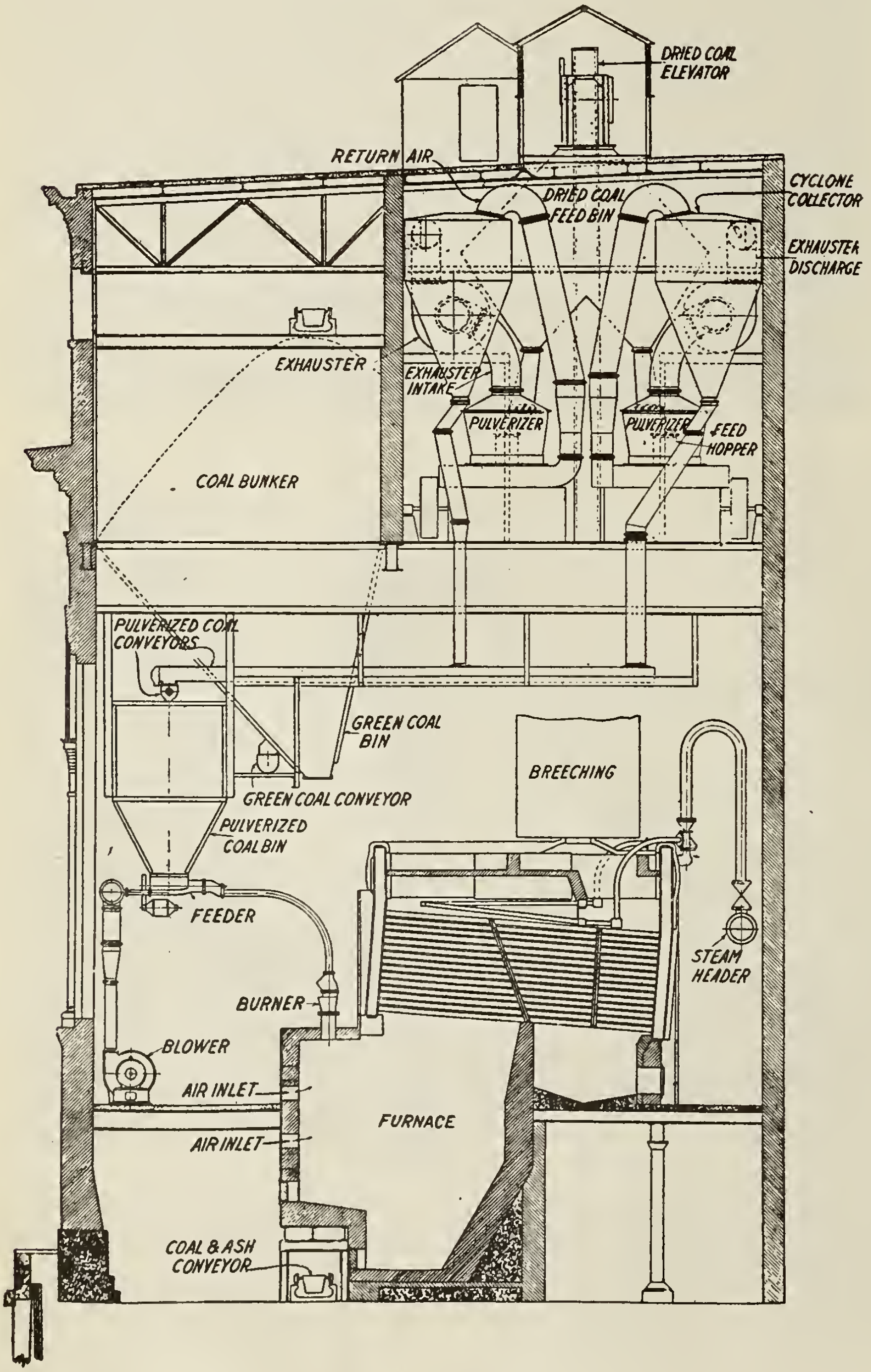


Fig. 2—Cross section through Oneida Street Boiler Plant of Milwaukee Electric Railway & Power Co.

By operating the control gate attached to the bottom of the pulverized coal bin, the fuel enters the blow tank in the desired quantity, and the gate is then closed. The operator makes a record of the amount of fuel in the tank and then admits air for driving the fuel in bulk through the 4 in. diameter distribution mains. By means of switching valves appropriately located along the fuel distribution lines, the coal can be diverted into any furnace bin desired, and the amount of fuel transported, as indicated by the scale dial, is charged against the furnace served by the bin to which the fuel has been sent.

The air for transporting the coal is supplied from a motor-driven air compressor. A receiver for storing the compressed air is located adjacent to the compressor and suitable means are provided for drying the air before it is used for transporting the fuel. The switching valves for diverting the fuel from the transport line to furnace bins, are operated from the floor by hand chains.

Furnace Bins

All bins are of steel plate, entirely enclosed and dust tight. In order that the furnace operator may determine the amount of fuel available for firing, each furnace bin is provided with a fuel gauge, having an indicator conveniently located.

When more fuel is required in any particular bin, the operator at the milling plant is notified, the switching valve is set for delivery, and the desired amount of fuel blown through the transport line, the milling plant operator recording the amount as shown on his scale dial.

Dust Tight Gates

All furnace bins are provided with one or more dust tight gates for regulating the fuel passing to the controller. These gates are of heavy construction, enclosed in a cast iron body, and are operated from the floor by hand chains.

Controller

The controllers are attached to the dust tight gates directly beneath the fuel bins. The controller body consists of a substantial cast iron box and discharge head, housing an interrupted feed screw which is geared to a small shaft driven at constant speed. Two shutters within the controller close over the feed screw to form an adjustable opening for regulating the amount of fuel which passes from the controller to the burner. These shutters are operated by hand chain wheels, and can be adjusted for any range of control between minimum and maximum capacity. In operation, the regulation is similar to the opening or closing of a valve, so that the operator quickly becomes proficient in adjustment.

The discharge head of the controller showers the fuel into the ejector, where it is carried along by a primary air system to the nozzle of the burner, entering the burner either at the back or side, whichever may be most convenient.

Combustion

The method of combustion operates under primary and secondary air supply. The former if small in volume and at a pressure of less than 6 ounces per square inch, draws the fuel from the discharge head of the controller, the pressure being greatly reduced in carrying the coal to the burners. The secondary or combustion air in large volume and at very low pressure (½ ounce per square inch), here mingles with it. Both primary and secondary air are under perfect control of the furnace operator by means of blast gates. The secondary air amounting to 85 per cent. of the total volume required for combustion permits the operator to produce any character of flame desired. An oxidizing or reducing flame condition may be secured at will.

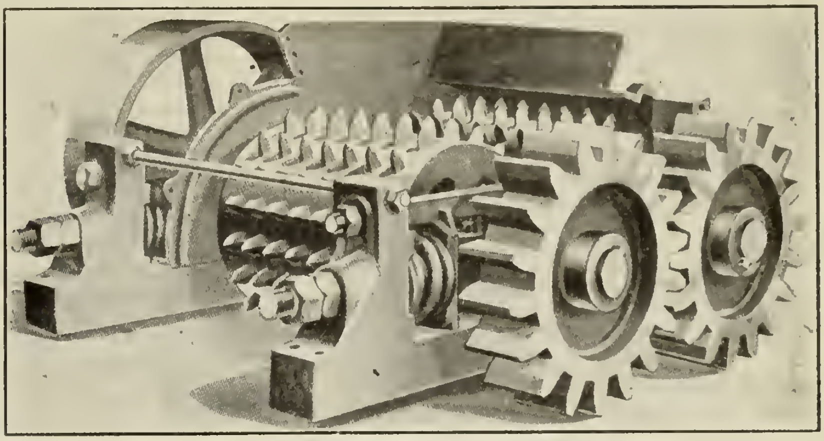


Fig. 5—Bonnot Two Roll Coal Crusher.

Burners

The burner is equipped with a specially designed air gate constructed so as to deliver the full volume of air, uniformly distributed at the tip of the burner.

Dust Tight Features

The entire powdered coal equipment in the milling plant is enclosed and dust tight. The fuel being distributed in bulk along the transport lines and being at no time mixed with sufficient air for combustion until it enters the burner, insures absolute safety of the system.

In Fig. 2 we show the first commercial installation of any considerable size, which was at the Oneida Street plant of the Milwaukee Electric Railway & Light Co., where five Edge Moor boilers, each of 500 h. p. capacity, were equipped in 1918. This plant, which is a combined heating and power plant, has been in operation for nearly five years. No unusual operating difficulties of any kind have been encountered. There have been no interruptions to service due to the operation of powdering the coal and the plant has met every requirement, including the very severe test of the winter of 1919-1920. The importance of the plant is indicated by the fact that it heats practically all of the down-town Milwaukee. This plant illustrates the ease

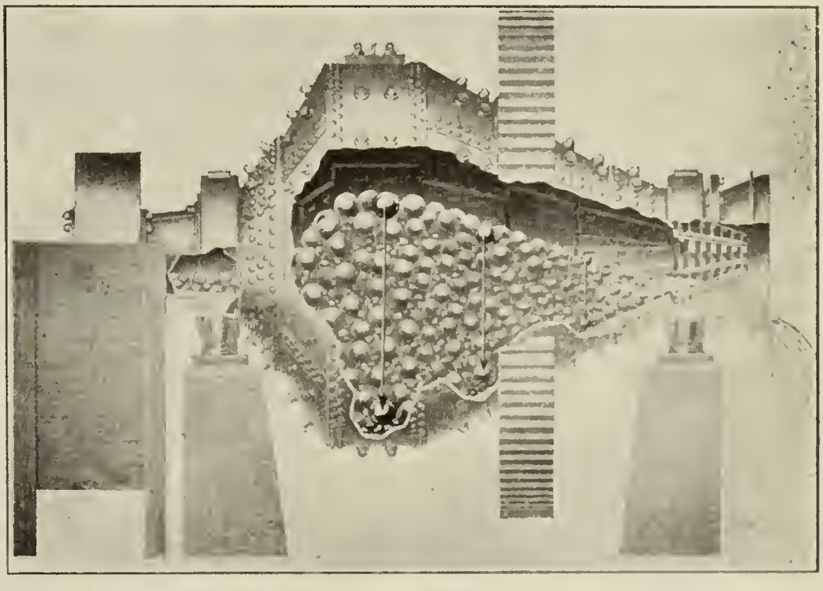


Fig.— The Hardinge Conical Ball Mill in section showing action of shot or pebbles upon material.

TABLE B.—SUMMARY OF RESULTS OF ELEVEN STEAMING TESTS, ON AN EDGE MOOR BOILER, BURNING POWDERED COAL, AT ONEIDA STREET POWER STATION, MILWAUKEE

Heating surface, boiler .... 4,680 sq. ft.
Heating surface, superheater .... 594 sq. ft.
Heating surface, furnace coil ... 48 sq. ft.
Total heating surface .... 5,322 sq. ft.

Draft—Natural
Burner—LOPULCO vertical
Coal Feed—Screw and air blast

Rating of boiler .... H.P. 468
Volume of furnace .... cu. ft. 1,600
Greatest height of furnace ...... feet 16.7
Greatest width .... feet 9.3
Greatest length .... feet 15.3

1. Test Number	28	29	30	31	32	33	34	
2. Duration, hours	22.90	23.72	18.17	23.62	23.60	22.47	25.22	Hours
COAL AS FIRED								
3. Per cent. through 100-mesh	96.10	95.80	....	95.40	93.20	93.10	90.80	Per cent.
4. Moisture content, per cent.	1.42	2.92	2.75	2.55	3.79	3.07	3.60	"
5. Volatile matter, per cent.	36.62	36.66	37.45	35.58	36.57	36.29	37.17	"
6. Fixed carbon, per cent.	48.16	46.63	46.08	48.07	48.43	49.01	46.39	"
7, Ash, per cent.	13.80	13.79	13.72	23.80	11.21	11.63	12.84	"
8. Sulphur, per cent.	2.66	3.64	3.49	2.92	2.40	2.66	3.43	"
9. Calorific value, B. T. U.	11,956	11,860	11,875	12,085	12,172	12,178	11,889	B.T.U.
10. Total fuel fired, pounds	40,214	39,862	52,746	46,613	43,947	45,469	47,459	Pounds
11. Coal fired per hour, pounds	1,756	1,681	2,903	1,973	1,862	2,024	1,882	"
12. Coal fired per hour per cu. ft. of comb. space, pounds	1.10	1.05	1.81	1.23	1.15	1.26	1.18	"
ASH AND REFUSE								
13. Carbonaceous content in furnace slag, per cent.	0	0	0	0	0	0	0	Per cent.
14. Carbonaceous content in 2nd and 3rd pass refuse, %	4.15	3.49	5.00	5.25	9.52	7.19	7.52	"
15. Carbonaceous content in uptake dust, per cent.	4.95	5.24	7.35	5.13	7.70	6.45	7.81	"
16. Calculated total carbon in refuse, per cent., coal fired	.50	.54	.62	.36	.87	.61	.67	"
17. Softening temperature of coal ash, degrees Fahr.	....	2,050	2,210	2,120	2,120	2,110	2,060	Degs. Fahr.
ASH ACCOUNT (PER CENT. OF ASH FIRED)								
18. From bottom of furnace	29.20	25.50	41.50	48.10	10.10	24.10	28.80	Per cent.
19. From second and third pass	12.10	11.60	5.80	10.40	10.30	7.00	9.10	"
20. From dust collector	31.50	25.00	33.20	29.20	27.50	29.00	28.50	"
21. Unaccounted for	28.20	37.90	19.50	12.30	52.10	39.90	27.60	"
AIR								
22. Temperature, air at furnace, degrees Fahr.	83	90	80	76	85	71	64	Degs. Fahr.
23. Pressure air at feeder, inches water	5.00	5.30	7.50	5.10	5.60	5.50	6.40	Ins. water
24. Excess air in flue gas, per cent.	30	22	18	18	19	15	20	Per cent.
FLUE GAS								
25. Carbon dioxide, per cent. by volume	24.10	14.90	15.40	15.50	15.30	15.80	15.10	Per cent.
26. Oxygen, per cent. by volume	4.80	3.80	2.90	3.30	3.20	2.40	3.60	"
27. Carbon monoxide, per cent. by volume	0	0	.26	0	0	.10	.10	"
28. Pounds of dry flue gas per pound of coal	12.40	11.20	10.60	11.00	11.30	10.80	11.00	"
29. Temperature of gases in uptake, degrees Fahr.	517	492	610	483	457	472	470	Degs. Fahr.
DRAFT								
30. At uptake, inches water	12	.10	.27	.09	.06	.08	.05	Ins. Water
31. Top of furnace, inches water	.00	.02	.00	.00	.01	.00	.01	"
STEAM AND WATER								
32. Steam pressure, pounds absolute	184	186	196	189	188	187	185	Pounds
33. Degrees superheat	60	59	80	58	53	61	67	Degs. Fahr.
34. Temperature of feed water, degs. Fahr.	108	99	99	101	101	100	100	"
35. Temperature water to coil, degs. Fahr.		No coil		54	53	52	50	"
36. Temperature water from coil degs. Fahr.		No coil		129	146	145	118	"
RATES OF HEAT ABSORPTION								
37. Per cent. of builder's rating (boiler only)	106.6	103.9	167.4	111.7	102.7	112.4	103.4	Per cent.
38. Horse power developed (boiler only)	498.8	486.5	779.0	523.2	480.8	526.0	484.0	Horse power
39. Superheater only, horse power developed	15.8	15.3	32.9	16.3	13.7	15.0	15.4	"
40. Furnace Coil, horse power developed		No Coil		49.7	55.0	59.7	45.9	"
41. Horse power developed, total	514	502	812	589	549	691	545	"
B. T. U. ABSORBED PER SQUARE FOOT OF H. S. PER HOUR								
42. By water in boiler	3,567	3,482	5,575	3,743	3,437	3,758	3,466	B. T. U.
43. By steam in superheating	892	861	1,856	920	772	845	869	"
44. By water in furnace coil		No coil		33,900	37,600	40,770	31,270	"
45. By water in boiler	9,500	9,690	8,990	8,870	8,630	8,710	8,885	B. T. U.
46. By steam in superheater	301	304	380	277	246	249	274	"
HEAT ABSORBED PER POUND OF COAL AS FIRED, B. T. U.								
47. By water in coil		No coil		843	995	988	815	"
48. Total absorbed	9,801	9,994	9,370	9,990	9,871	9,947	9,714	"
HEAT BALANCE, PER CENT. OF HEAT IN COAL FIRED HEAT ABSORBED								
49. By water in boiler	79.4	81.6	75.6	73.4	70.8	71.5	72.4	Per cent.
50. By steam in superheater	2.5	2.5	3.2	2.3	2.0	2.0	2.3	"
51. By water in coil		No coil		7.0	8.2	8.1	6.9	"
52. Total and thermal efficiency	81.9	84.1	78.8	82.7	81.0	81.6	81.6	"
HEAT CARRIED AWAY								
53. By dry gases	10.8	9.1	11.4	8.9	8.2	8.6	9.0	Per cent.
54. By steam from burning hydrogen	4.1	4.3	4.2	4.1	4.1	4.2	4.2	"
55. By steam from moisture in coal	0.1	0.3	0.3	0.2	0.3	0.3	0.3	"
56. By steam entering with air	0.3	0.3	0.1	0.1	0.1	0.1	0.1	"
57. By carbon monoxide	0.0	0.0	1.0	0.1	0.1	0.2	0.4	"
58. By carbon in ash and flue dust	0.6	0.6	0.7	0.4	1.0	0.7	0.8	"
59. By radiation	2.5	2.6	1.9	2.2	2.3	2.1	2.3	"
60. Heat unaccounted for (+or—)	0.3	1.3	1.6	1.3	2.9	2.2	1.3	"
61. Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	"

with which coal conditions can be met in making powdered coal installations. By reference to the illustration, it will be noted that the plant for the preparation of the coal, was installed over the boilers in a room, originally intended to house the economizers.

John Anderson describes the equipment for burning the powdered coal at this plant. The drier and pulverizers, he says, serve the five boilers which are of the three-pass, vertically-baffled type, with three drums. The coal passes from left to right through the direct-fire drier and over a magnetic separator to remove scrap metal, then through the variable speed pulverizer to the fuel bin from whence it is conveyed to the combustion chamber by two Lopulco feeders and burners with one blower for each boiler and all motor driven. The flame does not come within five feet of the ashpit door, therefore the ash collects as a carbon-free powder with only small pieces of slag easily removed.

The bulk of the air required for combustion is supplied, not through the burner, but through a number of 10-inch openings in front of the furnace. Tests made when operating at a rating of 116 per cent. showed a net efficiency of 85.22 per cent. on 10,779 B. t. u. coal received with 10½ per cent. moisture with an equivalent evaporation of 9.47 lb. per lb. of coal and an average of 13.85 per cent. CO_2 and no CO. The fuel for the drier and power for conveyors and pulverizers cost 26 cents per ton of coal treated, representing 4½ per cent. of the coal, and giving a net efficiency of 81 per cent. The boilers used were originally built for burning solid fuel, the only changes required being the addition of a mixing oven in front of the boiler and the rounding out of the corner formed by the door of the ashpit and the bridge wall. The furnace volume is 1,700 cu. ft. and with the proper air supply, there is no overheating or damage to the brickwork.

It might be of interest, at this stage, to see the actual results obtained from ordinary working conditions at such a plant and we give in tables in Fig. 6, a summary of several tests conducted over a period of ten months. These were tests made under actual operating conditions by Mr. H. Kreisinger under the Fuel Section of the United States Bureau of Mines in co-operation with the Research Department of the Combustion Engineering Corporation. The powdered coal equipment was designed and installed by the Locomotive Pulverized Fuel Co. The coal burned at these tests came from the Illinois coal field. The object of the tests was to determine what overall efficiency can be obtained with pulverized Illinois coal under various conditions of furnace operation. Conditions varied in respect of the various degrees of fineness and percentages of moisture.

It might occur to an engineer, that there is no means of banking the boilers during the period they are off. There is no difficulty whatsoever in this respect. During banked periods no coal is fired. Both the stack damper and the auxiliary air inlets are closed tightly. There is no flow of air through the furnace. The brick-work, however, acts as a regenerating medium, so that the loss of pressure in the boiler is extremely low. A boiler may be banked for more than ten hours with no coal fired and have a pressure drop during the whole of this period of not more than 20 lbs. This will be seen in table given in Fig. 5, which was an experiment conducted on No. 5 boiler over a period of ten hours.

RECORD OF OBSERVATIONS ON FURNACE DURING BANKED PERIOD AT ONEIDA STREET STATION

Date—August 19, 1919.

Boiler No. 5—Edge Moor, rated 168 nominal H. P.

	p.m.
Fuel feed shut off, uptake damper closed, and auxiliary air inlets closed..........	9 :00
Boiler steam outlet to header closed and 175 pounds steam on boiler	9 :20
Safety valves released about one minute ..	9 :40
" " " " " " ..	9 :55
" " " " " " ..	10 :08
" " " " " " ..	10 :15
" " " " " " ..	10 :25
" " " " " " ..	10 :38
" " " " " " ..	10 :43
" " " " " " ..	10 :52
" " " " " " ..	11 :02
" " " " " " ..	11 :09
" " " " " " ..	11 :18
" " " " " " ..	11 :28
" " " " " " ..	11 :38
" " " " " " ..	11 :48
" " " " " " ..	11 :52
Steam on boiler 155 lbs. when fuel feed started and boiler steam outlet to header opened	7 :00
Drop of steam pressure in boiler, from 9:00 p.m. until 7:00 a.m., or during 10 hours while fuel feed was off and during which time safety valves popped 15 times, for one minute each, or a total of about 15 minutes	20 pounds

A great amount of interest has lately been created in respect to the satisfactory utilization of our lignite deposits out West, for commercial purposes. The method of briquetting met with very poor success and we think the alternative will be found, after three years of success in the pulverizing of the coal, in adopting such a method which would help in the development of our natural resources and furthermore utilize such material to the best of advantage.

COAL CONSERVING

The value of hydro-electric energy as conserving coal consumption in Canada may be partly gauged by the fact that only 1½ per cent. of the total coal consumption takes place in central electric power stations. In the United States 2.6 per cent., and in the United Kingdom 9.7 per cent. of the total coal consumption occurs in the stations. In 1920 over 97 per cent. of all the power output from central stations in Canada was produced from water power. The steady growth of water-power development during the past two years indicates that this proportion will be maintained or even increased.

NO DANGEROUS STRAINS FROM SUDDEN STEAM DISCHARGES

No degree of shock whatever was shown when the effects of large sudden steam discharges from boilers were investigated by the American Society of Mechanical Engineers' research subcommittee on sudden initial pop lift safety valves. The results obtained by this committee, of which P. G. Darling is chairman, were presented at the recent annual meeting of this society. The tests were conducted to determine whether there is a shock to the boiler which under any condition may become dangerous or cause damage when a relatively large steam discharge from a boiler is suddenly stopped, as in the opening and closing of a safety valve.

The tests covered sudden steam discharges which in size, relative to boiler capacities, were far in excess of the capacity of any safety valve which would ever be attached to the boiler. With a 75-boiler-hp. Almy water-tube at the plant of the Crosby Steam Gauge & Valve Company at Boston (actual test in this case being made by the Massachusetts Institute of Technology) the maximum discharge tried was approximately three times the total safety-valve requirement of the A. S. M. E. Boiler Code. On a 94-boiler-h.p., 300-lb.-pressure Babcock & Wilcox boiler installed in the plant of the Consolidated Safety Valve Company at Bridgeport, Conn., more than seventeen times the total value capacity for the boiler was instantaneously relieved in the attempt to produce a shock. When it is considered that two or more valves would be called for by the A. S. M. E. Boiler Code, the sudden steam relief that was tested at Bridgeport would be thirty-four or more times the largest valve which would generally be used with this boiler. The locations of the pressure indicators in the Bridgeport test, selected because considered the most likely points to receive shock, are believed to be representative enough to justify the conclusion that no shock would be detected from an attachment at any other place.

In the opinion of the committee the investigation might be continued with prolonged trials on different types of boilers under different conditions of steaming, and with additional points of attachment for the pressure indicators. However, considering the fact that no degree of pressure increase or shock whatever was detected under the severe steam discharge conditions tried, the committee believes that it is extremely unlikely that any boiler conditions would be found so radically different as to produce a shock. In other words, if a pressure-increase shock could be produced by any reasonable boiler operation, the committee believe that the conditions of their tests were representative enough to insure detection of such shock.—Electrical World.

Fusibility of Ash from American Coals

The Data and Information Gained in the Investigation Upon the Fusibility of Coal Ash Should Very Materially Help the Engineer to Safeguard Against This Objectionable Condition

By W. A. SELVIG and A. C. FIELDNER, of the U. S. Bureau of Mines.*

INFORMATION concerning the fusibility of coal ash has become of considerable value to the consumer of coal, mainly in connection with the troublesome formation of clinker resulting from the melting of the ash constituents of the burning coal. The growing interest in such data has led the Bureau of Mines to make a general survey of the "fusing" or "softening" temperatures of ash from coals of the United States. It is hoped that this information, when used together with the large number of coal analyses published by the bureau, will assist the consumer of coal in comparing different coals, and in selecting the coal best adapted for his purpose.

Coal ash is the incombustible residue remaining after the complete combustion of coal; it is derived from the inorganic mineral constituents of the coal. The ash-forming constituents are (1) inherent or intrinsic impurities that are present in an intimate mixture with the coal substance, and are derived either from the original material or from external sources such as sedimentation and precipitation while the coal-forming plant remains accumulated; (2) impurities, formed either during the laying down of the coal bed or subsequently, that occur in the form of partings, veins, and nodules of clay, shale, "slate," pyrite, and calcite; and (3) impurities that become intimately mixed with the coal in the process of mining, such as fragments of roof and floor.

. . . . The fusibility of coal ash depends on several factors, such as the ratio of the silica to the bases present, the particular bases, and the percentage of alumina present. Mixtures extremely high in silica or extremely high in bases are not readily fusible. Ash that is low in iron is usually so highly siliceous that it is not readily fusible. Ash from coals high in pyrite is necessarily high in iron, and the ratio between the bases and silica is often such that easily fusible compounds may be formed. As a rule, coals containing considerable sulphur in the form of pyrite are apt to give trouble from clinker formation. Under conditions of the fuel bed the iron of the pyrite is apt to be converted to ferrous oxide, which with the silica present forms ferrous silicates that fuses at comparatively low temperatures.

Relation of Fusibility Tests to Clinker Formation

It is well to bear in mind that the conditions of fusibility tests in the laboratory may not be directly comparable to the conditions in the fuel bed of a furnace. In a laboratory test the ash-forming constituents are intimately mixed, whereas there is usually no such uniform distribution of the ash-forming constituents in coal.

Some coal ash is so fusible that little trouble is experienced from the formation of clinker. Ash that is slightly more fusible will often form a porous, spongy clinker which does not seriously obstruct the flow of air through the fuel bed and is easily removed. Coal ash with a low fusing temperature, say 2,100° F., not only melts in the average fire box but is heated several hundred degrees above its melting temperature, becoming quite fluid and spreading out in a thin sheet, over the grate, thereby obstructing the flow of air and localizing the heat in the fuel bed.

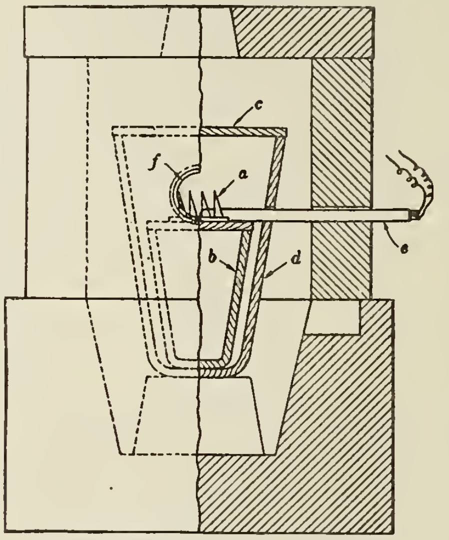


Fig. 1—Section of No. 3 melter's furnace arranged for fusion tests.

Effect of Atmospheric Conditions

The method adopted for making fusibility tests was the result of considerable experimental work, by the Bureau of Mines on the nature of the fusion of coal ash and the influence of various oxidizing, reducing, and neutral atmospheres on the softening temperature of ash molded in the form of Seger cones. The method takes into consideration the various factors that influence the result obtained, with special reference to the atmosphere surrounding the ash during the test. . . . . Analysis of clinkers from boiler furnaces indicated that fuel-bed conditions favored the formation of clinkers in which the iron was chiefly in the ferrous state; consequently the values obtained in the laboratory tests are, in this respect comparable to such conditions, and the tests give the lowest temperatures at which the intimately mixed ash will soften with the formation of clinker.

Method of Testing Ash

The interior of the furnace as arranged for making a test is shown in figure 1. The ash cones a are supported on a plate of alundum cement serving as a cover for the crucible, b, which is a Denver fireclay hard-burned crucible, No. E, 4 inches high and 3 inches in diameter at the top. An alundum tube of the proper height may be used in place of crucible b. Crucible d is a Denver fireclay hard-burned crucible, No. K, 7¼ inches high and 4⅝ inches in diameter at the top; it has observation and thermocouple holes corresponding to those in the furnace cylinder, and it rests on a fire-clay support. The thermo element is protected by a glazed Marquadt porcelain tube, e, one-fourth inch in diameter. A fused silica tube, 1⅞ inches in external diameter and 6 inches long, is placed in the observation hole of the furnace, the inner end being flush with the inside furnace wall and the other end projecting from the furnace. This crucible should be provided with two holes in the side, an observation hole 2 inches in diameter with its center 2 inches from the top of the crucible and a thermocouple hole 1 inch in diameter, 9° to the right of the observation hole. The bottom of this hole should be in the same horizontal plane as the bottom of the observation hole.

Ash Completely Oxidized

Spread out 50 to 100 grams of 60-mesh coal on a 5-inch fire-clay roasting dish, and completely convert it to ash in a muffle furnace at a temperature of 800° to 900° C. Transfer 5 to 10 grams of this ash to an agate mortar and grind to a fineness of 200-mesh. A mechanical agate-mortar grinder will save time where many determinations

(Continued on page 30)

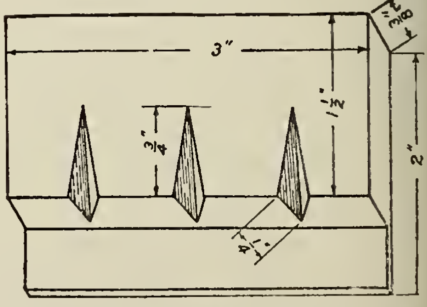


Fig. 2—Brass cone mold for making ash cones.

Factors That Influence Chain Drive Efficiency

Purpose of the Spring Cushion Wheel—Recommended Gear Ratio—Best Location of Drive—Taking Care of Slackness in Chains—Tendency to Individual Drive on Machine Tools

SPRING cushion wheels are designed for reducing the irregularities in the load on chains when driving certain classes of machinery. It is usually the driven wheel and while not occupying much more space than an ordinary wheel is considerably heavier. There is an outer toothed rim with two or more inwardly projecting vee blocks arranged equidistant. The inner portion of the wheel comprises a boss and rim with outwardly projecting vee blocks also arranged equidistant. Coil springs in partial compression are arranged between these vee blocks, one set taking driving effort and another and lighter set acting as buffer springs to neutralise the recoil when the extra compression is taken off the first set of springs. The springs are enclosed by a suitable cover plate. To keep the inverted tooth type of chain in place, guide plates may be arranged either on the outside or along the centre of the chain, though, of course when used on flanged wheels, the guide plates are unnecessary.

Recommended Gear Ratio

Horse powers from 1/10 to 5,000 have been satisfactorily transmitted by chains. The maximum gear ratio recommended for the roller type chain is 7 to 1 and for the inverted tooth type chain 6 to 1. For the roller type chain of ⅜ in. and ½ in. pitch the normal maximum chain speed in feet per minute is 1,000 and this is gradually decreased as the pitch increases so that for a 3 in. pitch chain 500 ft. per minute would be the normal maximum. In the inverted tooth type for ⅜ in. and ½ in. pitch 1,500 ft. per minute may be employed, and this gradually decreases to 1,200 ft. per minute for a 3 ins. pitch chain. These figures assume a sprocket pinion of not less than 19 teeth for the roller type and 21 teeth for the inverted tooth type. The desirable maximum centre distance expressed in pitches of chain for the roller type, ⅜ in. to ¾ in. is 100, 1 in. to 1¾ in. 85, 2 in. and upwards 70. For the inverted tooth type ⅜ in. to ¾ in. is 70, 1 in. to 1¾ in. 60, above 2 in. is 50. These figures apply for an ordinary horizontal drive with steady load or slightly inclined drive. The minimum centre distance should be such that the arc of contact is not less than 120 deg. between the chain and any wheel and with at least 7 teeth in engagement. Chain drives should preferably be arranged horizontal or inclined not more than 60 deg. when the large wheel is uppermost in the drive and not more than 45 deg. when the pinion is uppermost. These angles refer to the driving side of the chain and an horizontal line. It is important that the shafts should be truly parallel and horizontal.

Vertical shafts require special treatment. Wherever possible means should be provided for adjusting the shaft centres so that slackness due to a worn chain may be taken up. This prolongs the life of the chain. In electric drives, the slide rails of the motor make this provision. At least 1½ times the pitch of the chain should be allowed. If provision cannot be made, in the case of an horizontal or inclined drive, the chain may run slack until the slackness is such as to allow a link in the chain to be removed. Where the bottom side of a chain is the tight side, provision must be made to keep the two sides apart, hence the reason for large chain wheels in relation to centre distance. A chain works best with the tight or driving side uppermost and should be so arranged where a choice is possible. In all cases where there is a substantial amount of end play provision must be made to allow the chain to move laterally. Pinions should have an odd number of teeth if possible, in order to give uniform wear on the wheels and chain. Irregular loads should be corrected by the introduction of a flywheel and centre distance should also be short and the wheels as large as possible to prevent sagging. If a flywheel is impossible, the chain must be kept taut by adjusting the centres or the use of a jockey wheel or the introduction of a spring cushion wheel to absorb shock. Safety pins can be fitted in a driven wheel in the case of feed motions where damage may occur due to positive action of the chain. This shears in the event of an overload and allows the driven wheel to turn around on its shaft.

Cleaning and Lubricating

Lubrication of the working joints is essential for chain gearing. The most efficient form of lubrication is to encase the drive and pump a constant stream of oil on to the inside face of the chain from a filter pump, or the chain may be run through oil. This is essential for a chain speed exceeding 1,000 feet per minute. A drip feed lubricator may be used for slower speeds dripping on the inner face of chain, and a light or medium machine oil should be used. Periodic cleaning is essential.

The drive should be thoroughly cleaned and overhauled every three months and oftener if working in damp and dirty conditions. A bath of paraffin is recommended and then a suitable lubricant, tallow or grease for roller chain, light or medium machine oils for the inverted tooth type, all wearing surfaces should be thoroughly lubricated. If the chain has not a gear case, a light screen or guard may be necessary to guard against oil splashing. When the periodical examination is made it should be seen whether the chain requires adjustment, requires clearing, whether the wheels are correctly aligned, whether undue wear is taking place or whether lubrication is satisfactory. In the chain case, the chain runs through a reservoir of oil, and the level should be such that the lowest point of the chain will dip into the lubricant in its passing. The cases are divided, the upper half fitting inside the lower, and are dust-proof.

Necessary Conditions

When a chain is being renewed, it should be noted that where the drive is continuously in one direction a certain amount of wear will necessarily take place on the face of the wheel teeth in contact with the chain. Providing the wheel bosses are equal sided and bored parallel they should be reversed on their shafts to bring the unworn faces of the teeth into engagement with the new chain.

In addition to the numerous motor to lineshaft, lineshaft to countershaft and countershaft to machine chain drives which have been introduced in recent years both in replacement of existing drives and as new installations, almost every modern tool is now constructed so that it may be directly driven by motor. In this case the motor is self-contained with the machine, and the drive from the motor spindle to the driving spindle of the machine is very frequently by chain.

The invariable practice is to either mount the motor on a foundation plate connected to the machine or directly on the machine itself. Examples of both these methods are to be found in any modern engineering works, applying to the driving of lathes, planing, shaping, slotting, milling, drilling, gearcutting and other machines. The chain is also being developed for auxiliary drives, such as for driving the feed motion of a lathe, the power elevating gear for a planing machine, the quick power traverse of the carriage of shaping and various machines, tools etc. In some cases it is possible to displace quite a complicated arrangement of spur and bevel gears, horizontal and vertical shafts by a simple chain drive. Jockey wheels are employed to guide the chain past any desired point. The user is strongly recommended in any case of doubt to lay his information before any of the well-known makers of chain drives for their advice.

FUSIBILITY OF ASH FROM AMERICAN COALS

(Continued from page 28)

are made. Place the finely ground ash in a silica or porcelain capsule, about five-eighths of an inch deep and 1¾ inches in a current of oxygen, at a temperature of 800° to 850° C. The purpose of this ignition is to insure complete and uniform oxidation of the ash.

Figure 2 shows a brass cone mold for making ash cones, three-fourths inch high and one-fourth inch at each side of base, which is an equilateral triangle.

Temperature Measurements

This may be made with a thermocouple of platinum and platinum-rhodium, protected from the furnace gases by a glazed Marquadt, Usalite, Impervite, or equal quality porcelain tube and a high resistance millivoltmeter; or with an optical pyrometer preferably of the Leads and Northrup Wanner type.

Moisten the ignited ash with a 10 per cent. dextin solution, containing a small amount of salicylic acid as a preservative, and work into a plastic mass with a spatula. Mold the plastic material into small triangular pyramids three-fourths of an inch high and one-fourth of an inch wide at each side of the base. The pyramids are made by firmly pressing the plastic material with a steel spatula into a brass mold of the dimensions mentioned, the mold being similar to that shown in figure 2. Usually five cones are mounted on the refractory base. Put the test piece in the muffle furnace in the position shown in figure 1, place the loosely fitting cover c on the crucible, and ignite the gas. It is necessary to let the gas burn about 10 minutes to heat the furnace parts before the large cover plate of the furnace is replaced; otherwise the flame is apt to blow out. After the cover plate of the furnace has been put in position, the flow of gas and air is increased enough to cause combustion to take place just above the tuyeres and yet maintain a yellowish flame at least 6 inches above the opening in the furnace cover plate. While such a flame is maintained above the furnace, gradually increase the temperature by a suitable adjustment for gas and air to 800° C., then reduce the rate of heat increase to not less than 5° C. and not more than 10° C. per minute. Maintain this rate until the end of the test.

The softening temperature is defined as the temperature at which the cone has fused down to a spherical lump.

Critical points other than the softening temperature may be observed during the test and may be of value. They are as follows:

The initial deformation temperature—the temperature at which the first rounding or bending of the apex of the cone takes place.

The fluid temperature—the temperature at which the cone has spread over the base in a flat layer. Owing to the short life of the refractory crucibles used when heated to temperatures higher than 1,500° C., ashes that did not fuse at 1,500° C. were heated in a molybdenum-wire resistance furnace in an atmosphere of hydrogen gas to a temperature of 1,650° C.

Grouping of Softening Temperatures

In general, the softening temperature of coal ash from the coals of the United States ranges from 1,900° to 3,100° F. For convenience in discussion, the order of fusibility of ash may be expressed by subdividing this range of softening temperature into three groups, as follows:

Class 1, refractory ashes, softening above 2,600° F.

Class 2, ashes of medium fusibility, softening between 2,200° and 2,600° F.

Class 3, easily fusible ashes, softening below 2,200° F.

The coals of Ohio which were tested gave ash of medium fusibility, mainly in class 2. The bituminous and semi-bituminous coals of Pennsylvania that were tested gave refractory class 1 ash and medium fusible class 2 ash, chiefly the latter. Only a small number of coals from the Pennsylvania anthracite region were tested; these gave refractory ash in class 1. The semi-bituminous coals of West Virginia come principally in class 1 and class 2. Some very refractory class 1 coals are found in the Beckley bed in Raleigh County. Many of the coals of Maryland that were tested gave a refractory ash coming in class 1 or in the upper part of class 2. The softening temperature of the ash from coals of eastern Kentucky and of Virginia cover a wide range of fusibility from readily fusible ash, class 3, to refractory ash, class 1. The coals tested from Tennessee and Alabama come mainly in class 2, having ash of medium fusibility, but both class 1 and class 3 are represented. The ash-softening temperature of coals from Illinois, Indiana, western Kentucky, Kansas, Missouri, Oklahoma, and Arkansas, is uniformly low, practically all coming in class 3. The uniformly low softening temperature of the ash is unquestionably due to the rather general distribution of pyrite, calcite, and frequently gypsum in the coal beds. A great variety of coal is found in the West, ranging from lignite to anthracite. Most of the samples of Alaska coal listed were taken from outcrops or prospects, and range from refractory class 1 ash to ash of medium fusibility of class 2. The coals from Washington show all three classes of fusibility. The majority of the samples, however, come in class 1 and class 2. These coals have a high ash content, but in many the ash is refractory. Oregon and California contain little coal. The coals tested from Colorado and New Mexico range from refractory class 1 ash to easily fusible class 3 ash, the majority of the samples tested coming in class 1 and class 2. Many of the coals from Utah showed ash of comparatively low fusibility, in the upper part of class 3; a considerable number of samples gave ash of medium fusibility, in class 2. A few samples gave refractory class 1 ash. The lignites tested, from North Dakota, South Dakota, and Montana, have ash of rather low fusibility, the majority of the samples coming in class 3 or the lower part of class 2. The sub-bituminous coals tested from Montana and Wyoming also gave ash of rather low fusibility, most of the samples coming in class 3 and the lower part of class 2.

*The laboratory fusibility tests were made by A. E. Hall, V. C. Allison, W. A. Selvig, C. R. Locke, C. S. Purcell, W. C. Ratliff, O. C. Brown, W. F. Holbrook, and A. M. Ondrejco, all of the chemical laboratory of the Bureau of Mines.

SOAPSTONE FROM CANADA

Canada is expected in time not only to fill its own demand for soapstone but to export considerable amounts of it. A concern known as the Wabigoon Soapstone Company, Ltd., with a capital of $500,000, which will mine soapstone in the Wabigoon district about 200 miles northwest of Fort William, was recently organized. The company is said to own one of the largest soapstone deposits known, and it is claimed to be the only deposit in Canada that can be worked commercially. Samples of the stone are reported to be of a greenish color, easily worked and of excellent quality. The development of the industry will be watched with interest by the pulp and paper companies who use this stone for lining kraft mill furnaces and pulp digesters.

NICKEL-BEARING STEELS ARE STANDARD

The use of nickel-steel in the automotive industry, has been so broad and experience with it has extended over such a long period, dating back to the infancy of the industry itself, that the compositions used have become well standardized both by users and steel manufacturers. Specifications are published, both by the Society of Automotive Engineers and by the American Society for Testing Materials, covering grades of nickel-bearing steels used in the automotive industry.

In consequence, nickel steels are readily secured even on short notice, as they are produced by all alloy steel mills who consider the 3½% nickel and low chrome-nickel steels as standard heats. They are carried as standard stock by many of the steel warehouses and large drop forge companies. The ease with which these standard steels may be secured has often prevented serious tying up of large production. Through long experience, the steel makers are more familiar with the technique required to produce a high quality of nickel alloy than of any other alloy steels. This, of course, guarantees uniformity of product and freedom from trouble both in shop fabrication as well as in the finished product.

Fundamentals of Transmission of Power by Belting

Relative Tension of Tight and Loose Side of Belt—Adhesion of Belt to Pulley—Pulley Grip a Dominant Factor of Transmission—Purpose of Belt Dressings

By LOUIS W. ARNY, Secretary, Leather Belting Exchange

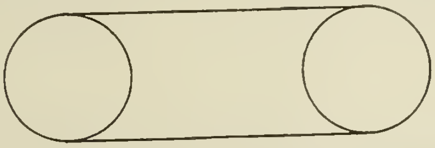
IN THE ideal belt drive, wherein the belt runs horizontally, pulling on the bottom, and in the modifications of it driving at an angle, certainly as much as 45 deg., and perhaps more, the belt still pulling on the bottom, we have a very favorable illustration of the value of elasticity in the belt. Where the belt is put on the pulleys under the usual tension of, say, 288 lbs., or thereabouts, when the belt is in a state of rest, the tension is fairly divided between the two strands of the belt (as illustrated in Fig. 1), if the shafts, or either one of them, are free to revolve. In the case of a belt of ordinary size, put on with belt clamps, the stress occasioned by the clamps usually is sufficient to revolve either one of the shafts to the extent of producing an equilibrium between the two strands of the belt, and the total tension on the belt is divided approximately evenly between the two strands. In the case of a very large belt, say a heavy main driver, over an engine and a long and heavy countershaft, this might not be exactly true, because it may be impossible to supply sufficient strain by the clamps to either slip the belt or to turn either shaft, so that the full strain of the clamps is not communicated to the other strand of the belt, and the tensions may be different. Ordinarily, though, in the case of smaller belts, the tension on the two strands of the belt in a state of rest is practically the same.

Effect of Motion

When the motion is applied, if the belt be of leather, the tensions probably will be slightly changed, even before the load is applied, the tension on the bottom side increasing slightly, and the tension on the top side decreasing slightly, but when a sufficient load is applied there gradually occurs a complete change, the bottom side becoming more taut, and the top side increasing in length and becoming loose and dropping considerably from a straight line drawn across the face of the two pulleys. Apparently, as in Fig. 2, the tension which existed in this top strand in a state of rest, has disappeared, or nearly so, and its total tension probably is not any more than that occasioned by its own weight. The tension on the bottom strand, however, has been increased by the application of the load, and whatever the load may be, it is being carried by this bottom strand. The carrying of this load by the bottom strand is dependent, therefore, upon the adhesion of the belt to the pulley, because there no longer is a tension on the top side to hold the belt in place. The belt is appreciably longer than it was when standing, and without this quality of adhesion, or pulley grip, it simply would slide around the pulleys, and the tension on the bottom ply would be lost.

Grip of the Belt

With a good leather belt this tension, however, is not lost, because the pulley grip is of sufficient intensity that the belt does not slide around the pulleys. It is obvious, then, that pulley grip is a dominant factor of transmission, and it must be remembered that this particular pulley grip of which we are talking, that is, the ability of the belt to hold firmly, or to stick tightly, to the pulley of its own accord, is a feature of the leather belt only, and that other types of belting do not possess it intrinsically. In belts which do not possess a natural pulley grip as described, it becomes necessary to supply something that will become its substitute, at least to an extent, and hence the use of sticky belt dressings, and the maintenance of a high tension on the top side. Some form of pulley adhesion may be supplied to them for a time by the application of "dope," but any advantage which they may acquire from such application is only temporary. Those belts which do not possess the elasticity of the leather belt, and hence will not pull out, or elongate, on the top side under a load, cannot rid themselves of their tension, or back pressure on that side.



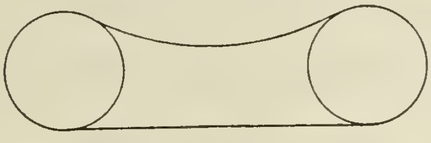


Fig. 1.—Top: tension evenly divided. Fig. 2.—Lower: tension on bottom portion due to load.

Power Transmitted

The power transmitted by any belt is the difference between the tensions of the top and bottom strands. From the total tension of the bottom side must be substracted the total tension of the top side. If, to prevent the belt from slipping, it be necessary that the original slow running tension on the top side shall be maintained, this must be deducted from the tension on the bottom side to secure the effective pull. This tension on the top side becomes a back pressure which the tension of the bottom side must overcome, and the maintenance of this tension, then, becomes a part of the cost of transmitting the load by this belt. If the same load can be transmitted by another belt without maintaining this tension on the top side, it is evident that it will transmit a larger load, or will transmit the same load at a less expense. Therefore, the belt whose pulley grip is sufficient to carry its load without slipping excessively, and which has sufficient elasticity to elongate on the top side to an extent to cancel the tension of that side, will operate more favorably, and more efficiently, than the belt whose adhesion to the pulley must be maintained by a continuance of the tension on the top side.

The factors of economical and efficient power transmission by belting, therefore, are pully grip and elasticity, and any belt to operate efficiently must possess both these qualities. This, then, becomes a measure of belt efficiency. Those belts which possess both of these qualities are efficient belts, and those which do not possess them both are inefficient. These points constitute the fundamental difference between leather and other types of belts. The grain, or hair, side of leather, properly prepared, makes a natural suction contact with the pulley which cannot be duplicated artificially in other materials. Many belts fundamentally are fabric, and fabric in any form is incapable of making this suction contact with the pulley, and is notably deficient in elasticity as compared with leather.

The advantages of elasticity in the belt as above described, are entirely separate and distinct from that other advantage of the increased pulley contact which is a result of the elongation of the top side of the belt. Pulley contact is one of the important factors of power transmission, and hence the more of the arc of the pulley that is covered by the belt, the more will be the power transmission; and the longer and looser the top strand of the belt may be, the more of the arc of the pulley will be covered. The value of pulley contact as a factor is, at least, in proportion to the degrees of arc of contact.

Combustion Enginee

THE COMBUSTION ENGINEERING CORPORATION, LTD.

Announces

A Complete Canadian Service

in the Combustion Field

Combustion Engineering Corporation, Ltd., of Canada, has acquired the sole manufacturing and sales rights in Canada for the following companies:

Combustion Engineering Corporation of New York
The Green Engineering Company of Chicago
Underfeed Stoker Company, Ltd., London, Eng.
Lopulco Systems, Inc., New York
Custodis Canadian Chimney Company, Limited

The equipment handled represents all types of mechanical stokers, pulverized fuel burning systems, ash conveyors, ash hoppers, air heaters, economizers, soot blowers, induced and forced draft fans, chimneys and recording instruments.

A research department with a complete engineering staff has been established. We solicit your inquiries.

Combustion Engineering Corporation, Ltd.

MR. A. J. T. TAYLOR, *Managing Director* MR. JOHN T. FARMER, *Chief Engineer*

Main Office: TORONTO

Montreal Winnipeg Vancouver

ng Corporation, Ltd.

A RESEARCH DEPARTMENT

has been established which has the benefit of the advice of such nationally known engineers as

JOHN VAN BRUNT, Chief Engineer, Combustion Engineering Corp.

HENRY KREISINGER, Research Engineer, formerly of United States Bureau of Mines.

JOHN E. BELL, Consulting Engineer, Research and Design.

T. A. MARSH, Chief Engineer, Green Engineering Co.

SAMUEL McEWEN, Chief Engineer, Underfeed Stoker Co., Ltd.

J. BEUZIT, Chief Engineer, Société Anonyme des Foyers Automatiques.

Power Plant
EQUIPMENT HANDLED

Green Chain-Grate Stokers
Green Ash Hoppers
Custodis Chimneys
Lopulco Pulverized Fuel Systems
Coxe Stokers
Air Heaters
Combusco Water Seal Ash Conveyor
Frederick Multiple Retort Stokers
Type E Stokers
Type D Stokers
Type K Stokers
Self Contained Stoker

Combustion Engineering Corporation, Ltd.

MR. A. J. T. TAYLOR, *Managing Director* MR. JOHN T. FARMER, *Chief Engineer*

Main Office: TORONTO
Montreal Winnipeg Vancouver

Combustion Problems and Furnace Design

Experimental Research and Co-operation of Mechanical Engineer Necessary for Looking Into Combustion and Furnace Problems With a View to Developing the Soft Coal Industry

By PROFESSOR CHARLES A. ROBB, B.Sc., S.M.

A VERY interesting lecture was given by Professor Robb before a general meeting of the Alberta Association of Professional Engineers on January 6th at Lethbridge. This was in response to a request by their council who decided to have a series of papers presented to promote discussion and encourage the co-operation among the members of the association upon many of the problems that demanded their attention.

Professor Robb started his lecture by referring to the economics of research, pointing out that Faraday's discovery of the law of the electric dynamo in 1813, for which the apparatus cost less than five pounds, has made possible the whole electrical industry in which England alone had invested, in 1917, £600,000,000, and the United States in 1920 had invested no less than four billion dollars.

Continuing, he said that Newcomen's Atmospheric Engine of 1705, Watt's condensor of 1763, Watt's rotative type engine of 1781 and his double-acting engine of 1782, paved the way for the application of power to the development of industry, and revolutionized the whole economic structure of England. Out of this grew the demand for machinery to replace manual labor; the capital to secure the machinery; the great shops in which to make the machinery, and the grouping of workers in these shops. This sequence gave rise to our modern system of finance and the organization of labor.

The discoveries of Pasteur gave to France in five years, sufficient savings to pay the whole debt caused by the Franco-Prussian war. It would be interesting to know what percentage of the savings effected by research is actually reserved for further research work.

Alberta's Natural Market

A typical problem for the mechanical engineer is that of combustion and furnace design. We have in Alberta vast quantities of coal and in great variety. Canada has a great demand for fuel. The Canadian sources of supply are limited to the Maritime Provinces and the West. Middle Canada must therefore draw from the East, the West, or import coal from the United States, and the latter is becoming increasingly difficult. Alberta has therefore in Canada a natural market for her coal, and combined efforts have established a firm hold on the Winnipeg market. Credit is due to our Trade Commissioner, Mr. Stutchbury and his assistant Mr. Pratt, who have been very active in demonstrating the virtues and characteristics of Alberta coal.

In 1920 a series of tests were carried out at the Provincial Government of Manitoba plant in Winnipeg, and it was shown that Alberta had coal which could be laid down at Winnipeg in competition with United States coal, both as to quality and price.

Engineers who are coal consumers, choose from the coals available, the one best suited to the furnace of their steam boiler, as to variety, size and the method of firing. Our coals range in quality from the best grades of bituminous, to that of comparatively high moisture, and high volatile gases, or so-called domestic coals. Most of the latter are mined during the winter months and the proportion of slack is very high. A few years ago this slack was considered a waste product and was placed on the dump. Furnaces and stokers have been devised which handle the slack successfully and real economies have resulted in their use. This economy is very far reaching, in that the coal operator gets a reasonable price for the slack, and the operative engineer gets his coal for half, or less of the cost of nut coal and with approximately the same boiler capacity and efficiency.

No Difficulty in Storage

Every ton of the sub-bituminous coal burned locally makes the equivalent in bituminous coal available for export, and with the latter, the problem of storage through the summer months presents no difficulty, whilst with our present knowledge, the tendency of the "high moisture" coal to slack, or crumble, makes storage difficult and expensive.

The export of the bituminous coal insures a more equitable basis for freight and tends to stabilize the whole industry, leaving the domestic market to be served by the higher moisture coals.

The problem for the mechanical engineer is, therefore, to devise improved means for burning the domestic coal, that is to say, improve the furnaces and methods of firing. Having done that, they must encourage the use of boiler furnaces best suited to the local coals. Broadly speaking this calls for a furnace with ample combustion space to take advantage of the high percentage of volatile constituents, and to overcome the effect of the moisture. Some progress has been made, and this field should prove very profitable.

In 1914 a special furnace, supplied by Babcock & Wilcox, was installed at the University of Alberta to permit the use of slack coal. This gives a satisfactory steam for "Dollar" economy, and the current annual saving amounts to approximately $20,000.00 or 50 per cent. The plant consists of four units of which three are equipped with stokers, and the remaining furnace, which is hand-fired, is designed on liberal lines for the high moisture coal. The heating surface is 2,197 sq. ft. per unit and the grate area 60 sq. ft. for the chain grate stokers and 44 sq. ft. for the Dutch oven, hand-fired furnace. In all units the boiler is placed well above the grate and in the stoker furnaces, a heavy arch is provided to assist in the ignition of the green coal.

It has been found that the high-moisture coals will not ignite properly on the standard chain grate stokers as designed for bituminous coal, and before the furnaces were rearranged the practice was to mix in a portion of bituminous coal which proved rather expensive.

Burning Slack Once Wasted

Other plants in the Province, including the municipal plants at Edmonton and Calgary, now burn slack coal that formerly was wasted. The annual reclamation value from this source must now be little short of half a million dollars, while the saving in coal cost to the plants is large.

Present conditions leave us with a moderate efficiency for the boiler and furnace and the specific problem covers a study of the furnace to establish suitable proportions, arrangement of arches, draft for various thicknesses of fire, etc., and special characteristics applying to stokers.

A comprehensive programme if developed in co-operation with the superintendents of the larger plants in the Province would lead to the accumulation of data covering the experimental work already accomplished, and co-ordinating efforts in the future. Broad outlines could then be established for the guidance of engineers in the design of furnaces for steam boilers and higher efficiencies should then be obtained.

A further point is that authoritative data covering furnace design should help to rectify the confirmed practice of installing furnaces suitable for bituminous coals only, to serve large steam boil-

(Continued on page 36)

Fitting of Keys in Crossheads and Flywheels

Operation That Requires Particular Skill—Sharp Corners Should Be Avoided—Parts Must be Accurately Fitted Before Driving Keys—Select Right Position for Keyway

A CHAIN is no stronger than its weakest link and in an engine there are so many "links" upon which the safety of the whole structure depends that considerable care must be exercised to see that all parts are in as good condition as circumstances will permit. Engines should be overhauled from time to time and this, very often, calls for a disconnecting of several parts. At times it may be necessary to replace old and worn parts with new. In such replacement a great deal of attention must be paid to securing correct fits or mating of the new parts with the old. In particular, we have in mind the fitting of the piston rod into the crosshead which, when these two are keyed or gibbed together, is a job calling for no small degree of skill.

Work for Skilled Mechanic

Attention need hardly be called to the desirability of obtaining the services of a first class mechanic skilled in the fitting up of engines to do such work. Such men are not always available, however, and the owner may have to be contented with a less skilled workman. In such cases the owner will naturally be interested in knowing how the work should be done so that he may give instructions to the mechanic he employs. Even with skilled hands to do the work the owner will naturally have some interest in the reasons for the steps that are taken.

The more usual construction that is found in this type of cross-head and piston rod joint is the one in which the end of the rod is tapered, although the straight cylindrical end is sometimes used. These two variations in the general construction are illustrated in Figs. 1 and 2. The end of the rod, where it fits into the crosshead, is sometimes relieved or undercut over a length slightly greater than that taken up by the keyway. This is illustrated in Fig. 1. The cylindrical end is also made with the outer or tip section of a slightly smaller diameter than the inner section, the part between the two being undercut. It should be borne in mind, however, that any reduction in the diameter of the rod will naturally weaken it and undercutting should not be done without due consideration of this effect. Furthermore, sudden changes in diameter with sharp corners should always be avoided because very severe stresses may be produced thereby. The end of the rod should also be rounded off as shown to avoid possible cutting when it is pulled into the crosshead.

Fitting the Tapered End

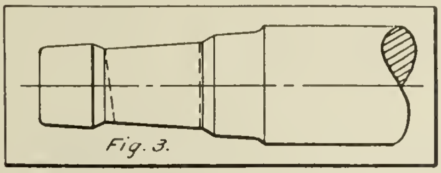


Fig. 3—Relieving middle portion.

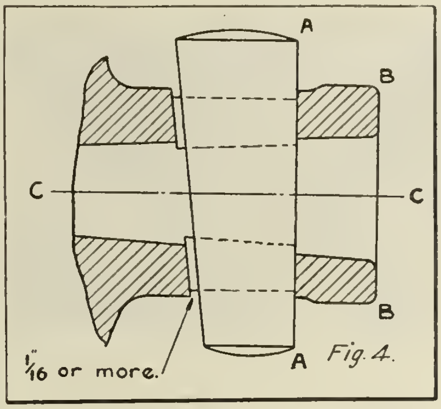


Fig. 4—Arrangement of tapered key.

A description will be given of the method of fitting the tapered end and from this it will not be difficult to see what treatment should be given the cylindrical end. The first step is to fit the tapered end of the rod into the hole in the crosshead so that the two parts will bear evenly and fully on the surfaces which touch each other and so that, when pushed together by hand, there will be a slight space between the end of the crosshead boss and the shoulder on the rod.

This space is for the "draw" and will be taken up when the key is driven in, thereby providing a snug, tightly-fitting joint. The amount allowed for this "draw" will vary with the size of the rod and the degree of taper. On large diameter rods not so much would be allowed as on small rods. With a rod diameter of 2½ in. about 1/16 in. would be correct. If the rod has a cylindrical end, the two parts should go together with what a machinist terms a "push fit."

The tapered end of the rod should be lightly smeared with Prussian blue and the two parts pushed together by hand and then given a slight turning or twisting motion. When the parts are separated those surfaces which had the closest fit will have the blue fairly well rubbed off and should be carefully filed down with a fine cut file until a neat fit is obtained over the entire length of the taper. It will be noted that no small degree of skill is called for in this fitting as a full bearing must be secured while keeping the diameters such that the proper "draw" is provided.

Proper Arrangement

After this fit is secured the next step is to obtain the proper relation between the key and the keyway or slot in the crosshead. This is shown in Fig. 4. The key, in this instance, has been shown with the tapered edge facing inward. The arrangement may be the reverse from this but, whichever it may be, it is desirable that the straight edge A-A be at right angles to the axis C-C. If the face B-B of the crosshead has been turned square with the bore this condition of the key may be inserted by making the edges A-A and B-B parallel. Sometimes the key is tapered on both edges. In such a case a vertical dividing line or axis may be scribed on it and this line may then be used as a reference to obtain the right angle condition. We might add that it is not absolutely essential that the key and the axis of the bore be at an exact right angle. There may be some deviation from this but whatever it is should be carefully noted.

Position of Keyway

The position of the keyway in the rod should be such that the relation shown in Fig. 1 will be obtained when the shoulder on the rod is brought up firmly against the crosshead. Note that it is well to provide some clearance at the front end of the keyway in the rod. It will be sufficient to make this 1/32 in.

While the position of the keyway in the rod may be obtained with comparative ease it must also be borne in mind that the tapered side of this keyway

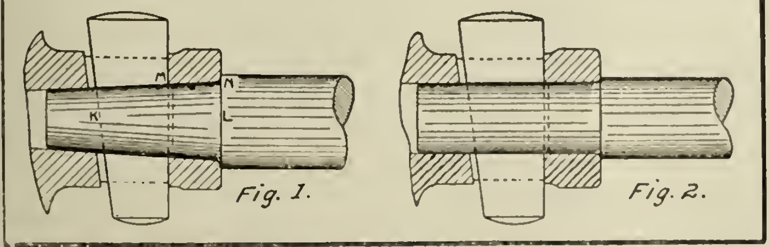


Fig. 1—Showing a tapered fit. Fig. 2—Parallel fit.

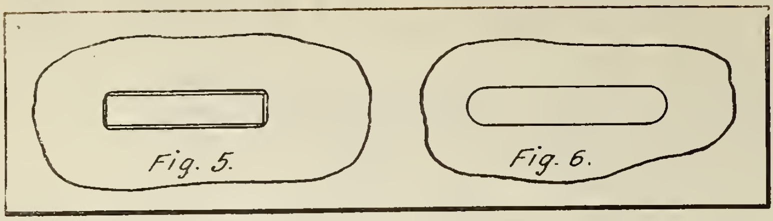


Fig. 5—Keyway with square corners. Fig. 6—Keyway with round ends, minimizes chance of breakage.

must make the proper angle with the axis of the rod. The key should be placed in the slot and, while it is bearing against the tapered side, its angularity with the axis of the rod should be measured. This angularity should be the same as that given the key when placed in the crosshead and brought to bear against the straight, non-tapered side. If this is not done, the key, when the parts are assembled, will not have a full bearing over its entire length and severe local stresses may be set up.

Making the Joint

The joint may now be assembled, the key placed in position and then driven in until the shoulder on the rod is brought up firmly against the end of the crosshead. By this method of fitting, a tight joint is made by pulling the tapered rod rigidly into the crosshead. The holding stresses will be a hoop tension or tensile stress in the metal surrounding the rod with a corresponding compression in the rod itself. These two stresses produce a pressure on the bearing surfaces which thereby set up a large frictional force to hold the joint together. In addition there is a tensile strength lengthwise in the rod between points K and L and compression in the crosshead between points M and N. (See Fig. 1.) Of course when the engine is operating there will be alternate compressing and pulling of the cast metal beyond the point M, but the crosshead has been designed by the maker to carry this stress, provided, of course that no accident occurs. This is a tensile stress that can be predetermined, whereas the tensile stress that can be set up by an improperly fitted key can very readily become severe enough to wreck the best of designs. The illustration shows a crosshead that was broken by an improperly fitted key.

There are a few points regarding this fitting of the key in the crosshead that require particular care. If a rectangular key is used the corners should be relieved because it is difficult to obtain a perfectly square cornered hole in the crosshead. A key with square corners produces the effect shown in Fig. 5, which condition cannot help but set up stresses tending to shorten the life of the crosshead. An excellent way to avoid any such trouble is to make the key with full rounded edges as shown in Fig. 6. Of course this requires possibly more time to fit than a rectangular key but the stresses are more equally distributed. If a rectangular key cannot be avoided it should have the corners relieved.

Disconnecting the Rod

It is not always easy to separate a rod and crosshead when they have been drawn firmly together on a taper joint. For such work a "driving out" set of keys is very helpful. This set is composed of three specially formed pieces which are shown in Fig. 7, assembled in place and ready for use. By striking on the center wedge B, the joint may very readily be eased up.

Fitting Shaft Keys

Some mention might also be made of the keying of wheels and pulleys to shafts. The function of a key used for this purpose is to prevent turning between the wheel and the shaft, endwise motion or sliding usually being prevented by set screws or by the compressing of a split hub on the shaft. For this reason the key should be a close fit on the sides but should have a clearance at the top. If this clearance is not provided, the load, when the hub bolts are tightened up, will be concentrated over the key, and the stresses tending to break the hub will be very much greater than if the load were equally distributed over the shaft. The illustration herewith shows a flywheel hub that was broken in this manner. The key had first been driven into place without allowing for the proper clearance and the hub bolts were then heated, put into place and pulled up tight. When the bolts cooled they of course exerted an intense clamping effect on the hub. The load was localized, however, over the key and, although failure did not take place immediately, the hub, no longer able to withstand the severe stress, broke, as shown, about a month later.

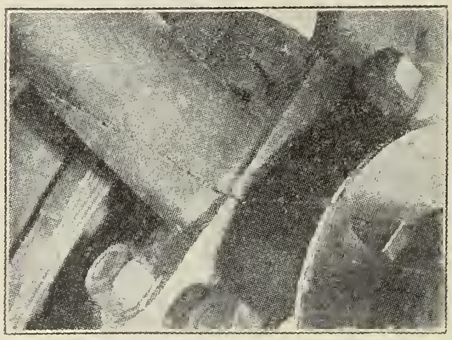


Fig. 8—Flywheel broken by key fitting too tight at top.

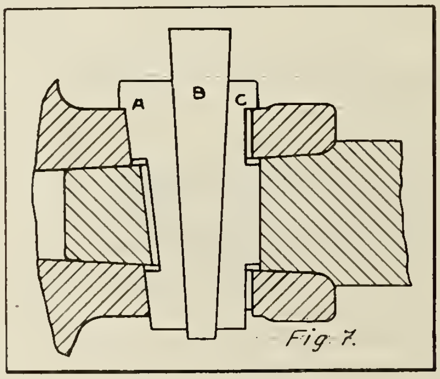


Fig. 7—Application of "driving out" set.

Extract from The Locomotive.

EFFECT OF NICKEL ON STEEL

(Continued from page 22)

gineer and the metallurgist, who selects the proper analysis and heat treatment, a wide range of possible physical properties to meet successfully almost every engineering requirement of tensile strength, elastic limit, ductility, hardness, and resistance to abrasion, shock and fatigue. In this condition we see it used in important forgings, axle shafts, gears, cam-shafts, piston pins, etc.

Nickel steels are an almost indispensable material for case-hardening or carburizing. The case-hardening process is used to secure an extremely hard surface, or case, combined with a tough center or core. We see from the effects of nickel on steel, noted above, that it naturally tends to fulfill this condition.

COMBUSTION PROBLEMS AND FURNACE DESIGN

(Continued from page 34)

ers, and which gives neither good boiler efficiency nor capacity.

Stoker manufacturers are recognizing the demand for more liberal combustion space as evidenced by their action at a convention last year in settling upon certain dimensions for various stokers. Experimental work has been carried out on lignite coals by the manufacturers of the B. & W. Jones, Green and Allan stokers. During the past month, word also came of results on the turbine stoker.

Investigations with a view to the solution of such problems is called Industrial Research. There is established in the province a Provincial Research Council, which exists as a department of the University with a staff of research engineers. In the organization of the Provincial Government, the work of the Research Council is attached to the Department of the Provincial secretary.

With regard to fuels, the programme of the council for the future includes "Screening and Storage," "House-heating" and "Furnace-tests" on coals. Boiler trials have been carried out on all the large samples of coal, also one on mixed coal. Fourteen trials in all have been made during the year. An experimental carbonizer for lignites is in operation, also a briquetting machine.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

S. S. MOORE - - - Managing Editor
W. B. ROBERTS - - - - - - Editor
B. G. NEWTON - - - - - Manager
H. D. TRESIDDER - Advertising Manager

SUBSCRIPTION RATE
Canada, $2.00; United States, $2.50, Great Britain, Australia and other colonies, 8s. 6d. per year, other countries, $3.00. Single copies, 25c. Advertising rates on request.
THE MACLEAN PUBLISHING COMPANY, LIMITED
143 UNIVERSITY AVENUE, TORONTO, CANADA
JOHN BAYNE MACLEAN, President
H. T. Hunter, Vice-President.
H. V. Tyrrell, General Manager.

Precaution Necessary With Oxygen

ALTHOUGH we think it is generally understood by engineers, that compressed oxygen must never be allowed to come into contact with mineral oil, they must not at the same time overlook the fact that it is equally dangerous to allow this gas to come into contact with any form of lubricating oil or even grease. It was due to this cause that one or two disastrous explosions have recently occurred, which were of such an appalling nature, that it is advisable for those who have any dealings with compressed oxygen to take this timely warning.

In one case, a 100 H.P. gas engine, which was usually started with compressed air raised to a pressure of eight atmospheres, was about to be started up. By some unfortunate misunderstanding or mishap in the mechanism, the cylinder of the gas engine was charged with compressed oxygen that had been raised to a pressure of seven and a half atmospheres. The moment the engine started to move, a violent explosion occurred in the cylinder killing the engineer and his mechanic, who were both standing nearby, and also seriously injuring several other workmen who were working some distance away.

In another case, an engineer who had charge of a refrigerating plant, had to charge up his system with ammonia. On account of the similarity in appearance, he took a bottle of oxygen by mistake, and whilst he was charging his machine, it exploded blowing the machine to pieces and instantly killing the engineer.

If engineers would only realize the danger of bringing matter of an oxidizable nature in contact with compressed oxygen, it would promote greater safety in plants and tend to reduce the liability of disaster. Manufacturers of the gas, who are aware of this condition, take the greatest conceivable care to insure that the gas is not contaminated.

It is interesting to note in following the history of oxygen compression, that accidents have occurred with some of our most thoughtful and experienced men, who would never have dreamed that such a small percentage of impurity could have had, or been the cause of such drastic consequences. In the case of oil, it is not merely the combustion of the oil itself that causes the trouble, but the metal parts of the apparatus burn freely as soon as they become sufficiently heated by the ignition of the oil or grease, and the consequences may transcend all imagination. The only lubrication that is used in an oxygen compressor is pure water, except in a few isolated cases where a little soap is dissolved in the water. In such cases, which are usually to meet a special condition, the mixture of soapy water is thoroughly analyzed to first insure that it contains no uncombined or unsaponified oil or grease, and furthermore, the packings that are used must be absolutely free from grease or graphite. If, therefore, such precautions are necessary in the manufacture of this gas, the same precaution is necessary in using it, and when a man talks with appropriate earnestness about the danger of allowing compressed oxygen to come into contact with oil or other combustible organic material, it is easy for those who are unenlightened or uninitiated to believe that he is inspired by unreasonable precaution or timidity, but this is not the case.

Lignite Coal

REVIVED interest has lately been shown in respect to the development of some of the larger deposits of lignite throughout the Dominion. These deposits in many cases are in the form of thick seams of easy access, which could be cheaply worked. The physical properties, however, such as the high percentage of water, low calorific value, disintegration in handling and storing, and lacking in coking properties tend to depreciate its value as a commercial heat-giving product. Its character, we are afraid, has fallen into even further disrepute on account of the poor success that has been experienced in attempts to successfully burn this low-grade fuel in an ordinary boiler furnace. Haphazard methods are of no use whatever, and if these wonderful lignite fields are to be developed, the situation should be grappled with in a proper scientific manner.

A very promising field offers itself wherein this class of fuel could be used in the pulverized form, and some very encouraging results were recently obtained from experiments conducted upon Texas lignites. One of the difficulties in this system, is retaining, during the process of carbonization, sufficient volatile matter to insure continuous burning. The low-temperature carbonization of lignite is also a process that will open up new avenues for research. This is comparatively a new process which should prove to be most interesting both from a commercial and scientific standpoint. It is a case where the chemist must join hands with the engineer, and with their united efforts we will know that the subject is being pursued to its ultimate end. Experiments have recently been conducted in England upon these lines, which have shown it possible to considerably enhance the calorific value of low-grade coals, and at the same time recover various useful by-products in the process. The upgrading of this type of fuel may also be effected by the utilization of the waste gases generated in the process, and which helps to very materially cheapen the cost of operation.

It would therefore seem that there are great possibilities for the future development of some system whereby lignites could be utilized for the generation of power on a large scale and there is no doubt that whatever obstacles that have been met with in the past would be eliminated one by one.

Our Question Box

Question.—If a large volume of water which was stored on a hill top was released and allowed to run down the hill and up the side of a hill facing it, would it reach the same height as the point from which it was released?—H.C.F.

Answer.—We understand this is the question H.C.F. wishes to ask, and we had better explain in the first place Torricelli's Theorem. "The velocity with which a liquid issues from a small orifice in the side or bottom of a vessel is equal to the velocity which would be acquired by a body in falling from the level of the surface of the liquid, to the level of the aperture." This applies equally as much to water flowing down a hill side since the water although flowing over the surface of the ground is actually "falling," but it is being subject to a greater surface resistance by falling in this manner, than it would by falling vertically down through the atmosphere. If water could be run down a chute that was so well lubricated that it was without friction, then the water would rise on the opposite hillside to the corresponding level of water from which it had originally started from. To explain this by way of formula, we would point out that the velocity of the water at the lowermost part of the valley or at the point where it leaves the orifice in the tank is proportion to the square root of the depth, providing there is no friction or resistance. To double the velocity we require to make the depth or height four times as great. If, therefore, H be the depth of the orifice or the vertical, height of the hill, V the velocity of the liquid, and G equals gravity (32), then

$V^2 = 2\,GH$ and $V = \sqrt{2GH}$

Question.—In babbitting a solid journal there is difficulty in removing the shaft to cut the oil grooves. What is a good method to overcome this trouble?—G.E.P., Edmonton.

Answer.—We are afraid that whatever method is adopted, the result would be that the ends of the oil groove are left open, thereby allowing the oil full exit. It may be posible, however, that these ends could be plugged up and we would suggest that a piece of clean, half-round split pin wire be bent around the shaft pin spirally with the flat side around this wire, which, after being left to cool down, will contract sufficiently to allow the wire to be withdrawn, leaving the half-round impression in the bearing metal. It is possible to burn a small portion of metal over the ends of the groove to prevent the oil from running away.

Question.—Could you tell me the name of a good book on babbitting?

Answer.—We do not know of any technical book on the market that makes a specialty of babbitting. Perhaps, however, if you get in touch with some of the big American publishing houses, they might be able to advise you of a book that touches upon the subject sufficient to meet your needs.

Question.—I have a hand force pump fitted in my house which is situated about 160 feet away from the well. It has a lift of 60 ft. and gives me a lot of trouble to get the water, and I would like to know the best thing to do.—F. B. Foleyet.

Answer.—We are afraid F. B. has made some mistake in his measurement. If his pump is an ordinary suction pump, as we should imagine it was by the description he gives, then he cannot possibly draw water from a depth of 60 ft. When a pump lifts water it withdraws the pressure of the atmosphere from the surface of the water inside the section-pipe, and the pressure of the atmosphere outside the suction pipe forces the water up until the pressure inside and outside become balanced. The distance the water is lifted is equal to the height of a column of water weighing 15 lbs. per square inch of area at the base which is theoretically about 34 feet. It is impossible in practice to have perfect tightness as some small leakages of air are sure to occur at the joints, valves or piston, and a perfect vacuum is never obtained.

The greatest distance that a pump will lift water is 28 feet, but even at this distance the pump is liable to lose its water if the barometer is standing very low. To prevent occasionally having a dry pump, the supply should never be drawn through a greater height than 25 feet, but as the efficiency of the pump varies, the suction pipe should be shortened up as much as possible and the maximum safe distance that should be made is 15 feet to insure that the pump will work well and uniformly at all times and draw the proper quantity of water at each stroke. It will of course be understood that the quicker the speed of the pump the shorter the suction pipe will have to be made. If, therefore, F. B. will study the principle of the pump he will be in a better position to know how to act because his explanation was not made too clear in his letter to us.

The question of the inter-provincial acceptance of engineers' certificates granted by provinces outside the one in which an engineer may be residing is commented upon by R. N. Blackburn, chief inspector of steam boilers, in his annual report to the Department of Public Works.

Some suggestions for the working out of a practicable scheme were made by Mr. Blackburn at an interprovincial conference held at Winnipeg in 1918, but, owing to pressure of other work, the matter was left in abeyance.

Mr. Blackburn says:

"It may reasonably be supposed that an engineer who is qualified to operate a steam engine in one province is equally qualified to operate a similar engine in another province, and at first sight it would appear that there should be no difficulty in arranging for inter-provincial certificates. In practice, however, there are a number of difficulties to be provided for. For example, the standard of examinations varies very considerably in different provinces, and it would manifestly be an injustice to engineers in a province where the standard of examination is fairly high to admit engineers from other provinces where the standard of examination is low on an equal status with them. Again in some provinces there are a large number of engineers holding certificates which they have obtained without examination, and it would be obviously unfair to Saskatchewan engineers who have passed a fairly high standard of examination to admit men holding such certificates on an equal footing. Also the grading of certificates in respect of the capacity the steam plant which the holder of the certificate is authorized to operate varies very considerably in the different provinces. Finally, the province final certifi-

(Continued on page 44)

[Correspondents sending us inquiries should sign their communications with full names and post office addresses.—Editor.]

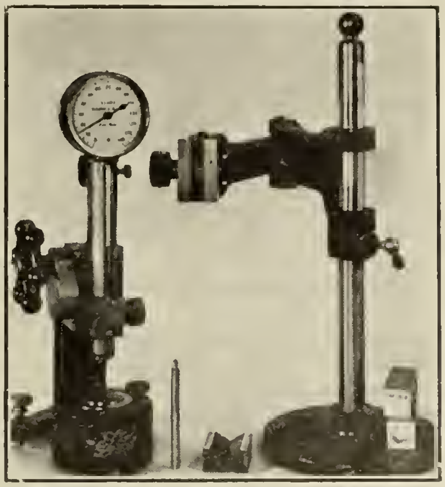
Progress in New Equipment

DIAL RECORDING SCLEROSCOPE

The scleroscope which has long been in general use for measuring the hardness of metals, is now provided with permanent indicating mechanism, a pointer hand and graduated dial. This feature is to be contrasted with the original model classified as Model C-1, in which the vertical graduated scale is used and against which the height of the rebound of the hammer indicating the hardness is read. The improved dial instrument is known as the "Model D Recorder," for here, instead of the indication being momentary, the hand remains fixed an indefinite length of time, or until the next test is made. The mechanism employed consists of the usual drop hammer. The function of this hammer is, by virtue of its accumulated energy of motion, to overcome the penetrative resistance of the metal under test. This absorbs more or less of its striking energy, which is always constant. That which is not absorbed, as most notable in the harder metals, remains available for reacting on, or rebounding the hammer itself, and which is proportional to the hardness of any metal.

Dial indicator attachment.

The hammer employed differs from the earlier models in that it is longer, heavier and drops and rebounds a comparatively shorter distance. The mechanism consists in the main of a sensitive one-way ball clutch and pilot sleeve, which normally holds the hammer at its upper starting position. When released, the pilot sleeve falls with the hammer, with the result that the slightest rebound, even though less than one thousandth part of an inch, is instantly fixed by the one-way clutch. Following this cycle, the clutch assembly is raised up to its starting position, carrying the hammer with it in its now superposed position, due to the percentage of rebound recorded. Simultaneously, the hammer arriving at its upper or starting position, engages and actuates a rack and pinion and hair spring dial mechanism, which in turn faithfully indicates the amount of rebound of the hammer and, therefore, the hardness of the specimen. The hardness values shown by this instrument agree faithfully with those shown on the vertical scale, or the older instrument, which is still popular and which the manufacturers shall list as heretofore, but which can be supplied at a somewhat lower cost.



Dial recording scleroscope.

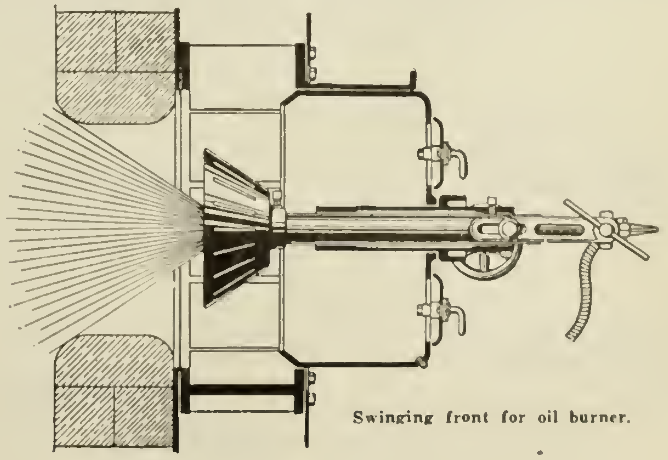
SWINGING FRONT FOR OIL BURNERS

Improvements have been made to the Bethlehem mechanical oil burning apparatus by incorporating a new swinging front which may be used with both natural and forced draft. This new front, says Marine Engineering, combines all the features of the regular burners, including the slotted cone, the nine-vane air register and hand ratchet adjustable pot air valve. Probably the greatest advantage claimed for the new front is that access to the furnace may be had without taking down the front. The front may be swung aside by simply moving two dogs and removing one lock pin. The front half of the pot swings open with the front itself, leaving the vanes of the air register locked, so that in the case of forced draft any one of a battery of furnaces may be opened without interfering with the draft in the others. Cone adjusting handles have also been added and a peep hole put in the slotted cone which lines up with a peep hole in the door so that the operator can observe the flame at the burner tip from in front of the furnace. Three Luckenbach ships which are being equipped with the largest Scotch marine boilers ever built are being fitted with this new type front—forty-eight furnaces in all.

SAFETY LOCKNUT

A new type of locknut has just been placed on the market. In this design of locknut it is not necessary to drill a hole through the bolt, as the nut proper has a slot cut across its outer face in which a clip is fitted to engage with the thread of the bolt. After the clip is in position the two pointed ends are closed around the thread. It is claimed that a grip is obtained that prevents turning of the nut, while no damage is done to the threads of the bolt. It is also stated that the nut cannot be removed from the bolt while clip is in place, without injury to the thread. It is further claimed that the nut can withstand vibration as well as twisting strains without signs of loosening. These nuts are furnished in all standard sizes up to ¾ in. and larger if desired. These nuts are made by the Specialty Manufacturing and Sales Co., Brooklyn, N. Y.

The safety engineer must be a social engineer. If he can invent and educate the "safety spirit" among the entire force from top to bottom, then the workmen and foremen will invent and demand and use more safety devices than he ever could think out and install by himself. He adds his personality to the going concern.



Swinging front for oil burner.

Operators Point of View

A USEFUL PIPE CHART

By W. F. Schaphorst.

We often want to know the velocity of flow through a pipe of given diameter, and, we want to know quickly. Or, we want to know the cubic feet of liquid or gas flowing through the pipe per minute, the gallons per minute, or the pounds of water per minute. All of these quantities are dependent, of course, upon the size of the pipe, and since pipe sizes vary, standard pipe not being exact in internal diameter and extra heavy pipe being different also, it is always necessary to search through tables and make lengthy calculations before arriving at the results. And then, after a result is arrived at one is not certain that the answer is correct.

Here is a chart that takes care of all of these matters in a decidedly simple way. The best way to explain the use of the chart is to give a problem. First, it will be observed that there are three sets of figures given in connection with the left hand column A. The left hand column of figures, marked "No. 1, standard," gives the actual internal diameter of standard pipe. This column shows, for example, that the internal diameter of a 1 in. standard pipe is somewhat greater than 1 in. The column of figures marked "2 exact," gives the exact diameter. Thus if we have a pipe the internal diameter of which is exactly 2 in. as used in the problem which is cited below, we have this column of figures. The right hand column of figures marked "3 extra heavy" gives the actual internal diameter of a 1 in. extra heavy pipe as less than 1 in.

For example, how much water is passing through a pipe, the internal diameter being exactly 2 in. and the velocity of the water being 2 ft. per second? Locate the 2 in column A over the word "exact" and from its point of intersection run a straight line through the 2 ft. per second in column C as shown by the dotted line. This straight line intersects column B. From the point of intersection in column B, run a straight line over to the similar point of column G, also as shown by the dotted line. The intersection of this perfectly horizontal line from column B to column G gives answers simultaneously in three columns —columns D. E and F. It shows that: 2.6 cu. ft. per minute are flowing through the pipe. (The correct amount is 2.615 cu. ft.) A trifle over 19 gallons per minute are flowing through the pipe. (The correct amount is 19.58 gal.) About 165 pounds of water per minute are flowing through the pipe. (The correct amount is 163 lb.)

This shows that the chart is accurate enough for all practical purposes.

It is evident, now, on studying the chart, that if the pipe were a two inch "standard" pipe instead of exactly 2 inches, the horizontal line from column B to column G would be slightly lower and three quantities would be slightly greater. On the other hand it is evident that if a 2 inch extra heavy pipe were used instead of the 2 inch exact, the horizontal line from column B to column G would be raised slightly above its present position and the three quantities would therefore be slightly less.

At the same time it will be noted that this chart can be conveniently used as a conversion chart. For example, how many gallons in 2.6 cu. ft.? The dotted horizontal line already drawn shows that the answer is—slightly over 19 gallons, which is also equivalent to about 165 pounds of water. At the same time this chart gives a visual demonstration of the relationship of pipe sizes—standard, exact, and extra heavy. By using this chart one can quickly "read off" the correct internal diameter of a standard or extra heavy pipe. The range of this chart has been made great enough to take care of almost any problem dealing with water, the standard pipe sizes ranging from 1/8 in. to 15 in. and the velocities from 0.3 to 20 ft. per second. Should anybody prefer to use formulas rather than this chart either for solving the problem directly or for checking the result taken from the chart, here are the formulas on which the chart is based:

$$Q = 2.45\ d^2\ V$$

where Q = gal. per minute;

d = internal diameter inches;

V = velocity, ft. per second.

Cu. ft. per minute $= 0.327\ d^2\ V$

Lb. water per minute $= 20.4\ d^2\ V$

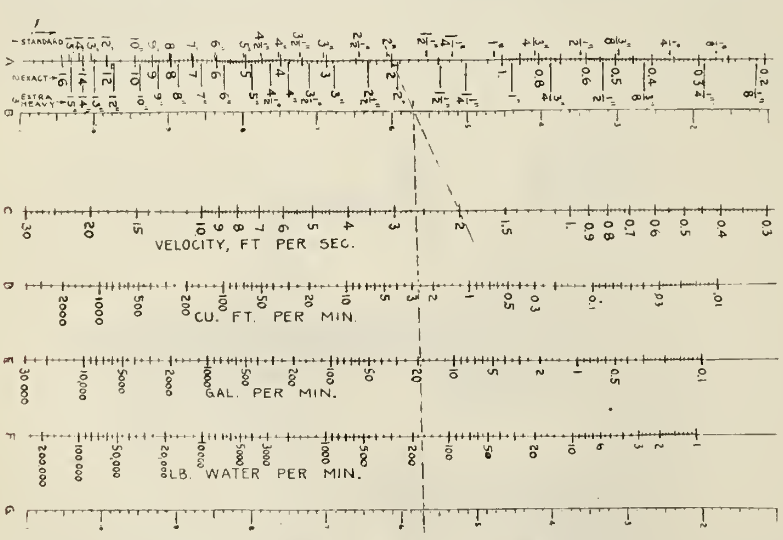


Chart for finding velocity of flow through pipes.

COMBUSTION OF SAWDUST

The burning of sawdust for boiler purposes is best accomplished by means of a simply-constructed "Dutch-oven" furnace, according to the United States Bureau of Mines. As a rule only one feed hole in the roof of the furnace is used, for sawdust is such an excellent fuel that it will produce a hot fire even when handled roughly and carelessly. Of course, with a single feeding hole in the top of the Dutch oven, the sawdust forms a cone on the grate surface. A cone is about the least effective form in which any fuel may be arranged on a grate for burning. The draft penetrates the bed of fuel at the points of least resistance, that is, at the shallowest parts; hence the air enters at an excessive rate around the edges of the cone while the largest part of the grade is effectually air-tight and consequently is "dead." This difficulty can be reduced or eliminated by different methods, which are described in Technical Paper 279, just issued by the bureau.

MR. CHAS. HETT DEAD

Mr. Chas. Hett, of the Boiler Repair and Grate Bar Co., died on Sunday evening, the 18th inst., in Toronto in his 69th year. He was salesman for the above company for about 33 years and was well known throughout the Dominion by engineers. His brother Adam Hett, is the president, and Oscar Hett, who is his nephew, the manager of the same concern.

Ottawa Car Manufacturing Co., have considerable work on hand at the present time, including fifty cars for Toronto Transportation, two cars for Moncton, N. B., and two cars for Oshawa Railway Co., Oshawa.

Electrical Section

Practical Electricity for Power Plant Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

THERE are two distinct systems of winding armatures: one is called lap-winding, and the other is known as wave-winding; the prefix "lap" and "wave" describe the form taken by the winding in each case.

If at one end of the armature we connect a conductor to another conductor, which is separated from it by a distance approximately equal to the pole-pitch (the distance measured along the armature circumference, between the centre lines of two neighboring pole pieces) the E. M. F.'s in the two conductors will at every instant be added. The reason is that whilst one of these conductors is passing under cover of a north pole-piece, the other will be passing under cover of a south pole-piece, so that the two E. M. F's act in the same direction round the loop formed by these two conductors. (Fig. 1).

Such a loop forms a complete turn of the winding. For convenience in making the end connections between conductors, one of each pair of conductors forming a loop or turn of the winding, is placed at the top of a slot, and the other at the bottom. Usually the coils forming the top layers in a slot are given odd numbers to identify them, whilst those at the bottom of the slot are given even numbers. (Fig. 2).

Lap-Winding

For the sake of simplicity, we shall suppose each slot to contain only two conductors arranged one above the other. Let the slots be numbered consecutively and let us suppose that we start with the top conductor in slot 1 (Fig. 3). The top conductor in slot 1 is carried forward by an amount equal to the pole-pitch. It is there laid in the bottom of the slot. We thereby form a single turn of the winding. Now let the remaining end of the conductor at the bottom of this slot be bent backwards, so that it can meet the end of the top conductor in slot 2, which is bent forward and let the conductors be joined as on the other side of the core. Now the top conductor in slot 2 forms the beginning of the next loop or turn, it being carried forward again by the amount of the pole-pitch, and then bent backwards again to link up with the conductor in slot 3, etc. We will later observe that we obtain a succession of over-lapping loops or turns, hence the name lap-winding.

A closed-coil or re-entrant winding must always fulfill the condition, that the total resultant E. M. F. around the winding vanishes; otherwise there would be local currents circulating in the armature winding even when there was no connection to an external circuit.

Lap-winding is sometimes called multiple or parallel winding because of the fact that such a winding consists of as many circuits as there are field poles, and these circuits are connected in parallel between the brushes. The number of brushes required therefore equals the number of armature sections in parallel, and also equals the number of pole pieces.

A lap-winding can always be distinguished from a wave-winding from the appearance of the end connections. In the wave-winding, the front and back ends of the coils lead in opposite directions. With a lap-winding the front and back ends of the coils continue in the same direction round the armature.

Pitch of Winding

The distance between two sides of a coil measured in coil sides at the front or commutator end of the armature, is called the front pitch. The distance between two sides of a coil, measured in coil sides at the back end of the armature, is called the back pitch. The total winding pitch is equal to the algebraic sum of the front and back pitches. That is, in a lap-winding, the front and back pitches are of opposite directions on the armature, and the total pitch will therefore be the difference between them.

When a coil spans exactly the distance between the centres of adjacent field poles or a full pole pitch, it is said to be a full-pitch coil. In cases where a coil is less than a full pitch, it is said to be a "fractional pitch" or a "short-pitch" coil.

Fractional pitch windings are much used, because of the following advantages:

(1) They make it possible to have shorter end connections and therefore call for less copper.

(2) Armature reaction is reduced be-

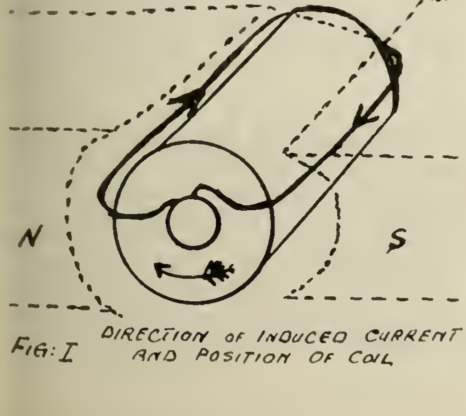


FIG: I DIRECTION OF INDUCED CURRENT AND POSITION OF COIL

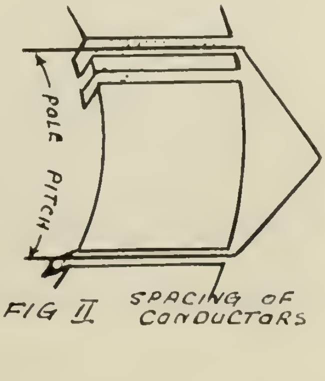


FIG II SPACING OF CONDUCTORS

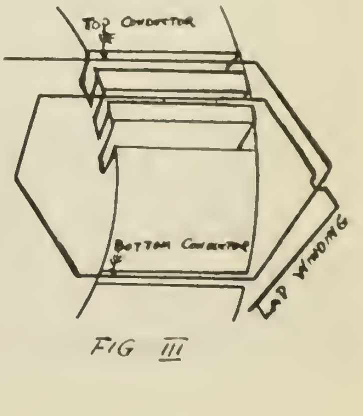


FIG III

cause the currents in the neutral zone flow partly in opposite directions and so neutralise each other.

Mr. Daniel H. Braymer of the "Electrical World" has developed a very concise formula on the selection of pitches for lap winding, which are given below:

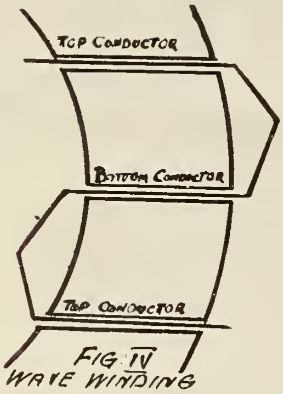


FIG IV
WAVE WINDING

Formulae for Lap Winding

(1) The front and back pitches (in winding spaces or coil sides) must both be odd numbers and differ by two or some multiple of two.

(2) The front and back pitches are of opposite sign (one positive and the other negative) since they are laid off in opposite directions on the armature.

(3) The winding pitch is equal to the algebraic sum of the front and back pitches. Suppose the front pitch be plus 9 and the back pitch be minus 7, the algebraic sum will be (9 — 7) = 2.

(4) The total number of armature conductors must be a multiple of the number of slots on the armature.

(5) The number of armature slots may be odd or even.

(6) The number of current collecting points or brushes on the commutator must equal the number of poles.

(7) The maximum E. M. F. between two consecutive coil sides (top and bottom) in the same slot, is equal to or a little less than the terminal voltage.

(8) The end of one coil is joined from the commutator to the start of another coil (usually the next) under the same pair of poles.

Mr. Braymer's formula is then as follows:

Front Pitch $= y_1 = \dfrac{N \pm b}{2p} \pm 2$

Back Pitch $= yk = \dfrac{N \pm b}{2p}$

Winding pitch = y = algebraic sum of y_1 and $y_2 = \pm 2$.

When N Number of coil sides of winding.
y Winding pitch or coil pitch.
y_1 Front pitch of winding element.
y_2 Back pitch of winding element.

It will have been made apparent that a lap-winding has two pitches, a forward pitch, and a smaller one in a backward direction. The coils will be alternately stepping forward with a long "stride" and stepping backwards with a short "stride."

Wave Winding

A wave winding possesses only one pitch, and that is in a forward direction all the time, these steps are in a zig-zag or wave-like form. These steps are made equal in order to render the winding symmetrical. This winding is frequently called a series winding or a two-circuit winding, because of the fact that half of the armature coils are connected in series, and the two halves are connected in parallel. The winding therefore only has two current paths in parallel between the brushes regardless of the number of poles. Only two sets of brushes are required with this type of winding, regardless of the number of pole-pieces on the machine. However, in cases where there is rather a high current value ,it is usual to fix additional brushes evenly spaced round the magnetic circuit.

The following is the formula for wave winding:

Winding pitch =

$$y = y_1 + y_2 = \frac{N \pm 2}{p}$$

Front pitch $= y_1$
Back pitch $= y_2$
Number of pairs of poles = p
Commutator pitch =

$$yk = \frac{y_1 + y_2}{2} = \frac{K \pm 1}{p}$$

Number of commutator bars =

$$K = \frac{N}{2} = p \times yk \pm 1$$

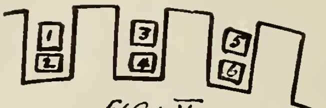


FIG: V
METHOD OF NUMBERING CONDUCTORS.

With an armature operating in a 4-pole field, either wave-winding or lap-winding may be used, but in a 2-pole field, only lap windings are used. In a 4-pole field, lap-winding is employed for heavy currents. In a 4-pole field, wave-winding is employed for light currents and high voltages. Lap-winding in a multipolar field, gives as many parallel paths for the current through the armature as there are poles. With the wave-winding, there are two circuits only, irrespective of the number of field poles.

Wave windings demand an odd number of segments on commutator.

Lap windings demand an even number of segments on commutator.

One of the advantages of wave winding in a multipolar field is that the combined effects of all the field magnets are added together so that any slight differences in pole strength does not cause sparking troubles through variations in the E. M. F. induced in each branch. To secure good commutation and eliminate heating and sparking troubles, all windings should be made symmetrical. This amongst other things means that there should not be more armature circuits in parallel than field poles. Where the number of armature circuits equals the number of poles, either the lap or wave windings may be used. The lap winding in such cases being most frequently chosen. The wave winding need only be considered in cases where the number of armature circuits will be less than the number of field poles.

Generally where changes in armature windings are necessary that call for a choice of windings, it is advisable to employ lap winding with as many circuits as there are poles, or a wave winding with two circuits.

In addition to the pitch of the coils on the armature there is also the commutator pitch to consider, the commutator pitch being the number of segments of the commutator spanned by the two ends of the coil. Suppose we number the segments of the commutator consecutively 1, 2, 3, 4, etc., and the commutator pitch is say 10, this would mean that one end of the coil was connected to segment number 1, the other end of the coil would miss 10 segments and would be connected to segment 11. The ends of the next coil would then be connected to segment number 12. In every case there would be 10 commutator segments intervening between the two ends of the coil.

EVERLASTING BOILERS

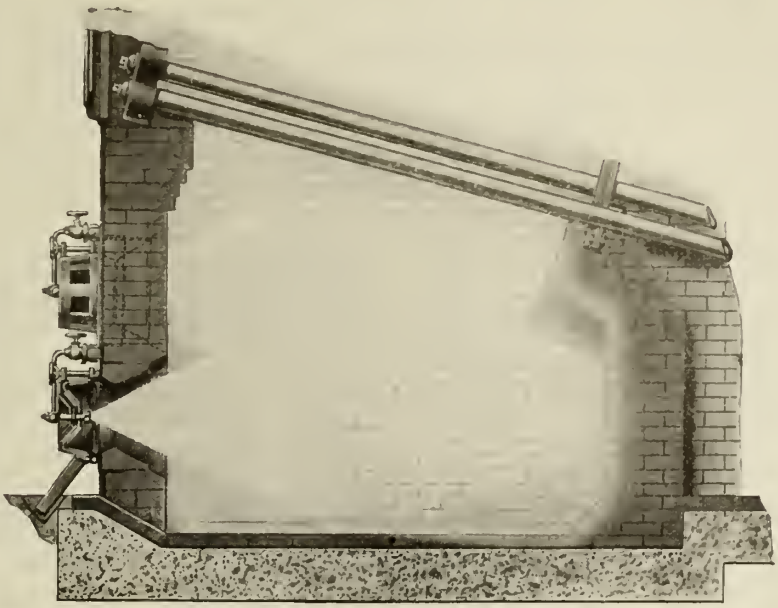
In some parts of England it is possible to find small steam boilers which were installed anything from fifty to one hundred years ago. These boilers are still at work and are kept at work more for sentimental reasons than because of their high efficiency. They provide, however, active witness to the excellence of British engineering. A short time ago a leading British boiler expert had the curiosity to subject two old iron boilers, probably about 60 years old, to careful tests. He found that the old iron stood up astonishingly well under heavy hydraulic pressure, and he noted particularly that the slight cracks which had been formed round the rivet holes in the original punching had not extended during the working life of the boilers. Thus he proved that the old kind of iron used in these British boilers was hardly surpassed by the material employed in the finest of up-to-date plants.

Defective elevator motor is the cause of a $2,000,000 fire. Three nine-storey buildings owned and operated by the Omaha Packing Co., Omaha, Neb., were burned to the ground by faulty equipment.

Montreal.—Two additional vessels are being built in England for Montreal Light, Heat & Power Co., owners of Keystone Transports, Limited. The latter are not interested in the investigation of the so-called shipping rate combine, as the whole of their tonnage is required for the transportation of coal for their owners.

BABCOCK & WILCOX

OIL BURNING EQUIPMENT



Babcock & Wilcox furnace for burning oil fuel only

The merits of oil as a fuel for steam generation, in places where its cost compares favorably with coal or wood, are, briefly, the following:—

1. An increase in boiler efficiency, owing to the clean condition in which the boiler heating surface can be maintained, and the completeness of combustion obtainable with a good system of oil firing.
2. A constant and equal distribution of heat in the furnace, and, as there are no fire doors to be opened, the cooling effect of a large volume of air passing over the furnace is avoided.
3. A reduction in the cost of handling the fuel, as this can be done by a pump; and a large reduction in manual labor, the firemen not being required as they would be for ordinary fuels. One man can regulate the burners of a considerable number of boilers.
4. No wear and tear of grate bars.
5. No dust, no ashes, and no clinker.
6. When once arrangements have been made, the storage of oil fuel is simpler than the storage of coal, and oil does not deteriorate.
7. The control of the steam production is easier, more effective and more rapid than with solid fuels.
8. Instantaneous ignition, and extinction of the fire.
9. No smoke.

The three main systems for burning oil fuel are:—

1. That in which STEAM is used as a spraying or atomizing agent.
2. That in which AIR is used for this purpose.
3. That in which the oil is atomized mechanically by PRESSURE.

We would be glad to go into details with a prospective purchaser.

BABCOCK & WILCOX, LIMITED

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE: BANK OF HAMILTON BUILDING

MR. BLACKBURN

(Continued from page 38)

cates are good for life, while in most other provinces engineers' certificates must be renewed each year.

"These difficulties amongst others could no doubt be overcome if the question was fully considered at an interprovincial conference of the examining bodies of each province, and engineers' certificates might thus be placed on a uniform basis, but special legislation would be required in nearly every province. Any arrangements made at such conference would have to be confirmed by the respective provincial legislatures, and on account of the many conflicting interests that would be involved it might be very difficult to get uniform legislation passed.

"It has been the practice of the Steam Boilers Branch for a number of years to grant Saskatchewan certificates to holders of engineers' certificates granted by other provinces, who produce satisfactory testimonials from former employers, etc., without further examination. Where the standard of examination is equivalent to our own, a certificate of the same grade is usually granted, but where the standard of examination is lower, a certificate of a grade only which is considered equivalent to the standard of examination passed by the holder is granted This meets the case of engineers coming into this province from other provinces fairly well, but as similar liberal treatment is not invariably accorded to holders of Saskatchewan certificates when applying for certificates in other provinces, the present arrangement cannot be considered as entirely satisfactory."

CELITE OPENS CANADIAN OFFICE

Celite Products, Limited, has recently been established in Canada, with offices in the New Birks Building, Montreal, to market the products of the Celite Products Company, who have sales offices in the principal cities in the United States.

The products of this company are sil-o-cel insulating brick, sil-o-cel powder, filter-cel for better filtration.

Sil-o-cel insulating brick for the prevention of heat loss through radiation are largely used for the insulation of boiler settings, brick kilns and all other types of heated equipment. The loss of heat through radiation is practically eliminated, which means a direct saving in fuel. Other advantages claimed for this product are: Increased capacity of the equipment; more uniform temperatures, and better working conditions.

Montreal office is in charge of Lawrence Russel, and complete stocks of various sil-o-cel products are maintained there. This company recently furnished all the insulating brick for the boiler equipment at the new plant of the St. Lawrence Paper Mills, Three Rivers, Que.

COMBUSTION ENGINEERING

Engineers and purchasers of power plant equipment in Canada will be interested to learn of the incorporation, under a Dominion Charter, of the Combustion Engineering Corporation, Limited, with an authorized capital of $250,000. The head offices of the Company are at Toronto and branches are being established at Montreal, Winnipeg, and Vancouver. A. J. T. Taylor, A.S.M.E., A.I.E.E., a well known Canadian mechanical engineer is president and managing director. Wilfred R. Wood, managing director of the Underfeed Stoker Company, London, Eng., is vice-president. George Usher of the Societe Anonyme des Foyers Automatiques, Paris, is a director, and John Anderson, is secretary-treasurer.

The new Corporation has acquired the sole manufacturing and sales rights in Canada for the complete line of power plant equipment owned by the Combustion Engineering Corporation, New York; The Green Engineering Co., Chicago; The Coxe Travelling Grate Company, Port Carbon, Pa.; The Coshochton Ironworks, Monongahela, Pa.; Underfeed Stoker Co. Ltd., London, Eng.; International Pulverized Fuel Corporation, New York and Lopulco Systems Inc., New York.

These various companies represent collectively one of the most complete line of steam power plant equipment ever brought together. It includes all types of mechanical stokers, pulverized fuel burning systems, ash conveyors, ash hoppers and air heaters.

In addition to these lines, which cover the whole range of fuel burning equipment, the new company will sell in Canada, economisers, soot blowers, induced and forced draft fans, Custodis radial brick chimneys and recording instruments, in short everything in the boiler house except the boilers. They will manufacture as much of this equipment as possible in Canada.

It is the Corporation's intention to co-operate with all consulting engineers and will place freely at their disposal the services of their engineers. By an arrangement with the International Combustion Engineering Corporation they will have the benefit of the advice of such internationally known engineers as Henry Kreisinger, research engineer, formerly of United States Bureau of Mines, John Van Brunt, chief engineer, Combustion Engineering Corporation, John E. Bell, consulting engineer, New York; T. Marsh, chief engineer, Green Engineering Co., Samuel McEwen, chief engineer, Underfeed Stoker Co., London; I. Beuzit, chief engineer, Societe Anonyme des Foyers Automatiques.

The Combustion Engineering Co. Ltd., is establishing a research dept., to give special attention to some of the fuel problems of Canada particularly in regard to the coals of Western Canada. John T. Farmer, M.E.I.C., A.S.M.E., Montreal, is chief engineer for the Corporation.

The Corporation already has important work in hand for the Imperial Oil Company and The Ford Motor Co., and many installations of its equipment are in successful operation throughout Canada. The Corporation is in a position to select from the best British, French and American practices, those pieces of apparatus that best fit the particular problem and then combine them to suit the special conditions.

Mr. Taylor, executive head of the Corporation is thoroughly experienced in Canadian engineering practice and has done notable power plant work covering a wide range in the industrial field. He is a member of many of the leading engineering societies, among them the A.S.M.E., A.I.E.E., A.I.M.M., C.I.M.M., is a Canadian by birth and will be ably supported by J. T. Farmer, of Montreal, whose reputation as a mechanical and hydraulic engineer is thoroughly established. Mr. Farmer is chairman of the Montreal section of the A.S.M.E. this year.

Winifred P. Wood, London, is an authority on combustion problems, while G. C. Usher, will be remembered in this country as the former general manager of the Green Fuel Economizer Co., which position he left two years ago to return to England. He is now in France in charge of important developments in combustion engineering equipment now being undertaken by the Societe Anonyme des Foyers Automatiques.

TORONTO C. A. S. E.

A meeting of No. 1, Toronto C.A.S.E was held in Cumberland Hall on th 6th inst., when a very interesting pape was read by R. McLaren, upon "Th desirable auxiliaries in a power-plant.' This was greatly appreciated by al those present, who after an interestin discussion showed their appreciation i the usual way. There was only on officer absent from his accustome chair, which vacancy was temporaril filled by the Engineer's friend, Howar Fletcher who explained in his bes style, for the benefit of new member the meaning of C.A.S.E.

On the evening of Thursday, the 15t the Joint Executive Committee of th No. 1, Toronto C.A.S.E., and the Ex hibitors' Association met in the Centr Technical school to decide and mak final arrangements for the coming co vention, which is to be held on Jun 25-28.

Fredericton, N. B.—There is a poss bility of the Grand Falls on the St. Joh River being developed by the Provinci Government. The Grand Falls powe rights have been held for some years b the Grand Falls Company, that is co trolled by International Paper Compan interests. Their rights expire ne April.

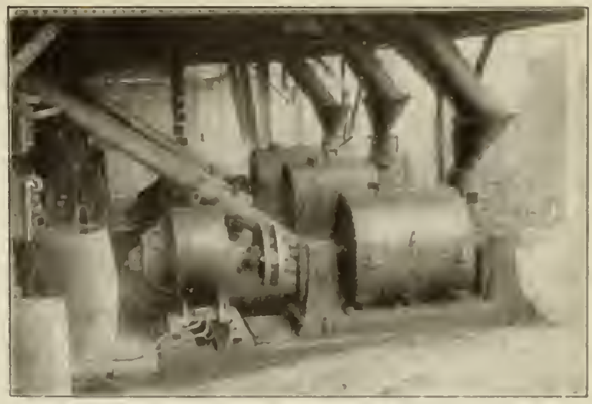
Pulverized Coal

THE AERO UNIT SYSTEM

Reduces the equipment and the operating cost to a minimum. The coal is received undried and exhausted directly into the furnace. Greater efficiency, mechanical simplicity and ease of control feature the Aero installations.

AERO PULVERIZER COMPANY

165 BROADWAY - NEW YORK



Bronze to Bronze

DART

At the Joints

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

ROLE OF THE ENGINEER

Engineering was represented at the Boston gathering of the American Association for the Advancement of Science last week in two of the many sections—Section K (social and economic sciences), of which Dr. Henry S. Graves of the Yale Forestry School is chairman, and Section M (engineering), of which the chairman is F. M. Feiker, vice-president McGraw-Hill Company, Inc. At a joint session of the two sections John T. Black, State Health Commissioner of Connecticut, spoke on "Conservatism and Industrial Waste," and William S. Murray, New York, on "Conservation of Power." O. C. Merrill, executive secretary of the Federal Power Commission, and Gen. Harry Taylor, Corps of Engineers, U. S. A., were unable to present their papers because of badly delayed train schedules.

"The Place of the Engineer in Civilization" was the keynote of the meeting of Section M. Dr. Ira N. Hollis, president of Worcester Polytechnic Institute, led the discussion, instancing the factors of transportation and communication as vitally touching the activities of men in every walk of life and dwelling on the need for the engineer to make an analytical study of the facts governing the solution of present-day problems. A similar point of view was expressed by Harrington Emerson, who alluded, as did Dr. Hollis, to the engineer's control of the instruments of production. Dr. J. B. Tyrrell told of the growth of the mining industry in Canada. The paper of C. F. Scott, professor of electrical engineering at Yale, was read in his absence by Dr. D. C. Jackson. It dealt with new phases of engineering education and pointed out that the large part played by engineering in modern life made it essential that the training of engineers be approached with a new viewpoint of the engineer's place in the community.

NEW PUBLICATION

Machinery Foundations and Erection, by Terrell Croft, 5½ in x 8 in., cloth bound, 690 pages, first edition published by the McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York.

This book will fill a long felt need with engineers who have the excavating, laying-out and setting of concrete foundations for the installation of all forms of prime movers and machinery. He will have no difficulty whatever from the worked out examples and liberal illustrations to successfully lay out his foundations in the most practical, up-to-date and approved manner. The author has been successful in simplifying all mathematical formula, and has treated with his subject in such a manner, that a very ordinary knowledge of simple arithmetic is all that is necessary to install a safe foundation for any machinery, at the same time keeping within the bounds and confines of good mathematical practice. The subject is treated with in a very exhaustive manner and the book is indispensible to the practical engineer.

New harbor facilities for Vancouver, B. C.—A resolution proposing the loan of five million dollars has been well received in Federal parliament. This bill has been given its first reading. Hon. Ernest Lapointe, Minister of Marine, states that Vancouver is in line for a huge Oriental trade. These new facilities are necessary to compete with Seattle. With these improved conditions a Saskatchewan farmer could ship grain to England via Vancouver for 8 cents a bushel cheaper than via eastern ports. The rate to Liverpool via Vancouver—39-2/5 cents per bushel. Via eastern route—47-3/5 cents per bushel.

Toronto Engineers' Club have elected the following officers for the ensuing year: W. R. McRae, president; E. G. Hewson, first vice-president; A. B. Cooper, second vice-president; George G. Powell, third vice-president; R. B. Wolsey, secretary-treasurer; J. C. Armer, chairman of House Committee; J. B. Carswell, chairman of Finance Committee; Frank R. Ewart, chairman of Admission Committtee; George R. Mickle, chairman of Library Committee. The other members of the Board of Directors are W. G. Gordon, T. D. LeMay, Balmer Neilly, A. V. Thimble, John van Nostrand, A. F. Wells and E. W. Wright.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we willtell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg.. Co., Ltd., The.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

AMMONIA PLANT EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
Under-feed Stoker Co. of Canada, Ltd. Toronto.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co.,: Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd., Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. McLaren Limited, Montreal, Que.

BELT HOOKS
Bristol Co., The, Waterbury, Conn.
D. K. McLaren, Limited, Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd.

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, FABRIC
D. K. McLaren Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. McLaren, Limited, Montreal, Que.

BELTING, SOLID WOVEN
D. K. McLaren, Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

CORD CLOTHING
D. K. McLaren Limited, Montreal Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd., Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Suply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co. Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE-OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren, Limited, Montreal, Que

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES ● $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and **Operation** of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulas. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ______________________

Occupation ______________________

Employed by ______________________

Residence ______________________

Reference ______________________

FOR SALE

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. **Inside** dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order Apply Box 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

SAWMILL MACHINERY—MODERN DESIGN—most satisfactory to operate. Apply Box 105, Power House.

SAWMILLS—PORTABLE — DOUBLE EDGES; also all kinds sawmill machinery. Apply Box 106, Power House.

WELDING

ELECTRIC AND ACETYLENE WELDING of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

BELTING BARGAIN

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

BELTING OF ALL KINDS—NEW OR USED pulleys, saws, cable, hose, etc., shipped subject to approval at lowest prices in Canada. York Belting Co., 115 York St., Toronto.

REPAIRS

A. D. FISHER MANUFACTURING CO., 77 Front St. East, are prepared to build special machinery, dies, tools and all kinds of repairs; prompt service.

Member American Society of Mechanical Engineers

M. BARRY WATSON, M.E.
Consulting Mechanical Engineer

Designs Perfected. Inventions Developed, etc.

192 Arlington Ave., Toronto
Phone, Hill. 6976W

The proprietors of Letters Patent No. 127080 relating to "Process of Manufacturing Iron Electrodes for use in alkaline Accumulators" desire to dispose of the patent or to grant licenses to interested parties at reasonable terms, with a view to the adequate working of the patent in Canada.

Inquiries to be addressed to the actual proprietors—

SVENSKA ACKUMULATOR AKTIEBOLAGET JUNGNER
Stockholm, Sweden

GEO. CALLARD
BUILDER & CONTRACTOR

Furnace and Boiler Work a Specialty	Highest References from All the Leading Engineers of the City
Phone: Uptown 1590	210 Quesnel Street Montreal

FOR SALE
Fuel Oil Storage Tank
10,000 GALS. CAPACITY

This is a new tank. We have not yet taken delivery of it, and offer it at a very attractive price.
MR. VOGAN, The MacLean Publishing Co.,Ltd. 143 University Ave., TORONTO.

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

WESTERN REPRESENTATIVES:
THE TAYLOR ENGINEERING CO., LTD.,
VANCOUVER, B.C.

THE SUPERHEATER CO., LIMITED.
Transportation Bldg., Montreal

MADE IN CANADA
WORKS AT SHERBROOKE QUE

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co,, Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CARBONIC ACID GAS
Laurie & Lamb, Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STL.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., Elkhart, Ind.
M, A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co.. Ltd.. Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLINGS
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach, Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co,, Ltd., Hamilton.

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal,
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb. Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injetor Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can, Link-Belt Co., Toronto, Ont.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co,, Limited, Sarnia, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR DRIVES
Sterling Engine Co., Buffalo, N. Y.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto,
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N. Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B, F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER HEATERS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., Erie, Pa.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.

FILTERS, WATER
Frick Co., Waynesboro, Franklin Co., Pa.
Graver Corp., East Chicago, Ind.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal,
Elk Fire Brick Co., Hamilton, Ont,
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co,, Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal,
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane, Limited, Montreal.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N. Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Bolco Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Wm, B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FUEL ECONOMY DEVICES
The Boiler Repair and Grate Bar Co., Toronto, Ont.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome, N, Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Johns-Pratt Co., The, Hartford, Conn.

HINTS TO BUYERS

ECONOMY
through
QUALITY

is the keynote in the manufacture of
SMART-TURNER PUMPS

The Smart-Turner Machine Co., Ltd.
Hamilton .·. Canada

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

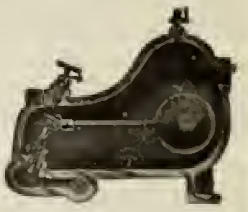
May We Send One on Trial ?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

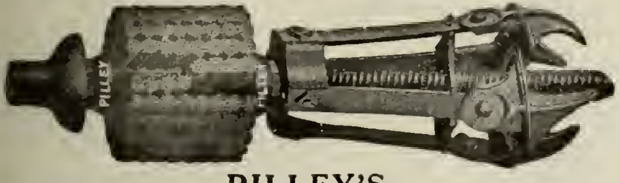
Send for Catalogue

THE GARTH COMPANY
Craig Street—MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

"Pop Off" Steam
Carries Ashes Away

"Into the hole and away they go" describes ash removal with a Green Steam Jet System. At the Kewanee Boiler Co., they use "Pop off" waste steam to do the work.

Write to Dept. X for descriptive literature.

GREEN ENGINEERING COMPANY
175 Kennedy Avenue
EAST CHICAGO INDIANA

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T.J. CUNERTY** *Company*
Room 240 17, Queen St, East Toronto

GARLOCK
Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS
THE GARLOCK PACKING COMPANY

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HANDHOLE
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Peldam Asbestos (Canada) Co., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N Y
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.

GASKETS, LEAD, COPPER AND SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

HANGES, GAUGES, AMMONIA, OIL, GAS, AIR
Schaffer & Bundenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Bristol Co., The, Waterbury, Conn.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div- Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal
Canadian Steam Boiler & Equipment Co., Toronto.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E. London, Ont.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRATE BARS, FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.
The Boiler Repair and Grate Bar Co., Toronto, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Gait.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicago, Ind.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Graver Corp., East Chicago, Ind.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INDICATING THERMOMETER, SARCO
Sarco Co., Inc., New York.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Bristol Company, The, Waterbury, Conn.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

Celite Products Limited, Montreal, P.Q.

INSULATING POWDER

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LACE LEATHERS
Can. Johns-Manville Co., Ltd., Toronto.
D. K. MacLaren Ld., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LINK BELTING
Can. Link-Belt Co., Toronto. Ont,

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LURRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mo.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MARINE CASTINGS
Muelier Mfg., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

METERS, F.M.
Canadian General Electric Co., Toronto.
The Bailey Meter Co., Cleveland, Ohio.
Can. Johns-Manville Co., Toronto.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil. Ltd., Torono.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.

OILING SYSTEMS
Lunkenheimer Co., Cincinnati, Ohio.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos Canada Co., Toronto.
Beveridge Suppy Co., Montrea.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor. Ont.

PACKING, H. P. ROD
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply-Ltd., Toronto, Ont

PENSTOCKS
W. M. B. Scarfe & Sons, Pittsburgh, Pa

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
The Superheater Co., Limited, Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto.

PIPE, BLACK AND GALVANIZED
Crane's Limited. Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE STEEL
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro. Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati. Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co., Cincinnati, Ohio

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINER
Can. Fairbanks-Morse Co., Ltd., Montreal
Engineering and Machine Works of Canada, Ltd., St. Catharinea, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

A Reasonable Saving of 5 to 10%

Should You Expect More?

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee St. PHONE G. 3660 Toronto, Ont.

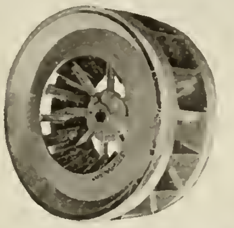
BETSON'S
U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

IDEAL for repairing furnace linings and arches or laying up complete linings and arches in one solid seamless piece and for making gas tight baffles at any angle. No special forms, tools or skill required. Any good workman can do it.

Shipped plastic in barrels ready for use or dry ready to add water, from nearest warehouse.

Send for instructive booklet on furnace linings and baffles.

Betson Plastic Fire Brick Co., Inc.,
P. O. Box 386-6, Rome, N. Y.
Canadian Distributors: International Chemical Co.,
26-6 Adelaide St. E., Toronto, Ont., Canada.



See for yourself the economy of the Sturtevant cindervane. It creates greater draft and eliminates cinders.

Our folder 609 proves specific savings. Let us send it to you.

Sturtevant
PUTS AIR TO WORK

B. F. Sturtevant Co. of Canada Ltd.
Montreal, Galt, Toronto

Foxboro quality indicating and recording thermometers, pressure gauges, liquid level gauges, vacuum and draft gauges and CO2 recorders are designed and built especially for power planta and industrial processes. Write to Dept. C.F.

THE FOXBORO CO., INC.,
Foxboro, Mass., U.S.A.

FOXBORO
TRADE MARK
THE COMPASS OF INDUSTRY 4915

OIL BURNING SYSTEMS
INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.
LAURIE ENGINE CO.
(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.

THOMSON-GORDON LIMITED

ENGINE
PACKINGS

HAMILTON ONTARIO

2

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations. *Write for our latest catalogue*
Patterns Machine Work

YORK Ice Making & Refrigerating **MACHINERY**

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO., LIMITED
Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co.; Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Pratt & Cady, Hartford, Conn.
Smart-Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady. Hartford. Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, GAS
Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co., (Inc., Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

OIL PUMPS FOR FUEL OIL BURNING SYSTEMS.
Albany Pump Co., Toronto, Ont.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMP TANK, RECEIVER
American Steam Pump Co., Batle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Bolco Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Bristol Co., The, Waterbury, Conn.
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Tayor Instrument Co., Toronto, Ont.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamieson Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Inde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Out.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester Mass.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham. Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.

Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch, Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q

STEAM ENGINES
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM JETS
Green Engineering Co., East Chicago, Ind.

STEAM SPECIALTIES
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
The Reliance Gauge Column Co., Cleveland, Ohio.
Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM CALORIMETERS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Division, Brooklyn, N. Y.
Sarco Co., Inc., New York.

STEAM TRAPS
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Julian D'Este Co., Boston 14, Mass.
Sarco Co., New York, N. Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal

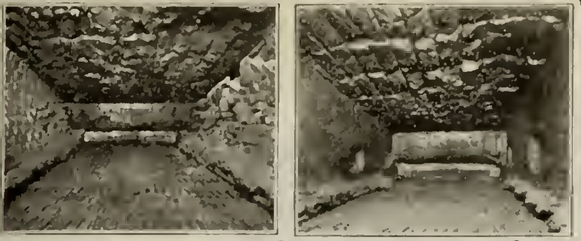
STOKERS
Canadian Planet Engineering Co., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd., Montreal.
Green Engineering Co., East Chicago, Ind
Underfeed Stoker Co., of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
Sturtevant, Co., B. F., Toronto and Boston.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co, Pittsburg, Pa

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.



Increase furnace life two to four times with PLIBRICO

JOINTLESS

FURNACE LINING

Send for this book; fifty pages of furnace facts free—

Both photographs above are of the same furnace taken after the same amount of service. At the left the crumbled side wall is an unanswerable argument against laid up fire brick; at the right the staunch, jointless walls are a sermon for Plibrico Furnace Lining.

Plibrico is a plastic furnace lining that can be applied by anyone who can use a mallet; when baked it forms a rock-like, gas-tight jointless lining that resists temperatures to 3100 deg. F. and that outlasts ordinary fire brick two to four times.

Plibrico is stocked in principal cities and is delivered only in steel containers of distinctive appearance as shown below.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's Ltd. Calgary, Alta.

JOINTLESS FIRE BRICK CO

1142 Clay St., CHICAGO, ILL.

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

"Made in Canada"

PACKING THAT LASTS

John Crane packing of spirally wound babbitt foil impregnated with graphite wear as only a non-corrosive, non-abrasive metal can. Its simplicity is its strength—flexible, compressible, easily applied using the piston rings principle of the fluid seal. John Crane packings give length and quality of service previously unequalled in packing. Send for our text book "Metallic Packings."

FLEXIBLE METALLIC PACKING CO.

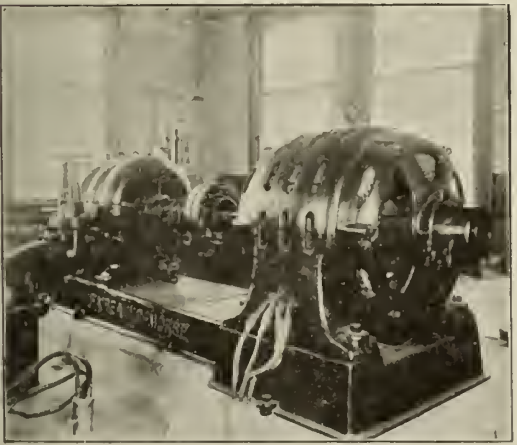
WINDSOR, ONTARIO, CANADA.

BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.

H. E. CARMAN, 334 Cordova Street, Vancouver, B. C.

The Heart of the Pumping System

The FAIRBANKS-MORSE Centrifugal Pump



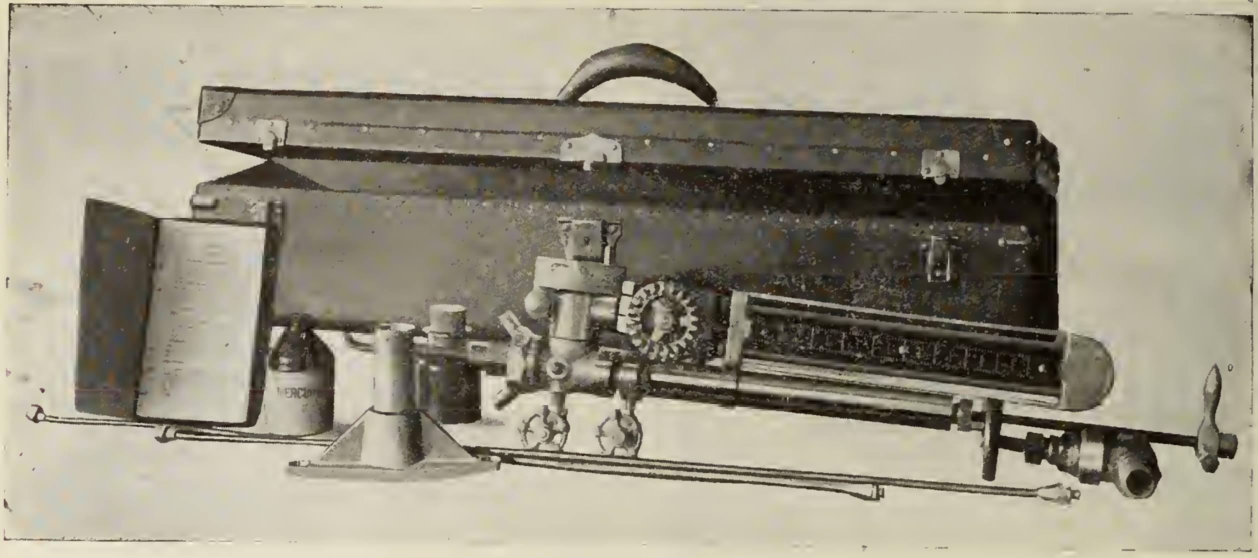
Particularly adapted to Municipal Water Supply, High Pressure Irrigation, Marine Service, Hydraulic Elevator Service, water supply for mills, office buildings and apartment houses, etc.

These renowned pumps have a long record of continuous satisfactory service. They are of extra rugged construction, and all bearings are renewable bronze, while they may be opened quickly for inspection without disturbing pipe connections.

We supply practically every type of pump, be it Air, Boiler Feed, Centrifugal, Fire, Marine, Gasoline, Heavy Oil, Irrigation, Rotary, Hydraulic or Typhoon, etc., and our engineers will gladly recommend the proper type for your conditions without charge or obligation. Write our nearest office for Pump data.

The Canadian FAIRBANKS-MORSE Co., Limited

Montreal Toronto St. John Winnipeg Quebec Ottawa Windsor
Vancouver Calgary Regina Victoria



Cory-Royer Flow Indicator
Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

CHAS. CORY & SON Inc.

183-7 VARICK STREET - - NEW YORK CITY

VANCOUVER
P. A. Goepel,
525 Pender St. W.

Est. CORY 1845

TORONTO
The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers

SUPERHEATER, STATIONARY
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, LOCOMOTIVE
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STEAM SHOVEL
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N. Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Canadian Johns-Manville Co., Ltd., Toronto
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, OIL, KEROSENE, GASOLINE
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

TANKS, WATER
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

TACHOMETERS
Bristol Company, The, Waterbury, Conn.

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

THERMOSTATS
Sarco, Inc., New York, N.Y.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N. Y.

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Sarco Co., Inc., New York, N.Y.
Wason & McDonald Co., Philadelphia
Taylor Instrument Co., Toronto, Ont.

TACHOSCOPES
The Reliance Gauge Column Co., Cleveland Ohio.
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS
Canadian Sirocco Co., Ltd., Windsor, Ont.
American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Schaeffer & Budenburg Mfg. Co., and Am-
Sarco Co., Inc., New York, N.Y.

TRAPS, DUMPING
Grant E, Cole Co., Toronto, Ont.

TACHOMETERS
Bristol Company, The, Waterbury Conn.,

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Sturtevant Co., B. F. Toronto and Boston.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal.
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES OF ALL KINDS
Reading Steel Casting Company, Inc.
  Pratt & Cady Division,
    Bridgeport, Conn.
Reading Steel Casting Company, Inc.
  Reading Valve and Fittings Division,
    Bridgeport, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio,
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Shell Bar Boico Supply, Ld., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.

When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*

Value of Business Newspapers

Recognized by Daily Press

FORTY publishers in Chicago recently formed an association to promote the morning newspapers' interests in competition with the evening newspapers as an advertising medium. They have announced their intention of employing the business newspapers for publicity purposes in furthering their aim.

This recognition of the place and power of the business newspaper coming as it does from daily newspaper men who know better than most people the necessity of discrimination by advertisers in selecting their publicity channels, is a striking tribute to the value of the business newspaper as an advertising medium.

These publishers realize that the business papers reach the most important men in every industry, the men whose opinions count, and who have most influence in the business world. And not only do the business papers reach these men but they are also read by them. Many business men are not great readers, but the papers which they must read—which they cannot afford not to read—are those which deal with their own business and give the news connected with it.

The following business publications are all leaders in their own field and by their means you can send your sales message to the leading men in the industries they cover. All the papers are members of the Audit Bureau of Circulations, which is a hall-mark or guarantee of quality-circulation. Information regarding circulation, advertising rates and fields covered, will be furnished on application.

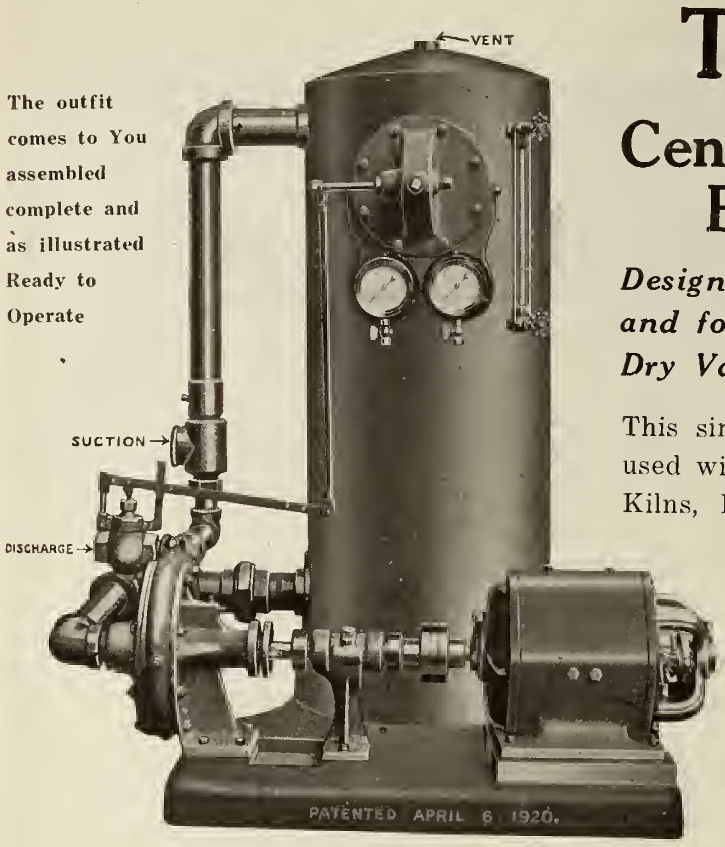
The MacLean Publishing Co.

143-153 University Avenue, Toronto

Publishers of:

The Financial Post
Canadian Grocer
Hardware and Metal
Dry Goods Review
Men's Wear Review
Bookseller and Stationer
Canadian Machinery
Canadian Foundryman
Druggists' Weekly
Power House
Canadian Shipping
Printer and Publisher
Sanitary Engineer
Canadian Automotive Trade

The outfit
comes to You
assembled
complete and
as illustrated
Ready to
Operate



The YOUNG

Centrifugal Vacuum and Boiler Feed Outfit

Designed for Vacuum Heating Systems and for All Conditions Where a Wet or Dry Vacuum is Desired—Highly Efficient

This simple, inexpensive and noiseless outfit is used with perfectly satisfactory results with Dry Kilns, Paper Driers, Feed Driers, Print Mills, Cooking Apparatus, Vacuum Pans, etc., for the purpose of effecting a saving by returning the condensate for boiler feed.

Manufactured in Canada by

Young Pump Co. of Canada
Room 310, Lister Building
HAMILTON, ONT.

Index To Advertisers

A

Aero Pulverizer Co. 45
Audel, Theo. 47

B

Babcock & Wilcox, Ltd. 43
Betson Plastic Fire Brick Co., Inc. 51
Bailey Meter Co. 12
Buyers' Directory .46, 48, 50, 52, 54
Builders Iron Foundry 13

C

Callard, Geo. 47
Canada Cement Co. —
Canadian Fairbanks-Morse Co., Ltd. 53
Canadian Link Belt Company, Limited 15
Canadian Steam Boiler and Equipment Co. 51
Celite Products, Ltd. 17
Cole Co., Grant E. 12
Cory & Sons, Inc., Chas. 54
Combustion Engineering Co., 32, 33
Cunerty Co., T. J. 49

D

Dart Union Co. 45
D'Este Co., Julian 14
De Laval Steam Turbine Co. 9
Detroit Stoker Co. —
Dominion Belting Co. 10
Dunham Co., C. A. 6
Durabla Mfg. Co. 4

E

Engineer and Mach. Works of Canada 6

F

Fisher Governor Co. 8
Foxboro Co., Inc. 51
Flexible Steel Lacing Co. 7
Flexible Metallic Packing Co. 53

G

Garlock Packing Co. 49
Garth Co., The 49
Green Engineering Co. 49
Goldie & McCulloch 18
Gutta Percha & Rubber Co. 3

J

Jamieson Cold Storage Door Company 11
Jenkins Bros. ...Front Cover
Jointless Fire Brick Co. 53

L

Laurie Engine Co. 51
Lunkenheimer Co. ...Inside Front Cover

M

Magnolia Metal Co. 12
Maclean Underfeed Stoker Co. 9
McGowan Co., The John H. 5
Morrison Brass Mfg. Co., Jas. ...Outside Back Cover
Moncrieff, Ltd. 56
Mueller Mfg. Co. ...Inside Back Cover

N

Northern Equipment Co. 14

P

Page-Hersey Tubes, Ltd. 10
Pilley Packing & Flue Brush Mfg. Co. 49

R

Reuters, Ltd. 47

S

Sarco Co., Inc. 17
Sanford Riley Stoker Co. 2
Sexton Boiler Setting, W. R. —
Shell Bar Boico Supply Co. 4
Smart-Turner 49
Sterling Engine Co. 13
Sturtevant Co. 51
Superheater Co. Ltd., The 47

T

Taylor Instrument Co., The 8
Thomson-Gordon, Ltd. 51

U

Underfeed Stoker Co. of Canada 2

V

Victoria Foundry Co. 51

W

Wall, W. J. 56
Waterous Engine Works Co. 1
Watson & McDaniel Co. 49
Watson, M. Barry, M. E. 47
Williams & Co., J. H. 8
Young Pump Co. of Canada 56
Westaway, W. J. & Co. —

Y

York Mfg. Co. 51

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

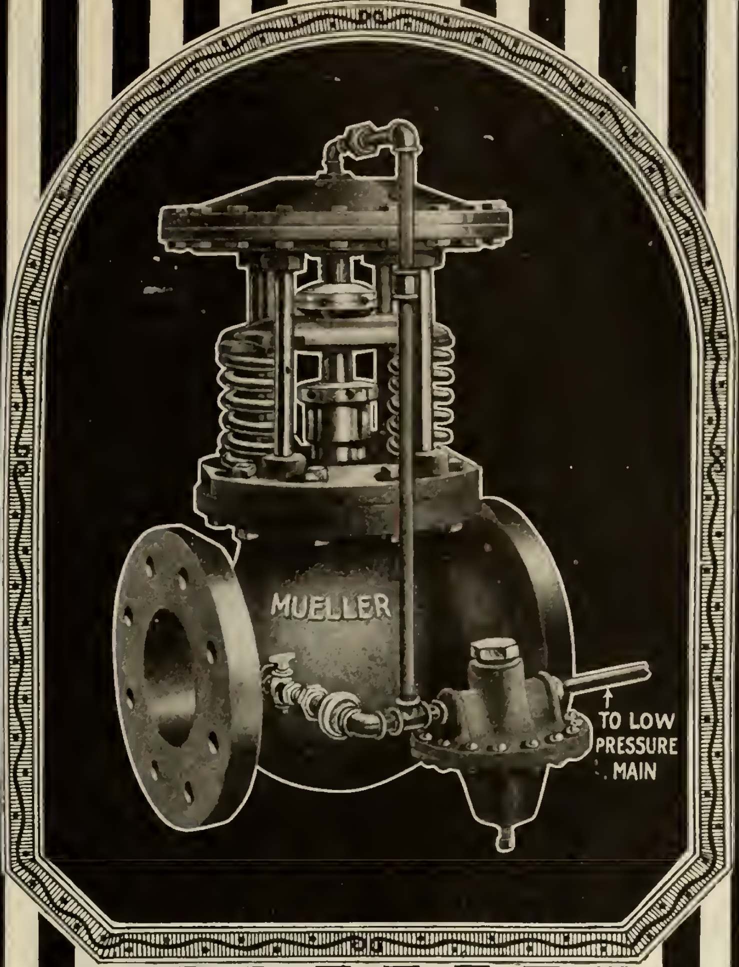
MONCRIEFFS "UNIFIC"

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

Make
Canada
Prosperous
by
Buying
Canadian
Products



Constant Delivery Pressure

Mueller Reducing and Regulating Valve A-5030 is specially constructed for use on exacting installations. It will reduce as desired and deliver at a uniform pressure regardless of variations in initial pressure. It is a single seat, auxiliary operated valve for water, gas and air and is made in sizes from 1¼" to 12".

Mueller makes valves for all purposes. Write and tell us your problems and we will give you the solution to them.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Ill., U. S. A. **Branches, New York and San Francisco**

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod, Brass and Copper Tubing, Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

Morrison Whistles
For Every Purpose

Morrison Steam Whistles will last as long as the plant. They are built in many sizes and to give many tones—all the result of over half a century's specialization.

Dependable Steam Whistles bear the name **"Morrison."** Under this name are grouped Steam Whistles with and without valve "Harmonium" Whistles, Sirens, Combination Whistle- Chimes, Mocking Bird Type, and many others.

For long service ask to see a **"Morrison"** Whistle.

"Every installation is a demonstration of merit."

The James Morrison Brass Mfg. Company Ltd.

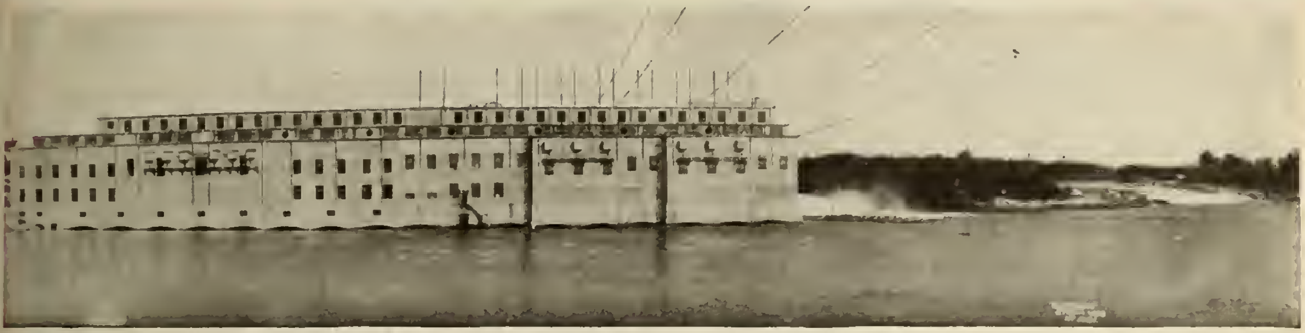
93-97 Adelaide St. W. - - TORONTO

POWER HOUSE

semi-monthly paper devoted to the Generation, Transmission and Application of Steam, Gas, Electric
Air and Water Power ; the operation of Refrigerating Machinery ; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
ONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street, E. C. NEW YORK, BOSTON, CHICAGO.

ol. XVI—No 5. Publication Office, Toronto—March 5, 1923 Published Semi-Monthly. Canada, $2: U.S. $2.50 a year



Power House, Point du Bois - View from Tail Race

Harnessing the Waters of the Winnipeg River

CANADA CEMENT CONCRETE FOR PERMANENCE

THE development of water power within economic transportation distance of Winnipeg, has reached a point where 70,000 horse power is available, and there is sufficient additional reserve power to develop 500,000 h.p. when required.

At the power house site, the Winnipeg River falls over a series of rapids with a natural fall of 33 to 28 feet within a ¼ mile. This fall is increased to a total head of 43 to 48 feet, by a concrete dam; giving a pondage area of 7 sq. miles.

The power house, completed in 1920-21 is of concrete and steel. The power house foundations, consisting, besides the series of draft tubes, of a series of flat tail race arches upon supporting walls tapered in plan, were built in pairs of arches; the two adjacent spans, built as a unit with a mid-wall, are resting upon asphalt painted skewbacks formed upon alternate tail race walls. The contraction joints are thus 56 ft. apart. By this means the use of reinforcing steel in these arches was avoided.

In the other elevation of the building the foundations were separated into three portions—the arrester bays, the transformer and generator room and the turbine and rack rooms. This was done by the use of two vertical expansion joints, running the entire length of the building. Above the tail race arches, parting planes, asphalted and keyed with wooden strips, were provided in the main walls, with considerable success in the effort to avoid unsightly cracks.

This great plan of hydro-electric development at Point du Bois has given Winnipeg power at the lowest rate on the continent, less than a half cent per K W H.

CANADA CEMENT COMPANY LIMITED

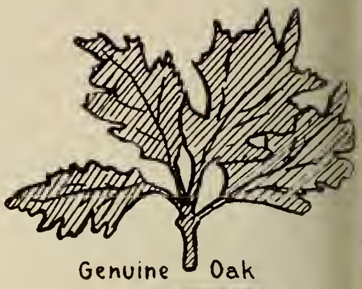
Canada Cement Company Building
Phillips Square Montreal

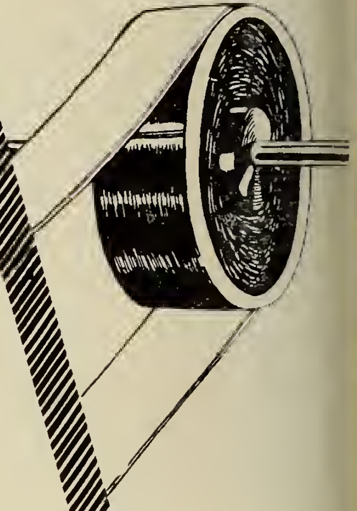
Sales Offices at
MONTREAL TORONTO WINNIPEG CALGARY

D.K.McLaren's

Genuine British Oak Tanned

Leather Belting





Belting that's Built For Better Service

The **back portions** only of flawless hides, chosen by experts, are just the beginning of D. K. McLaren's Leather Belting. Tough as these portions are, they are made tougher yet by being subjected to

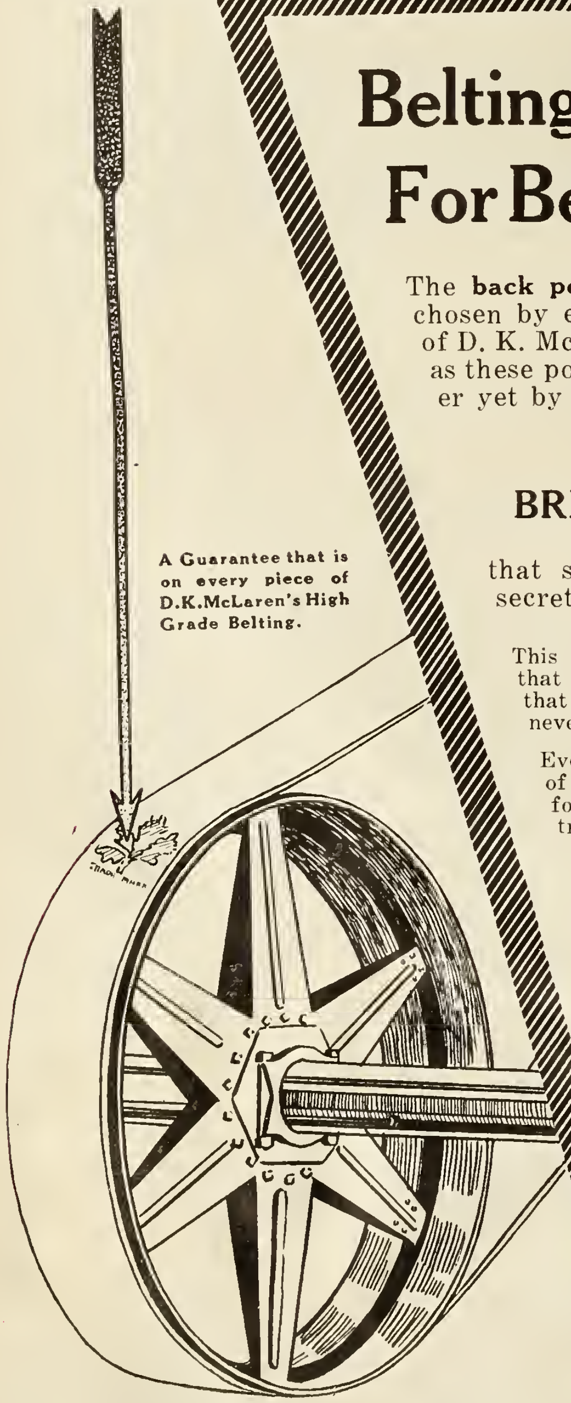
GENUINE BRITISH OAK TANNING

that slow and one-time closely guarded secret process of English Tanners.

This not only adds to the toughness but imparts that wonderful flexibility and "stretchless quality" that gives to D. K. McLaren's Belting "A Grip that never slips."

Even under adverse conditions the built-in quality of D. K. McLaren's Belting marks it as Belting Built for Better Service—a service reflected in minimum transportation costs.

The Oak Leaf stamped upon every length is your guarantee of this "trouble-free" service. Be sure to look for it.


A Guarantee that is on every piece of D.K.McLaren's High Grade Belting.

D. K. McLAREN
LIMITED

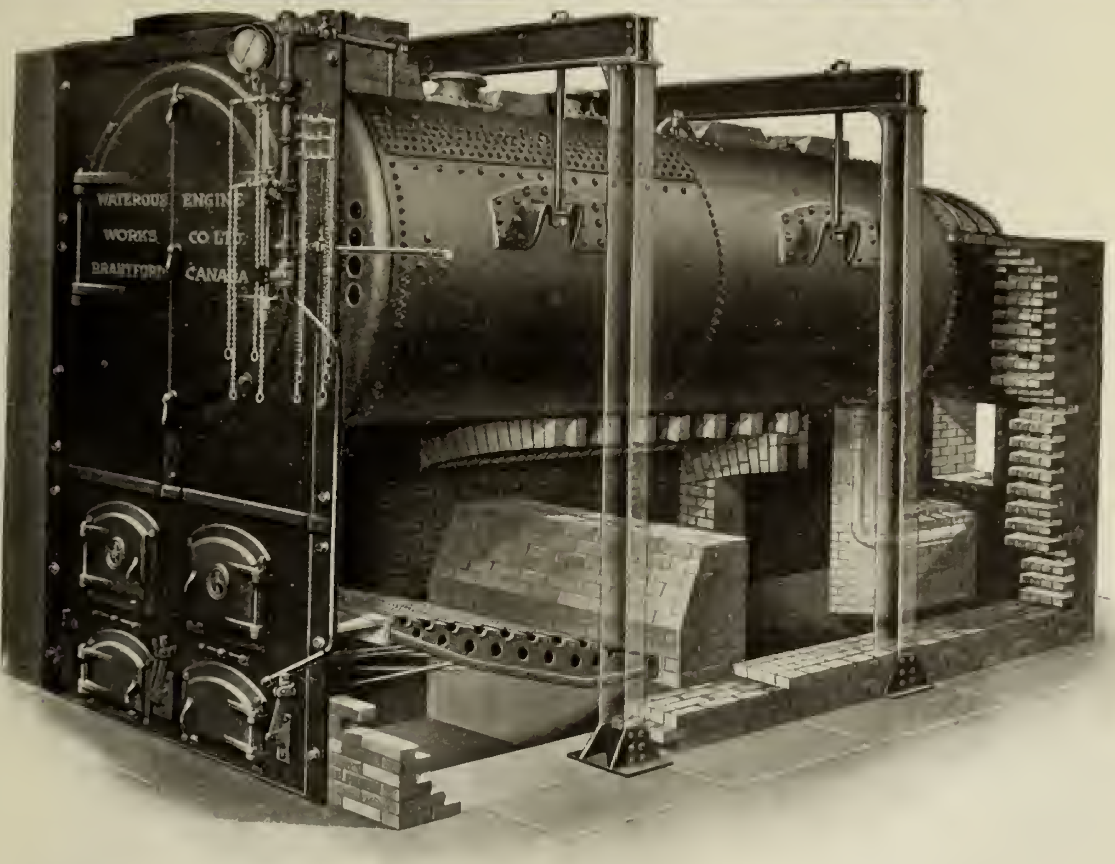
Head Office and Factory:
351 St. James Street, Montreal, P.Q.

Branches:
TORONTO, ONT.—194 King St. West,; St. John, N.B.—90 Germain Street.

Stock Depot:
CALGARY, ALTA—Gorman's Limited; EDMONTON, ALTA.—Gorman's Limited; VANCOUVER, B.C.—Gorman's Limited, 1158 Homer Street.

Files Stokers

Hand Operated



"Are Giving Absolute Satisfaction"—

S. KANN SONS COMPANY, Washington, D.C.

"In answer to your communication of Aug. 1st in reference to our **Files Stokers,** will state that they are giving **absolute satisfaction.** We have them installed under two 250 H. P. Heine Boilers.

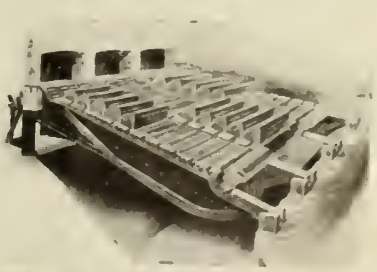
"While we have not made a test of the actual saving in coal, would judge from 10 to 15% as our load increased 25%. We were able to carry steam without difficulty, which we could not do when our boilers were equipped with the down-draft furnaces.

"Our smoke laws in this city are very strict and with one or two exceptions we have always been able to comply with same. With careful firing there should be very little smoke. Our expense for upkeep has been very reasonable.

"Hoping this information is what you desire, we remain,

"Yours very truly,

"THE S. KANN SONS COMPANY."



Waterous

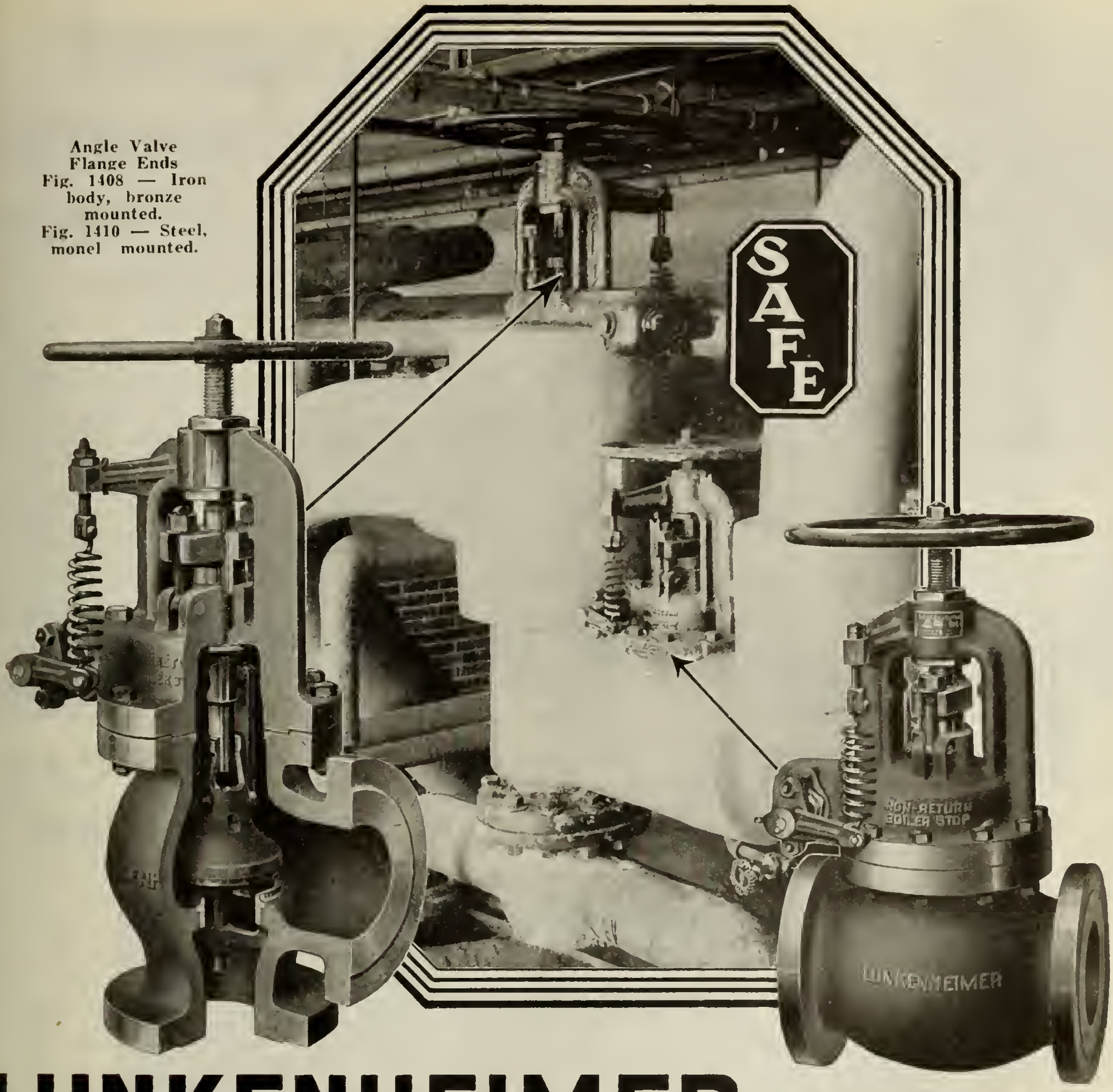
BRANTFORD, ONTARIO, CANADA

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Uniform!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast



Angle Valve
Flange Ends
Fig. 1408 — Iron body, bronze mounted.
Fig. 1410 — Steel, monel mounted.

Globe Valve. Flange Ends.
Fig. 1407—Iron body, bronze mounted
Fig. 1409—Steel, monel mounted.

LUNKENHEIMER
Safety Non-Return Valves

The rupture of one boiler connected with others in battery may cause considerable damage, but if MEANS are provided whereby pressure from the other boilers is instantly prevented from escaping through the ruptured one, not only is further damage avoided but the operation of the plant, through the medium of the live boilers, may be continued with perfect safety to the operatives.

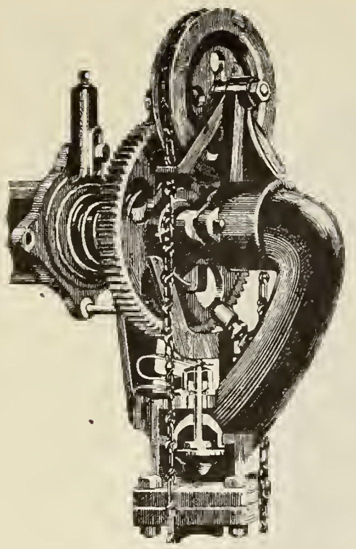
A Lunkenheimer Safety Non-Return Valve provides the MEANS.

Furnished in Iron Body, Bronze Mounted Pattern for pressures up to 250 pounds, 450° F. total temperature and in Steel, Monel Mounted, for 350 pounds pressure, 800° F. total temperature. For detailed information, write for catalog No. 58-DC.

10-20-43

"America's Best since -1862"

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK



Diamond Soot Blowers

The Best Paying Investment in the Boiler Room

BECAUSE:
They save 4 to 8 per cent fuel—one carload out of every twelve to twenty-five which enter your yard.

They save steam and labor, and labor turnover. The dollars and cents value of these savings alone in one year is more than the initial cost of the soot blowers.

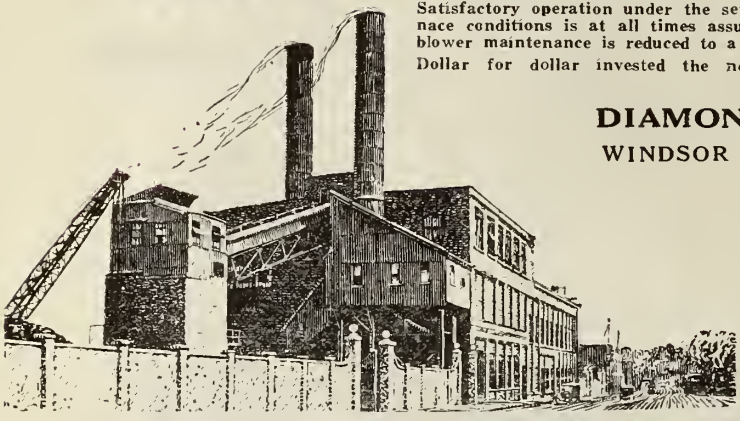
They completely solve the soot blower problem. Satisfactory operation under the severest furnace conditions is at all times assured. Soot blower maintenance is reduced to a minimum.

Dollar for dollar invested the net savings effected by their use amounts to more money each year than can be earned by any other single piece of boiler or engine room equipment.

REMEMBER there is only one "Valv-in-Head" soot blower—the DIAMOND—and that the blower elements are protected by a special process developed by the General Electric research laboratories—CALORIZING.

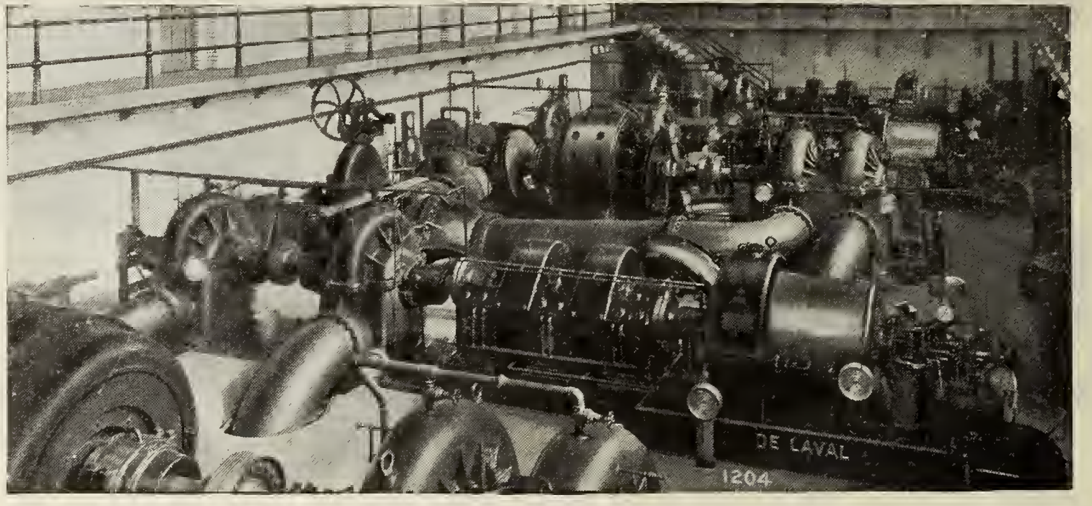
A Booklet which belongs in the library of every executive who is concerned with the cost of power production is yours for the asking. SEND FOR YOUR COPY OF BULLETIN 287

DIAMOND SPECIALTY LIMITED
WINDSOR - ONTARIO



Automatic Valved Soot Blowers

Diamond "VALV-IN-HEAD"



Records Made at Toronto by De Laval Pumps

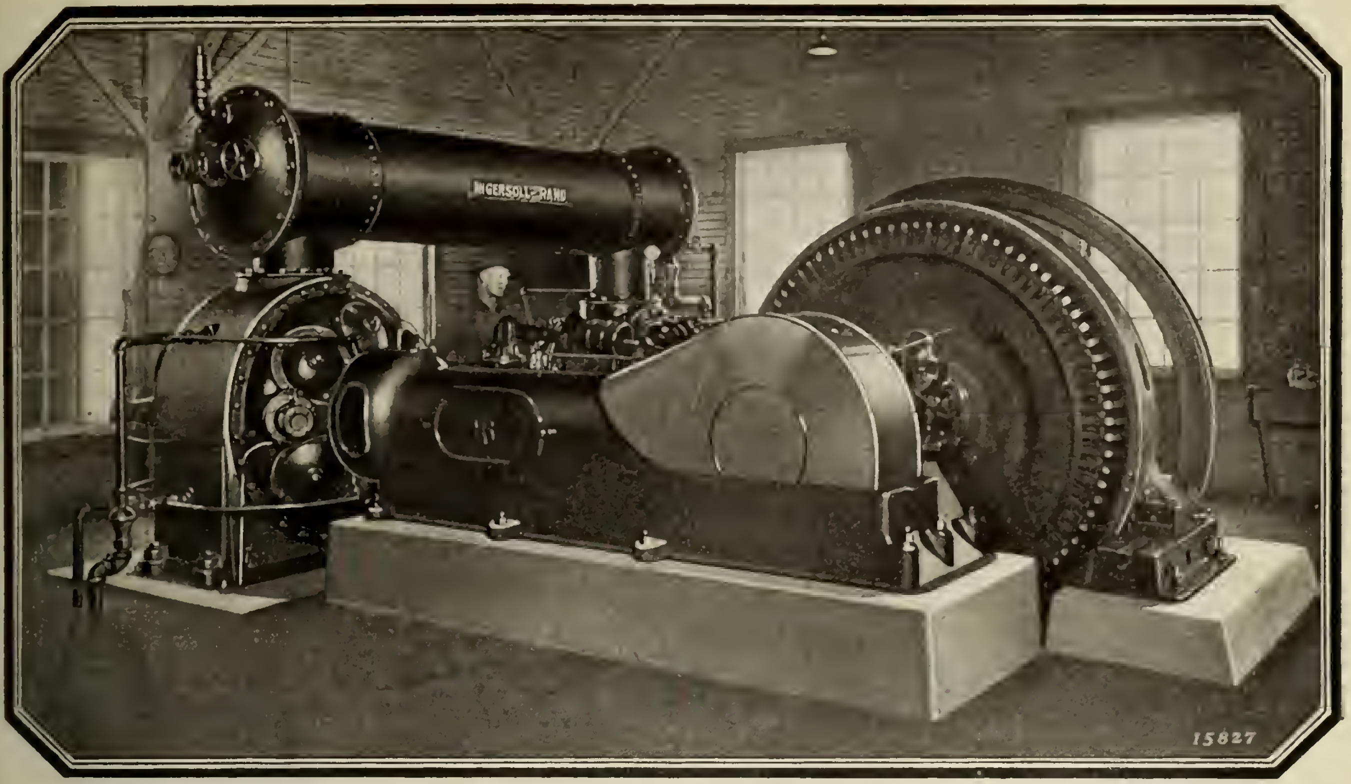
THE John Street Pumping Station at Toronto contains three De Laval Geared Turbine Driven Centrifugal Pumps having a capacity of 24,000,000 Imperial gal. each against 250 ft. head. The first unit installed was designed for a capacity of 15,000,000 Imperial gal. per day but provision was made for changing the capacity later to 24,000,000 Imperial gal. per day. This first unit, when tested by Prof. R. W. Angus in the year 1914, set the high record of 130,449,000 ft. lb. per 1,000 lbs. of steam when pumping at a capacity of 15,000,000 gal. per day, which duty had never before been reached by a steam turbine driven pump. One of the 24,000,000 gal. pumping units when tested by Prof. Angus in 1917, however, put the record up to 153,920,000 ft. lb. per 1,000 lb. of steam, which has only lately been surpassed by De Laval units of somewhat larger capacity and power. Efficiencies of over 87% were obtained at the official tests made by Prof. Angus of four 20,000,000 Imperial gal. per day motor driven De Laval pumps for 250 ft. head, recently installed at Toronto. The De Laval Steam or Electric Driven Centrifugal Pump is the most economical means for handling water. Ask for book W-100 on "Ten Years' Progress in Water Works Pumps."

De Laval

Steam Turbine Company

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.



DIRECT-CONNECTED SYNCHRONOUS
MOTOR DRIVEN AIR COMPRESSORS

Where requirements call for a compressor with a capacity of over 700 ft. per minute, and if you want electric drive, the Class "PRE" is the logical selection. The number of these machines installed in all parts of the world and the variety of industries served is proof of the fundamental engineering principles of their design and construction.

Direct-connected synchronous motor drive is efficient because the driving power is transmitted directly to the compressor shaft, avoiding belt losses and breakages. Standard unity power factor synchronous motors will improve the power factor of your electrical system—if desired a leading power factor motor can be installed to bring your line still closer to unity power factor. Also, the complete machine is compact and requires a simple foundation.

A distinctive feature of Class "PRE" Compressors is their **patented** 5-Step Clearance Control which causes the compressor to operate automatically at full, ¾, ½, ¼ or no load, depending upon the amount of air being used.

An enclosed dirt-proof flood lubrication system automatically furnishes copious lubrication to all running parts; force-feed lubricators oil the air cylinders.

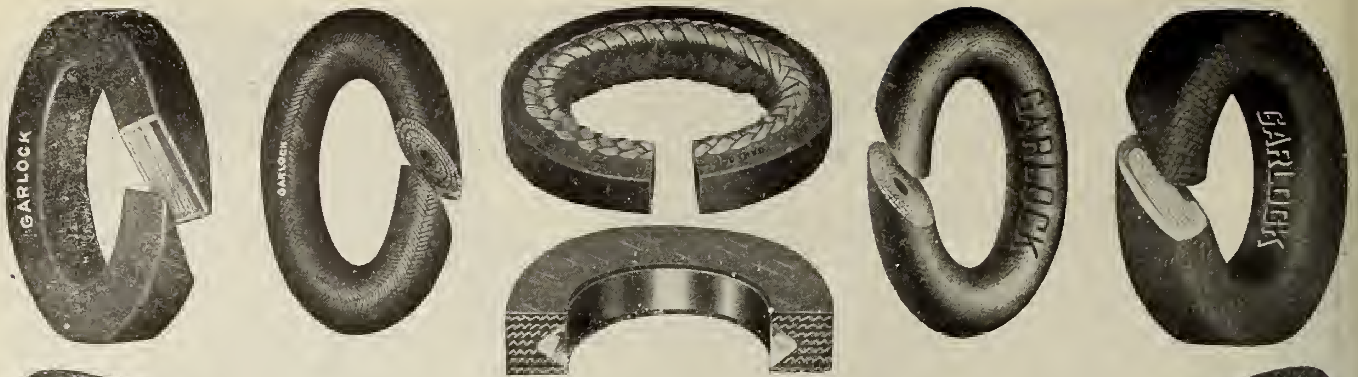
Class "PRE" Compressors are furnished complete with standard self-starting synchronous motor, exciter and starting panel, or with direct current motor and panel. When requesting details, specify your electrical conditions.

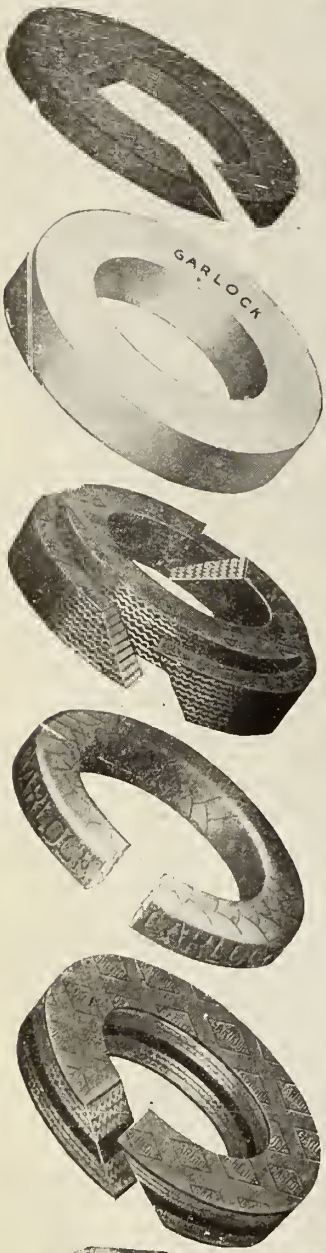
C.P.-4

Canadian Ingersoll-Rand Company, Limited
Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

Ingersoll-Rand

Condensors Vacuum Pumps, Gas and Ammonia Compressors, Drills.





Garlock Packings

Have you ever considered the loss in engine efficiency due to excessive friction on piston and valve rods caused by the use of inferior and poorly lubricated packing?

A horse power easily can be absorbed at the stuffing box and, when, considered in dollars and cents at the coal pile, the loss would pay for a high class packing many times over.

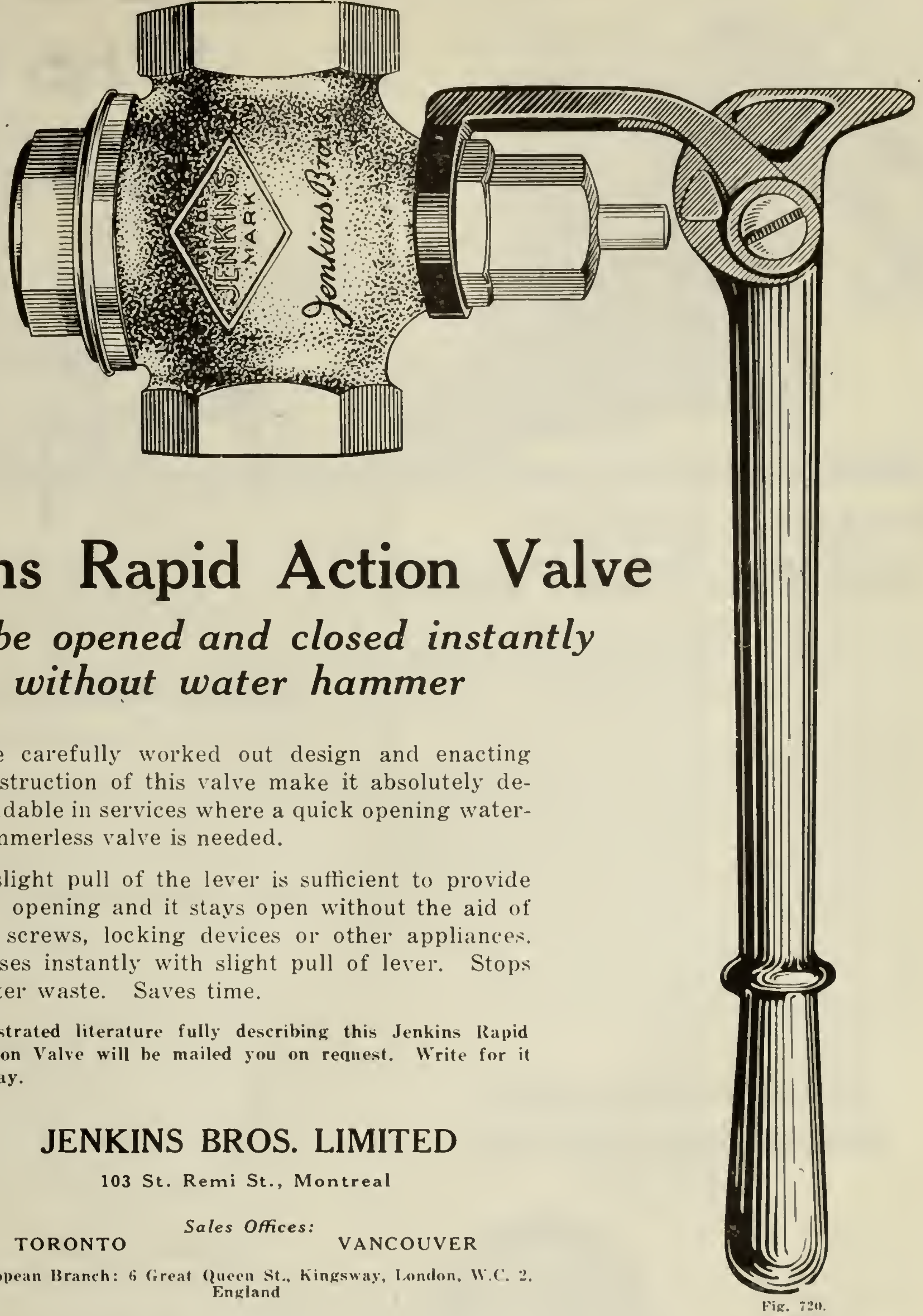
Garlock packings are designed to meet every condition of service.

Write for Catalog.

The Garlock Packing Company
Hamilton - Ontario

BRANCHES:

Montreal, Quebec.
Toronto, Ontario.
Winnipeg, Manitoba.
Calgary, Alberta.
St. John, N.B.
Vancouver, B.C.



Jenkins Rapid Action Valve

Can be opened and closed instantly without water hammer

The carefully worked out design and enacting construction of this valve make it absolutely dependable in services where a quick opening waterhammerless valve is needed.

A slight pull of the lever is sufficient to provide full opening and it stays open without the aid of set screws, locking devices or other appliances. Closes instantly with slight pull of lever. Stops water waste. Saves time.

Illustrated literature fully describing this Jenkins Rapid Action Valve will be mailed you on request. Write for it to-day.

JENKINS BROS. LIMITED

103 St. Remi St., Montreal

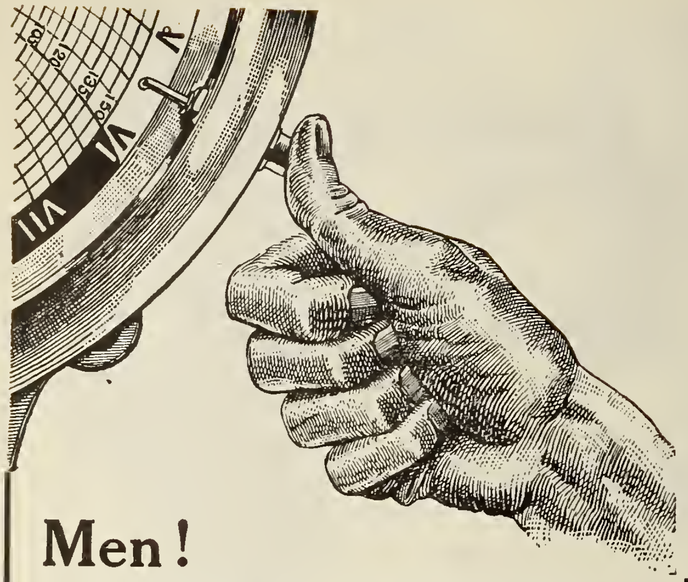
Sales Offices:

TORONTO VANCOUVER

European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, England

Fig. 720.
JENKINS
Rapid Action Valve

Since 1864



Men! Protect Yourselves With This Time Punch

Many a faithful employee, conscientiously performing his duties, in connection with heat-treating processes, has had to stand the blame for heavy spoilage in the past—simply because he couldn't prove that he was on the job.

In every manufacturing process calling for temperature control you can now protect yourself against unjust reprimand by means of the TIME PUNCH attachment of the Columbia Recording Thermometer.

The Day-and-Night Chart furnishes a true record of temperature variations, but the Time Punch, operating exactly like a time clock, registers the very minute of your visit, showing beyond question that you watched the chart at stated intervals. Your employer doesn't have to take your word for it—the little punch hole in the margin of the disc, made at the instant you press the button, backs you up in your assertion that you kept your eyes on the temperature. It proves that you were faithful in the discharge of your duties.

As a matter of self-protection urge your Superintendent to install Columbia Recording Thermometers with Time Punch attachment. They cost no more than ordinary recording thermometers without this valuable feature.

The Time Punch attachment is also supplied on Columbia Recording Gauges and Tachometers.

Write to-day for catalog H-33.

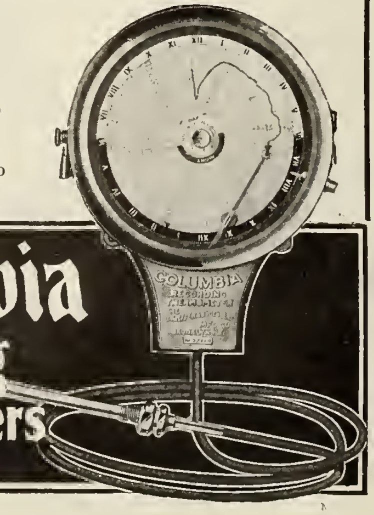
THE Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO. DIVISION
Brooklyn, N.Y.

Canadian Agency

THE CANADIAN
FAIRBANKS-MORSE CO.,
LIMITED

Montreal Toronto

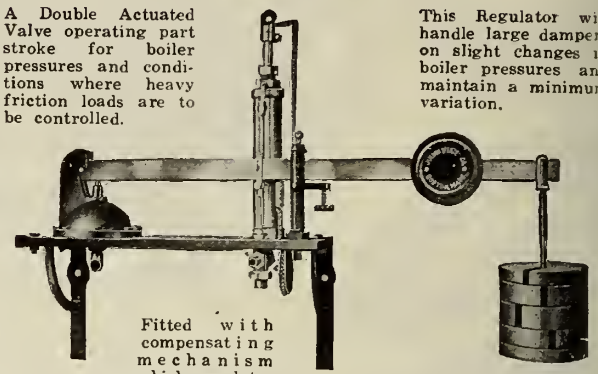
Columbia
Recording
Thermometers



D'ESTE
Hydraulic Damper Regulator

A Double Actuated Valve operating part stroke for boiler pressures and conditions where heavy friction loads are to be controlled.

This Regulator will handle large dampers on slight changes in boiler pressures and maintain a minimum variation.



Fitted with compensating mechanism which regulates opening and closing.

Our Catalogue No. 50 of CURTIS ENGINEERING SPECIALTIES sent on application.

Julian d'Este Company
Main Office: 26 Canal St., Boston 14, Mass.

The government-proved bearing metal

Magnolia Anti-friction Metal has been proven by United States and foreign government tests to have the lowest frictional coefficient of any known bearing metal. This fact alone clearly establishes its superiority to ordinary babbitts.

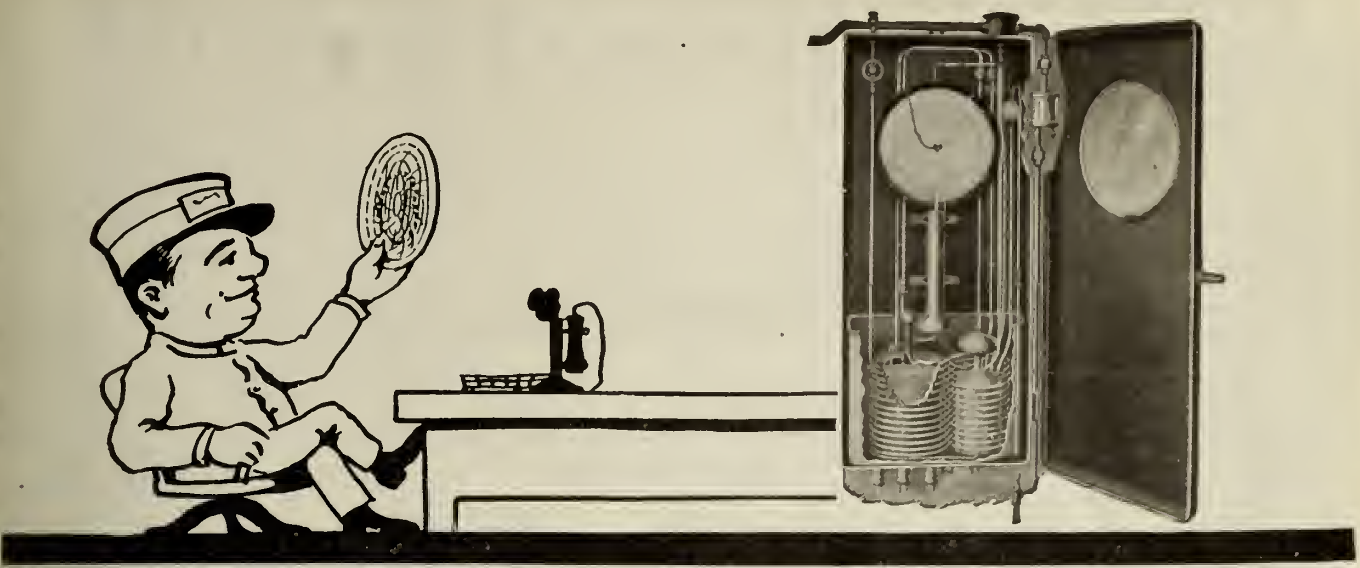
And there are additional reasons for the wide popularity of Magnolia Metal. It melts and pours well, is easily peened and scraped in, is always uniform in composition, adapts itself quickly to shaft inequalities and gives long and dependably good service.

A single trial will quickly prove the advantages of Magnolia Metal. If your dealer can't supply you, write direct to our nearest office. 20

Magnolia Metal Company
113 Bank St., New York

Chicago Fisher Bldg.
San Francisco Pacific Bldg.
Montreal 37 Shannon St.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK



No More Silver Threads Among the Gold

Special Foxboro
DRAFT RECORDING ATTACHMENT

A record of draft over the fire, on the same chart as the CO2 record, has the advantage of bringing two related records together for convenient comparison. The improved Foxboro diaphragm tube movement which has proved so satisfactory for measuring draft is combined with the standard CO2 Recorder to make an exceedingly reliable combination recorder.

Our friends who have installed Foxboro-Heath CO2 Recorders in their plants tell us that they have an exact knowledge of combustion efficiency at their finger tips, and that they never have to worry about the reliability of their source of information.

The Foxboro-Heath CO2 Recorder is a practical, common sense instrument for accurately recording CO2 content in flue gases. It is of all metal construction; no glass parts to break or rubber tubes to leak. There are only three moving parts.

Five minutes attention a day and twenty-five minutes at the end of each month keep the instrument in perfect working order.

In accuracy and dependability the Foxboro-Heath CO2 Recorder meets its full responsibility in upholding the Foxboro reputation as "The Compass of Industry."

Let us show you how the Foxboro-Heath CO2 Recorder can lighten your combustion burdens. Write to Dept. C.F.

THE FOXBORO CO. INC., Foxboro, Mass., U.S.A.
New York Chicago Boston Cleveland Tulsa
Pittsburgh Philadelphia San Francisco Birmingham
Peacock Brothers, Limited, 179 Delorimier Avenue, Montreal, Canada.

FOXBORO
TRADE MARK
THE COMPASS OF INDUSTRY

4924

LINDE

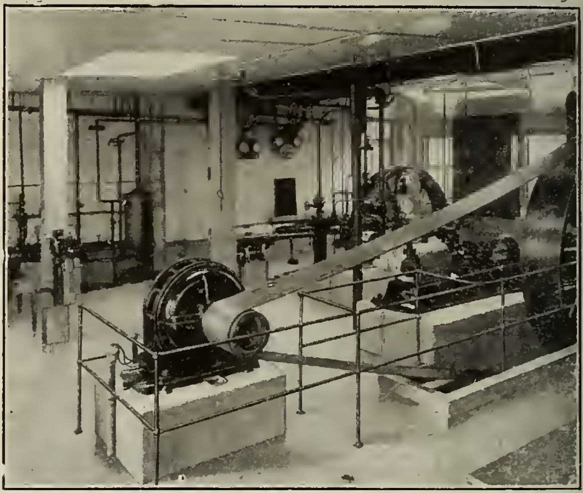
Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants.
Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

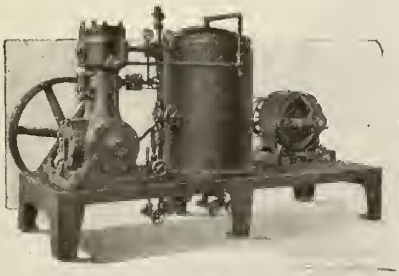
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.
37 St. Peter Street, MONTREAL, Que.
TORONTO WINNIPEG VANCOUVER

VILTER
ICE MAKING AND REFRIGERATING MACHINERY



A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada

CRANE

Ammonia Valves and Fittings

were used exclusively in the Construction of Refrigeration Plant, Montreal Board of Harbor Commission. All Ammonia Valves and fittings subjected to a rigid test of 300 pound air before leaving shops.

CRANE
LIMITED
General Office & Exhibit Rooms
386 BEAVER HALL SQUARE
MONTREAL
Works
1280 ST. PATRICK ST.
MONTREAL

Branches and Warehouses:
HALIFAX, OTTAWA, TORONTO,
HAMILTON, LONDON, WINNIPEG,
REGINA, CALGARY, VANCOUVER.

Sales Offices:
ST.JOHN,N.B.,QUEBEC,SHERBROOKE,
EDMONTON, VICTORIA,
SYDNEY, AUSTRALIA.

CRANE-BENNETT
LIMITED
Head Office and Warehouse:
LONDON, ENGLAND.

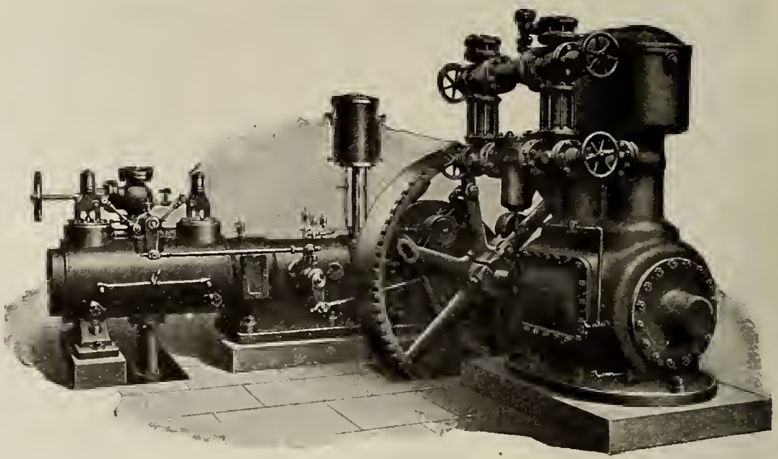
Sales Offices:
BIRMINGHAM, CARDIFF,
GLASGOW, LEEDS, MANCHESTER.

FRICK COMPANY INC. TRADE FRICK MARK WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical

Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.



We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

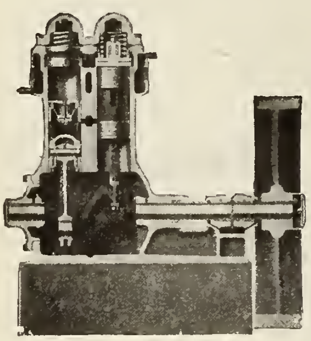
Ask for a copy of our List of Users covering 48 pages of satisfied customers---also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

---



Section of YORK Enclosed Ammonia Compressor showing simplicity of construction.

Representing
YORK MFG. CO.
Ice Making and Refrigerating Machinery Exclusively
YORK, PA., U.S.A.

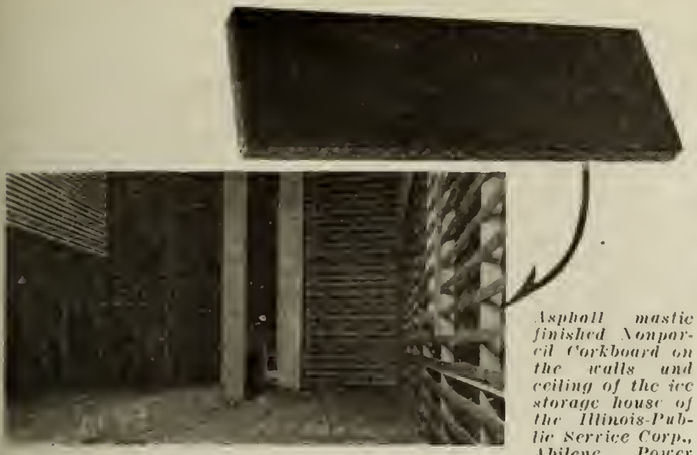
YORK Enclosed Ammonia Compressors

are designed and constructed for the BUSINESS

—which requires a Refrigerating Machine of moderate initial cost, that is reliable under all conditions—does not require a skilled operator, nor an experienced mechanic to make repairs. Although the necessity for repairs is almost negligible, it is realized that wearing and bearing parts must deteriorate eventually. All parts of York Enclosed Compressors are made to jigs and templates, insuring the fit of repair parts. The simplicity of construction makes it possible for any employee to take care of a York Refrigerating Machine.

Write us for detailed information and prices

CANADIAN ICE MACHINE CO., LTD.
Toronto: Villiers and Munition Sts., Eastern Harbor Terminals;
Montreal: 324 Craig St. West; **Winnipeg:** 1415 Whyte Ave.;
Vancouver: 1158 Homer St.



Asphalt mastic finished Nonpareil Corkboard on the walls and ceiling of the ice storage house of the Illinois-Public Service Corp., Abilene Power Plant, Abilene, Texas.

Asphalt Mastic Finish Here

AIR-PROOF, moisture-proof, frost-proof—asphalt mastic finish on Nonpareil Corkboard insures the maximum efficiency of your insulation. It prevents moisture penetration and the consequent formation of frost which sometimes destroys plaster finishes in ice storages, hardening rooms, coil bunkers, etc., when the temperature is low and humidity high.

Asphalt mastic finish is a special grade of odorless, refined asphalt, $\frac{1}{8}$-inch thick, ironed on one side of the sheets of Nonpareil Corkboard at the factory. The ironing keys the finish into the corkboard and assures uniform application without voids or air holes. Asphalt mastic will not run or peel at ordinary temperatures, nor will it crack when cold. The joints are sealed with a mastic filler. No plaster or other finish is required.

Asphalt mastic on Nonpareil Corkboard stands up under the most severe cold storage conditions of moisture and temperature and protects your insulation permanently.

Write for a sample of asphalt mastic finish Nonpareil Corkboard. It will be sent free on request, and further information and estimates will be gladly furnished without any obligation on your part.

Armstrong Cork & Insulation Company, Limited
902 McGILL BUILDING, MONTREAL, QUEBEC
11 BRANT STREET, TORONTO, ONTARIO, CANADA

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers, tanks and cold surfaces generally; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

KERR

"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville Ontario

Pressure Fluctuations

cause loss in economy

Protect yourself against such unnecessary loss, by means of the continuous day and night records obtained with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

Recording Pressure Gauges

They are a direct check as to how the men are holding the specified pressures, by showing every rise and fall in pressure.

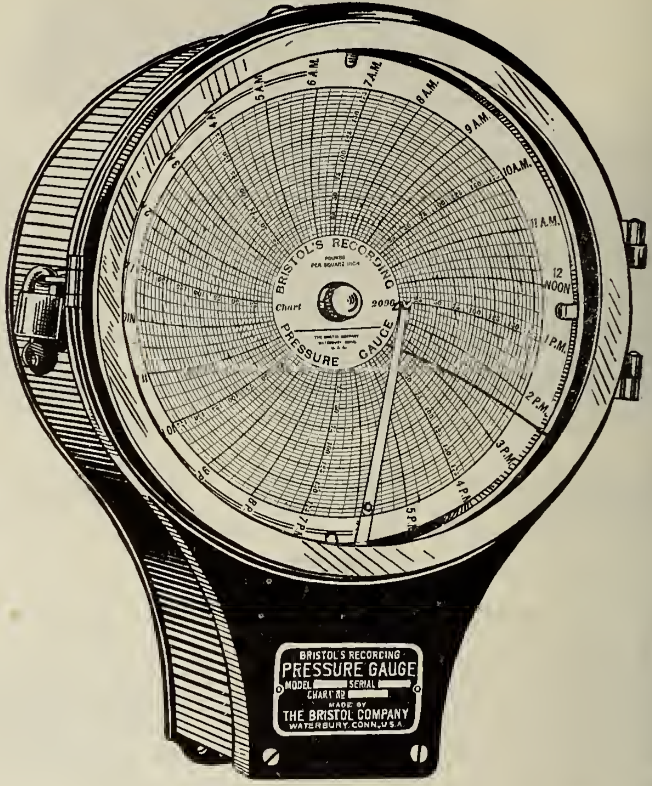
Our line of recorders is very comprehensive—they will furnish accurate, continuous records of the changes in pressure, temperature, current, voltage, kilowatts, water level, production, motion, etc.—and the time, day or night, when the changes took place. Bristol's Recording Instruments are the standard throughout the world.

Write for copy of Catalogue 1006-A

The Bristol Company, Waterbury, Conn

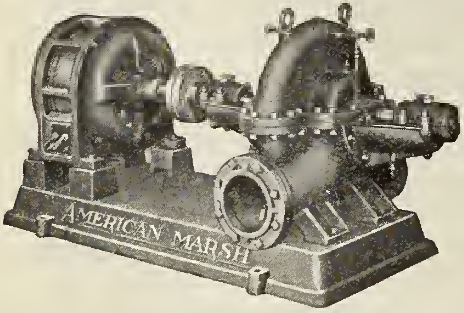
Branch Offices:

Boston New York Philadelphia Pittsburgh Detroit
Chicago St. Louis San Francisco


BRISTOL'S RECORDING PRESSURE GAUGE
BRISTOL'S RECORDING PRESSURE GAUGE
MODEL SERIAL
CHART No
MADE BY
THE BRISTOL COMPANY
WATERBURY, CONN., U.S.A.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
12 NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
7 P.M.

AMERICAN-MARSH PUMPS

Centrifugal and Direct Acting



Designed for use in power plants where absolute reliability and high efficiency are essential. For over thirty-five years American-Marsh Pumps have been recognized as standard throughout the Dominion. There are over 160,000 in successful operation.

The sturdy rugged construction and heavy cast bronze fittings insure long life and a minimum repair expense.

American-Marsh Centrifugal Pumps are built with the same painstaking care that characterizes the construction of the direct acting line.

The Line includes :

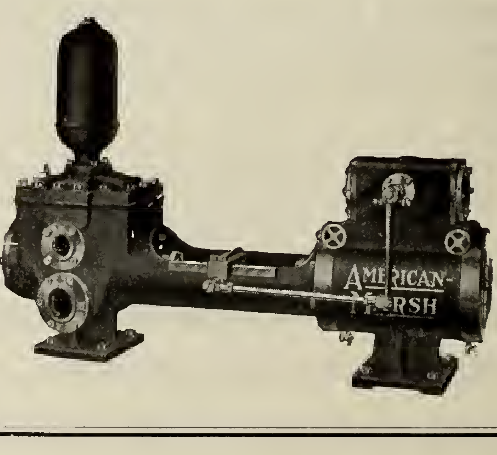
- Boiler Feed Pumps
- Air Compressors
- Deep Well Engines
- Centrifugal Pumps
- Jet Condensers
- Vacuum Pumps
- Condensation Pumps
- Sump Pumps

May we send you our general Catalog ?

AMERICAN STEAM PUMP CO.

BATTLE CREEK, MICH.

CANADIAN AGENTS:—A. R. Williams Machinery Co., Ltd., Toronto; Williams & Wilson, Ltd., Montreal; London Engine Supplies Co., Ltd., London; A. R. Williams Machinery Co., Ltd., Winnipeg; Mechanics' Supply Co., Ltd., Quebec; Gorman's Ltd., Edmonton and Calgary; J. T. Allan Ritchie, Vancouver.



COAL

A GREAT SOURCE OF POWER

HARD TO GET AND HIGH IN PRICE

Then why waste power by letting steam leak through poor packing in the stuffing box.

When the production of power costs as much as it does at present you should use

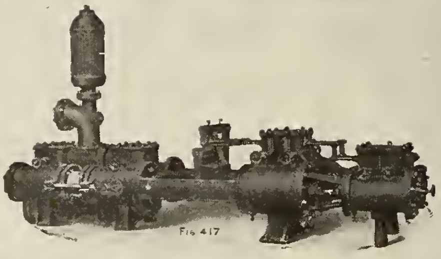
TRADE MARK
"PALMETTO" PACKING
REG U S PAT OFFICE

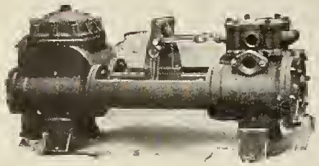
because it is a packing that can be depended upon to give the longest service under the hardest conditions known to packings—because of the unusually high grade of materials used and the superior methods of manufacture.

Free working samples to prove quality

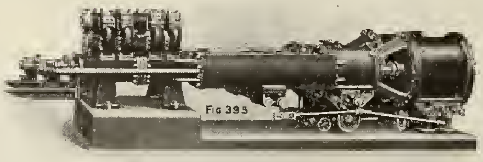
GREENE, TWEED & CO.
Sole Manufacturers
109 Duane St. New York

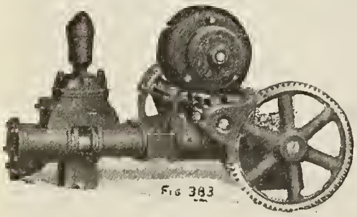
STEAM DRIVEN DUPLEX PUMPS POWER DRIVEN

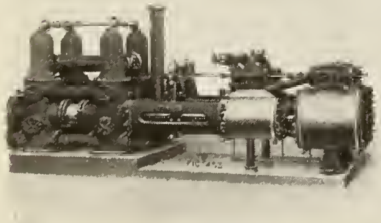




If you have had experience in buying, operating or maintaining duplex pumping machinery and have not tried McGowan, give us an opportunity on the next installation. Our designs obviate most of the troubles your former experience entailed. McGowan pumps are built for service.







For all Conditions of Service.

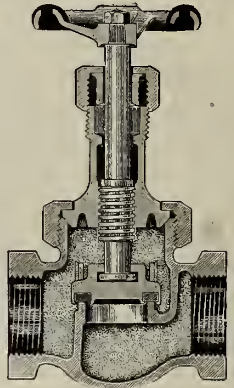
Mills
Mines
Railways
Power Plant

For all Industrial Plants.

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

PRATT & CADY VALVES

P&C CO TRADE MARK



P&C CO TRADE MARK

It is real economy to install Pratt & Cady Bronze Union Bonnet Renewable Disc globe and angle valves. It is so easy to replace parts subject to wear that you are sure to take advantage of this feature.

P. & C. Folder No. 2 describes this valve in detail. May we send you a copy?

Reading Steel Casting Co., Inc.
Pratt & Cady Division
General Sales Office: Bridgeport, Conn.

CANADIAN REPRESENTATIVES:--CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.

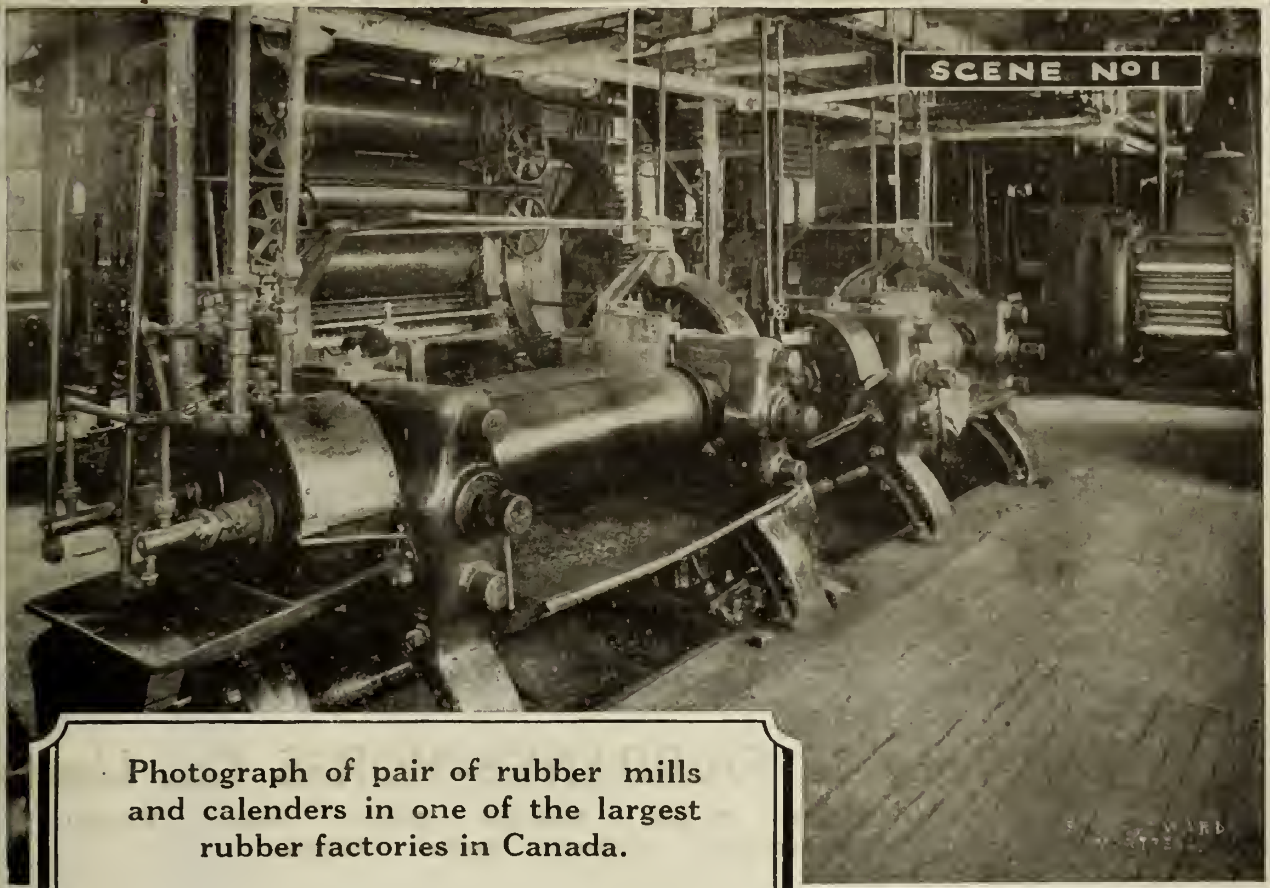
Building a one-piece furnace lining without special forms.

BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

Makes practicable, solid, one-piece furnace lining, including front and back arches, side walls and baffles. It costs but little to install in any make or type of boiler. It saves fuel, annoying shut-downs, costly repairs, and increases the amount of power from the fuel used.

Complete details of the many uses, methods of installing, how to order, measurement blanks, etc., are contained in a booklet of information which we will gladly send you. Tell us the individual to whom it should be addressed.

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6 Rome, N.Y.
Canadian Distributors:
INTERNATIONAL CHEMICAL CO.
26-6 Adelaide St., Toronto, Ont., Canada.



Photograph of pair of rubber mills and calenders in one of the largest rubber factories in Canada.

Imperial Lubricants in use:—

Imperial Special Fibre Grease.
Imperial Heavy Dark Machine Oil.
Imperial Gear Shield Grease.
Imperial Atlantic Red Oil.

Imperial Lubricants are manufactured with the same scientific precision as the finest units on which they are used. For years we have specialized in the production of oils and greases to meet the most exacting requirements of plant lubrication. Perhaps the right grade of Imperial Lubricants can promote efficiency in the operation of some of your machines.

Write our nearest branch when in need of the advice or services of our expert lubrication engineers.

IMPERIAL OIL LIMITED

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

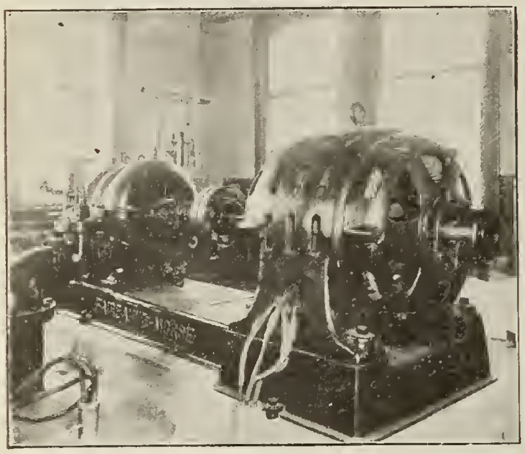
Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

The Heart of the Pumping System

The FAIRBANKS-MORSE Centrifugal Pump



Particularly adapted to Municipal Water Supply, High Pressure Irrigation, Marine Service, Hydraulic Elevator Service, water supply for mills, office buildings and apartment houses, etc.

These renowned pumps have a long record of continuous satisfactory service. They are of extra rugged construction, and all bearings are renewable bronze, while they may be opened quickly for inspection without disturbing pipe connections.

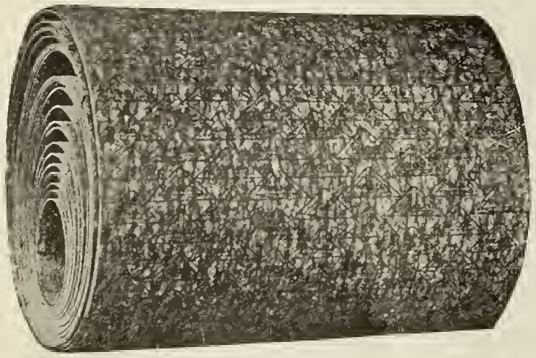
We supply practically every type of pump, be it Air, Boiler Feed, Centrifugal, Fire, Marine, Gasoline, Heavy Oil, Irrigation, Rotary, Hydraulic or Typhoon, etc., and our engineers will gladly recommend the proper type for your conditions without charge or obligation. Write our nearest office for Pump data.

The Canadian FAIRBANKS-MORSE Co., Limited

Montreal Toronto St. John Winnipeg Quebec Ottawa Windsor
Vancouver Calgary Regina Victoria

Durabla Gaskets Make Tight Joints

Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.



Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

DURABLA
TRADE MARK REGISTERED

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in. long.

In thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Let us send you a trial order.

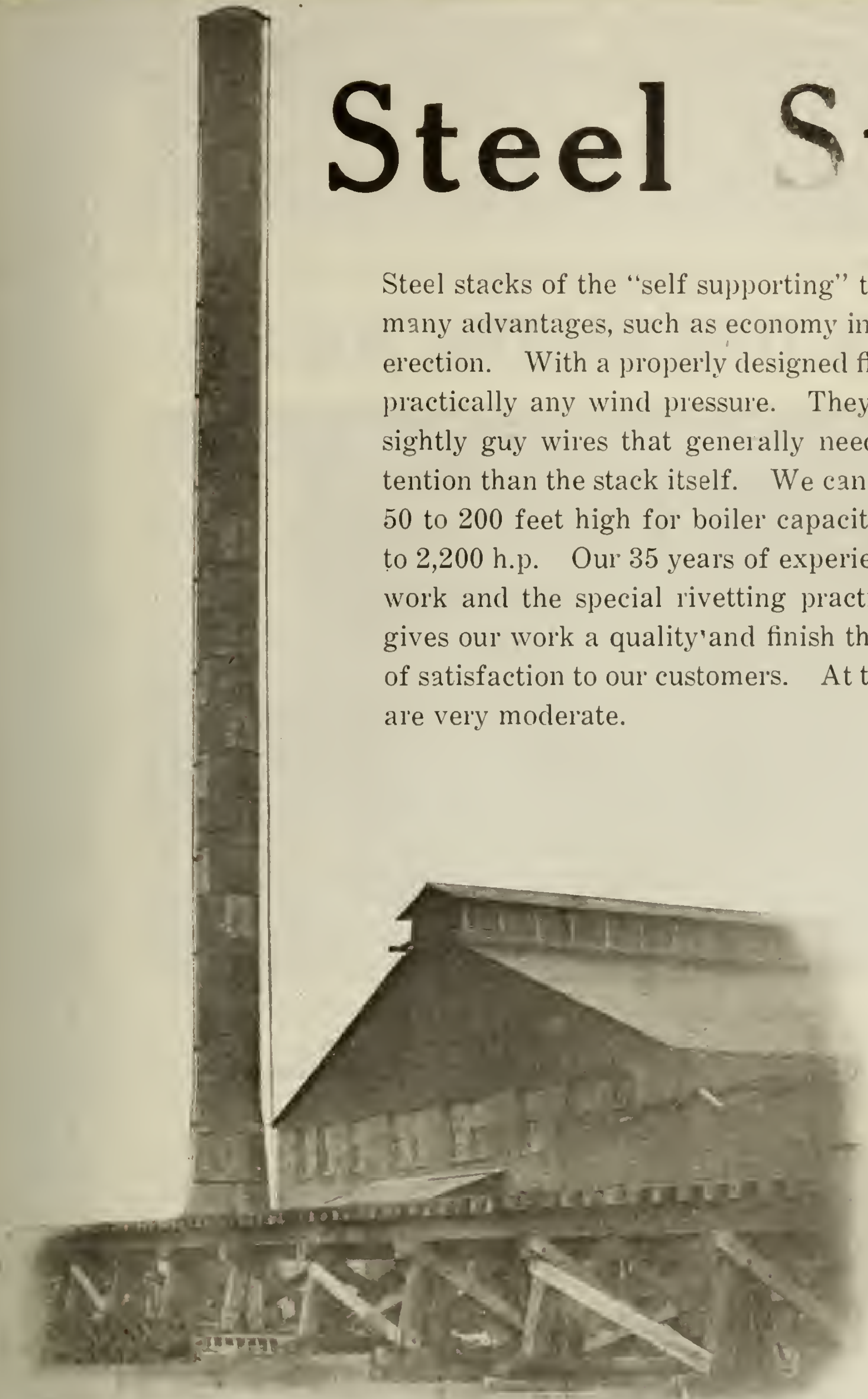
DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

Steel Stacks

Steel stacks of the "self supporting" type as illustrated, offer many advantages, such as economy in cost and time saved in erection. With a properly designed flare base they can stand practically any wind pressure. They do away with the unsightly guy wires that generally need more repairs and attention than the stack itself. We can build these stacks from 50 to 200 feet high for boiler capacity running from 20 h.p. to 2,200 h.p. Our 35 years of experience in high grade plate work and the special rivetting practice we have developed gives our work a quality and finish that is a continual source of satisfaction to our customers. At the same time our prices are very moderate.



A self supporting steel stack, 140 feet high, 6 feet, 6 inches diameter, erected by us for Pilkington Bros., Limited, Plate Glass Works, Thorold, Ont.

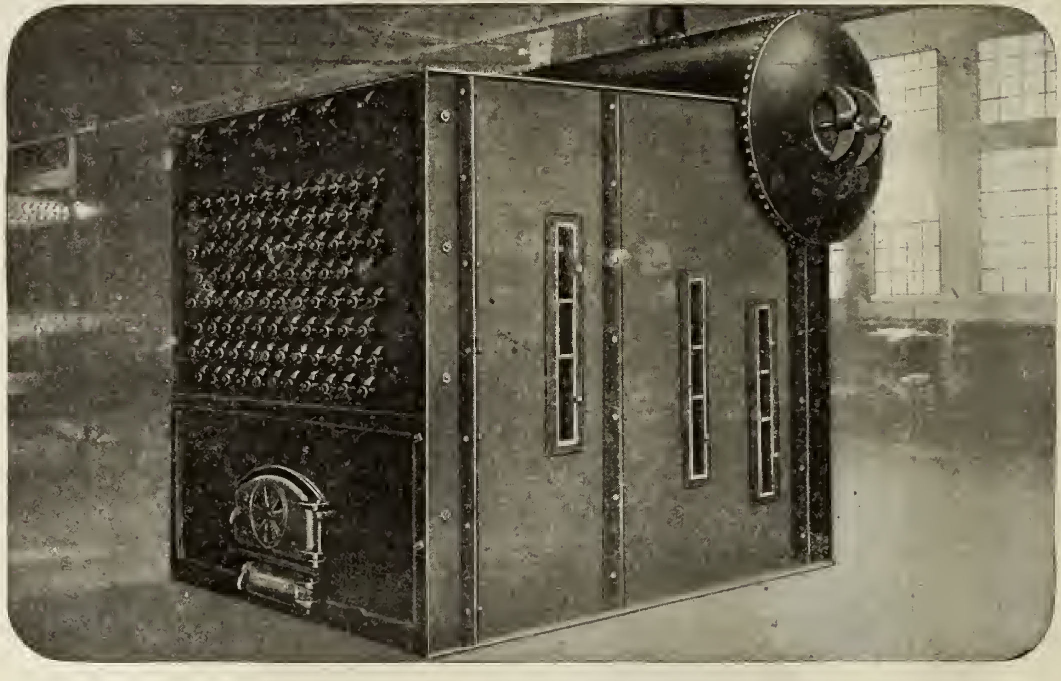
Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

GOLDIE & McCULLOCH
Dependable Power Plant Equipment

TYPE "H"
WATER TUBE HEATING BOILERS



Shop View of an Assembled Type "H" G. & McC. Co. Water Tube Heating Boiler.

With Temperature at 24° below Zero Ottawa Collegiate Boilers are Highly Satisfactory

The following letter from the Architect speaks for itself.

Office of J. ALBERT EWART, B.A Sc., Architect,
Jackson Building, Ottawa, February 6th, 1923.

THE GOLDIE & McCULLOCH CO., Limited, Galt, Ont.—

Dear Sirs:—Answering your letter of February 5th, regarding the type "H" Water Tube Heating boilers which have been recently installed at the Ottawa Collegiate Institute, I beg to state that these boilers have been in operation since the beginning of the winter and are giving entire satisfaction. I made inquiries to-day as to how they were working and Mr. Pearce reported that they were doing fine. As you are aware this was an exceptionally cold morning and it is a pleasure to know that we have a heating plant that can handle everything it is called upon to do without trouble.

This type of boiler we find to be a very fast steamer, so that the fireman can heat the building very quickly at any time when the fire happens to go down.

I should be very glad to recommend this type of boiler to any of your clients. Yours very truly.

J. A. EWART.

NOTE: Tuesday, Feb. 6th, 1923. The morning referred to above, temperature registered 24° below zero.

Ask for Circular, Prices, Engineering Advice, Etc.

THE GOLDIE & McCULLOCH CO., LIMITED.

Head Office and Works: GALT, ONTARIO, CANADA

Toronto Office: Suite 1101-2 Bank of Hamilton Bldg. **Western Branch:** 248 McDermott Ave., Winnipeg, Man. **British Columbia Agents:** Robert Hamilton & Co., Vancouver, B.C. **Quebec Agents:** Ross & Greig, 400 St. James St., Montreal, Que.

POWER HOUSE

Members of the
Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

How Ball Bearings Can Reduce Transmission Costs

Development of Ball Bearings for Lineshafting—Save 20 to 30 Per Cent. of Total Power—Cut Lubrication and Maintenance Bill 80 Per Cent.—Various Types of Drives

By R. C. HAWKES

IT SHOULD be quite unnecessary to commence this article by advancing proof showing that ball bearings reduce transmission costs, as everyone is familiar with the results that have been obtained with the use of ball bearing hangers for some years past, but it might be desirable to briefly outline the present day ball bearing and the difference between it and the original bearing with which the reader may have had some unfortunate experience. An entirely satisfactory ball bearing was not developed until about ten or fifteen years ago. Previous to that time several types of bearings were put on the market, but they were mostly designed along the lines of the bicycle ball bearing and would only operate satisfactorily under light loads at slow speeds, with the shafting absolutely in line. A bearing with these limitation is no use for lineshafting where belts are sometimes tightened almost to breaking point, and where mis-alignment is always present.

Load Factor

The bearing of to-day is quite different. In designing the modern ball bearing for transmission work, a load factor considerably in excess of the breaking strength of the shaft itself is used. The bearings are proportioned in this manner: take any size shaft, say 2-7 16in. for illustration, support it at points eight feet apart. Then at a distance of four feet from either support, weight the shaft down until failure occurs. This breaking weight is then noted, and the thickness of the metal in the inner and outer rings of the bearing together with the diameter of the balls is calculated to withstand three times this breaking strength of the shaft itself; therefore in order to crush a ball or fracture a ring, a pressure three times greater than that required to actually break the shaft would have to be exerted on the bearing; a condition which could only be brought about by either wilful destruction, collapse of the bearing or impact of a flying piece of broken machinery.

In addition to this, the modern bearing is self-aligning, so will continue to operate when the shafting gets out of line without increased friction or wear and without heating. As it is generally impossible to keep shafting in line through foundations settling, loads being placed on the upper floor and other causes, the self-aligning feature is essential. The speed difficulty has also been overcome, as will be shown later by the fact that shafting is being run in ball bearings with absolutely no trouble at 1,000 r. p. m. This would be impossible with babbitt bearings. The self-aligning and other features of the modern ball bearings are illustrated in Fig. 1.

Savings in Lineshafting

Coming to the subject of this article, the old method of driving machines naturally receives first attention. Under the old method a main shaft is run down the centre of the machine room and the machines driven from it by belts through the medium of countershafts. This system wastes a great deal of power, as from 40 per cent. to 60 per cent. of the total power consumed by machines and shaftings is used to drive the shafting, so only from 60 per cent. to 40 per cent. of the total

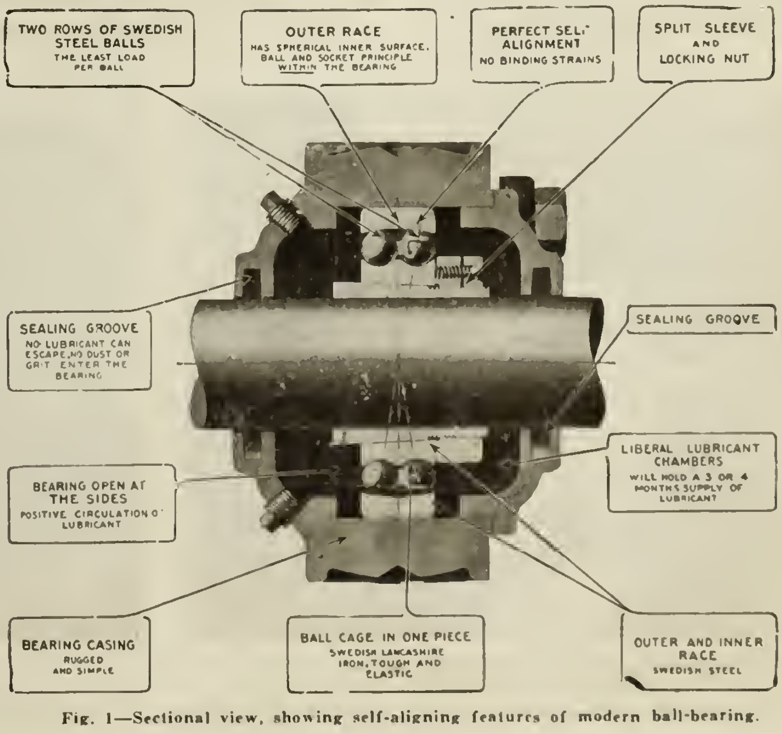

TWO ROWS OF SWEDISH STEEL BALLS
THE LEAST LOAD PER BALL
OUTER RACE
HAS SPHERICAL INNER SURFACE. BALL AND SOCKET PRINCIPLE WITHIN THE BEARING
PERFECT SELF ALIGNMENT
NO BINDING STRAINS
SPLIT SLEEVE AND LOCKING NUT
SEALING GROOVE
NO LUBRICANT CAN ESCAPE, NO DUST OR GRIT ENTER THE BEARING
SEALING GROOVE
LIBERAL LUBRICANT CHAMBERS
WILL HOLD A 3 OR 4 MONTHS SUPPLY OF LUBRICANT
BEARING OPEN AT THE SIDES
POSITIVE CIRCULATION OF LUBRICANT
BEARING CASING
RUGGED AND SIMPLE
BALL CAGE IN ONE PIECE
SWEDISH LANCASHIRE IRON, TOUGH AND ELASTIC
OUTER AND INNER RACE
SWEDISH STEEL

Fig. 1—Sectional view, showing self-aligning features of modern ball-bearing.

Illustrations supplied through the courtesy of the Can. S.K.F. Co.

power is actually delivered to the machines. This statement is substantiated by Kent's Engineers' Handbook. Shafting running in ball bearings will run at least 80 per cent. easier than in babbitt bearings, so will therefore save anywhere from 20 to 30 per cent. of the total power used.

In order to obtain some accurate figures on lineshaft bearing friction, the University of Wisconsin some time ago conducted tests which extended over a period of four years. It was decided that where a shaft running on ball bearings takes one unit of power, the same shaft on roller bearings takes from 2.2 to 3 units of power, and the same shaft on babbitt bearings from 3 to 4.5 units of power.

Annual Lubrication

Besides the power saving, ball bearing hangers make a big cut in the lubrication and maintenance bill, as it is only necessary to lubricate them once or twice a year, depending on the speed, with vaseline or a special ball bearing grease. This means that the oiler can be eliminated and the man be given some other work where he can produce. Also rebabbitting becomes a thing of the past, as do shut-downs through hot bearings. A properly designed and made ball bearing will last indefinitely.

Several large installations have been in operation in this country for over ten years, and the bearings show no appreciable sign of wear, and there is every reason to believe that they will run for at least another ten years. This should be all that is necessary to overcome the arguments of some of the older school of mechanics who claim that a serious drawback of the ball bearing hanger is that when the bearings fail they cannot be removed from the shaft and replaced as easily as babbitt bearings, because ball bearings are not split. They don't have to worry about that, when the ball bearings run for at least ten, and probably twenty years without requiring repairs.

Factor of Cost

A very recent example of ball bearing money saving was noted in Sherbrooke, Que. In a small planing mill the babbitt bearing hangers on the main shaft were thrown out and replaced with ball bearing hangers which cost $178.00. The proprietor reported that his power bill was reduced by $5.00 per month, and that he estimated he was saving about $4.50 in oil and time; also count about $50.00 per year for rebabbitting, making a total of $164.00 per year. Even if the rebabbitting charge is left out, he would still be saving $114.00 per year, which would represent a return of about 65 per cent. per annum on his investment. Very few propositions can show such a high return as this.

Overloaded Motors

Here is another opportunity for ball bearings to cut transmission costs. When the plant engineer or superintendent is confronted with the fact that a motor driving a group of machines is overloaded and the shafting is running in babbitt bearings, he can take one of two courses to remedy the trouble. He can buy a larger motor, or change the hangers and install ball bearings on the shafting. If he puts in the larger motor, which will cost a considerable amount of money, as much, or more power will be used than before. Also very little will be realized by the sale of the old motor. If ball bearing hangers are installed, however, a large power saving is effected, thus cutting the power bill, the overload condition is remedied and the old motor still used. This happened some time ago in Kitchener, Ont. In one of the plants there a 40 h. p. motor driving a line of machines was so much overloaded that it was heating badly, and the superintendent was hourly expecting it to burn out. He called in a well-known firm of anti-friction engineers, and they changed over the hangers on the lineshaft to ball bearings. Later, power tests were made, and it was found that only 30 h. p. was being used, so the ball bearings saved 25 per cent. of the power on the motor rating, plus the overload.

Group Drives

There is no doubt but that the group drive system is the most efficient in every way. In some cases it is not possible to so arrange the machines that this system can be used, but this does not happen often, so it will be found that in most of the plants which have been built or remodelled during the last few years, the machines are grouped, each group being driven by a separate motor. Here ball bearings play a big part. By running the short shaft, used to transmit the power to each machine in the group, on ball bearings, the shaft can be run at any speed up to 1,000 r. p. m.

It is then possible to drive directly down to the machines and eliminate countershafts. Also, owing to the high speed, the size of the pulleys on the shaft would be reduced. This in turn increases the speed of the belts and as a belt will transmit more horse power the faster it runs, lighter and narrower belts can be used. Thus by using the group drive system and running the shaft in ball bearings, such savings are made in counter shafts, pulleys and belts, that the initial outlay is less for ball bearings than for babbitt bearings, with the ball bearing hangers costing three times as much as babbitt bearing hangers. Then, of course, the power and maintenance bill is reduced as with the long lineshaft.

Another advantage of running the shafting at a high speed, is that the motor can be connected directly to the shaft by means of a flexible coupling, thus eliminating the drive belt and leav-

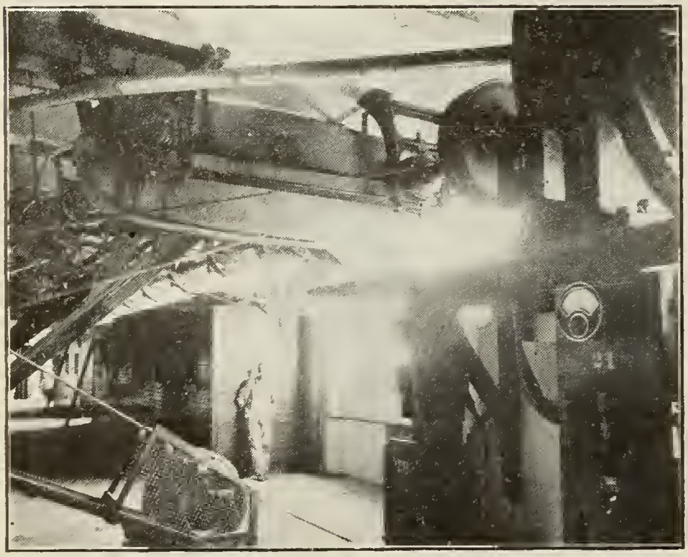


Fig. 3—Installation in Quaker Oats Plant at Peterboro, Ont.

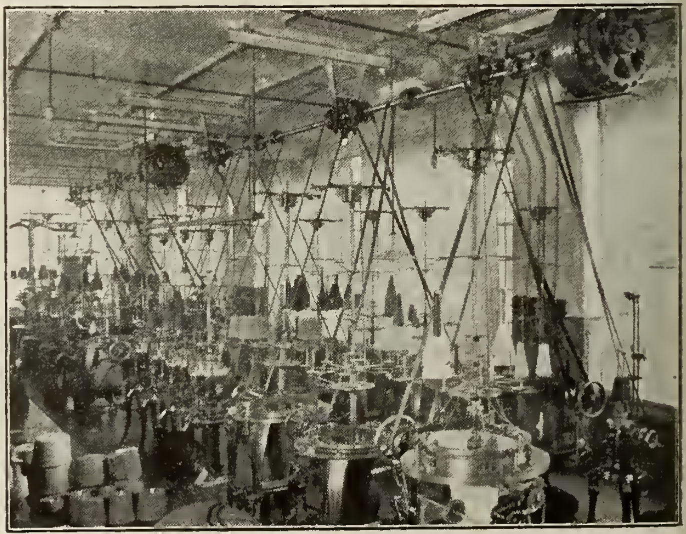


Fig. 4—Group drive in T. Eaton factory at Hamilton, Ont.

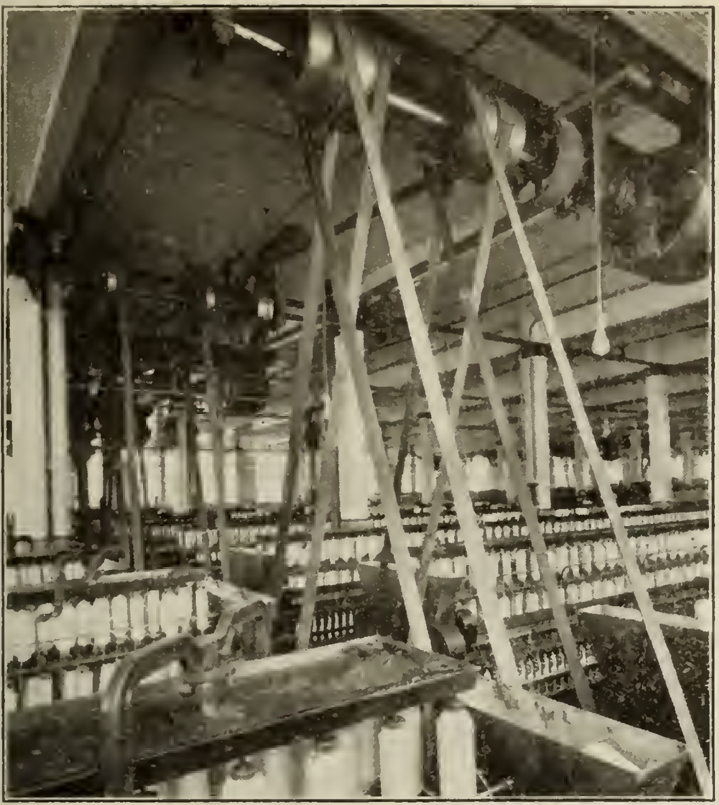


Fig. 2—Spinning frame drive in plant of Manhasset Cotton Co., St. Hyacinthe, Que.

ing that space which would have been taken up by the belt, available for other purposes. A good example of this type of drive is shown in Fig. 2. This is the spinning frame drive used throughout the plant of the Manhasset Cotton Co., St. Hyacinthe, Que. A 30 h. p. motor is directly connected to a short shaft which is driven at 900 r. p. m.; a belt drives a parallel shaft of about the same length. Six spinning frames are driven by each motor.

Typical Installation

Fig. 3 shows another instance where the motor is connected directly to the shaft. In this case the motor is 400 h. p. and the shaft size 4-15/16in. dia., running in ball bearing hangers. This installation is in the Quaker Oats Company's mill at Peterboro, Ont.

Fig. 4 shows another group drive installation in the T. Eaton Company's knitting factory at Hamilton, Ont. Again in this case the motors are supported from the ceiling, and do not take up any floor space.

In each of the above plants it is important that no oil be allowed to drop from the hangers onto the material in process of manufacture. The ball bearing hangers are absolutely clean. Grease is used as a lubricant and this is retained in the bearing housings by felt washer seals, and unsightly drip pans are not required.

Another instance where ball bearings made it possible to run the shaft at a high speed and eliminate countershafts, was found a year or two ago in a silverware factory where two rows of buffers were installed. Here a shaft about 22 feet long was mounted in self-aligning ball bearing hangers which were bolted to the floor. The shaft was driven at a speed of 1,000 r. p. m. The buffers were mounted on a bench built over the shaft and were driven from the shaft by light belts. This made a very simple and satisfactory layout, and money was saved on the initial cost, as if babbitt hangers had been used it would have been necessary to have used a countershaft for each buffer.

Efficient System

The group drive system has generally proven to be more efficient and economical than direct drive where an individual motor is used to drive each machine. In the first place the initial cost of a motor for each machine is naturally very high. Then smaller motors are required than would be used to drive a group of machines and it is well known that the smaller the motor, the less efficient it becomes, so that a great deal of power is wasted by a number of small motors. Also the upkeep of the motors must be considered. A fair sized plant would use several hundred motors on the direct drive system, and it would be necessary to permanently employ a staff of electricians to take care of them. With the group drive system a few motors of at least 25 or 30 h. p. are used, and the efficiency of a motor of this size is quite high compared with motors of one or two horse power.

It will be seen from the foregoing that there are many ways in which ball bearings can reduce transmission costs, so much so that the ball bearing question should be gone into very thoroughly when considering a new installation or contemplating alterations to an old one. The best way is to consult a reputable ball bearing company that can offer an engineering service, and obtain their engineers' opinion and suggestions.

Water and Tidal Power

In his recent presidential address to the Newcastle-on-Tyne Association of the Institution of Civil Engineers, Mr. R. F. Hindmarsh, M. Inst. C. E., Chief Engineer to the Tyne Improvement Commission, took for his subject "The Utilization of Water and Tidal Power." In the course of his remarks the President said that water wheels were in use 3000 years ago on the Nile, and that similar wheels continued in use without improvement until the early part of the eighteenth century; wheels turned by tidal currents had also been used in this country and in America, Spain and France, but on account of their insignificant magnitude and primitive design, and also to their intermittency, these were not suited to the ordinary industrial uses.

The water turbine was evolved in 1823 by a Frenchman, and such machines were capable of developing much greater powers and of operating at higher speeds than the old water wheels which they gradually displaced, although in some places water wheels were still doing useful work. Recent improvements in the water turbine and electrical appliances had made possible the great advance which had been made in hydro-electric work in the last few years. The total potential water power in the world was, said Mr. Hindmarsh, estimated at 200 million horse-power, but so far only about 25 million horse-power has been utilized. It would, however, take the whole output of the mines of the United Kingdom to produce as much energy as it at present produced from water in the world. The United Kingdom at present only developed about 200,000 horse-power from water power, and had not nearly the resources of many other countries, but there were still possibilities of much further development, especially in Scotland, it being estimated that energy could be developed at an economic rate from certain undeveloped water power resources nearly equalling the amount developed at Niagara Falls or an amount equal to the power generated in the 410 public steam power undertakings for electric supply to railways and tramways in Great Britain.

Although deficient in inland water resources, the motion of the tides around the coasts of this country represented, continued Mr. Hindmarsh, an enormous possible source of power, the western and especially the south-western coasts of Great Britain being particularly suit-

(Continued on page 31)

New Developments in Smokeless Combustion

Means of Utilizing the Heat of Generation to Consume the Heavy Gas Products—Thorough Mixing of Heated Excess Air With Volatiles Promotes Better Results

By H. M. NOBIS

COMBUSTION is said to be complete when the combustible elements have united with all the oxygen with which they are capable of entering into a combination, provided the ignition temperatures are high enough.

It would be foolish on my part to claim a perfect combustion in a heating boiler, but we certainly should strive to have a complete combustion. While combustion is complete but not perfect, there are losses due to excess air and it follows that the more nearly complete combustion can be made to approach perfect combustion, the less the loss that will occur in the burning of any fuel.

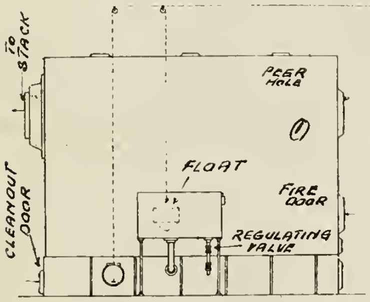


Fig. 1.—Automatic air control for single grate boilers.

The majority of the schemes employed for smokeless combustion consists of admitting excess air before, above, behind and through the bridge wall. It is a debatable question with some engineers where the proper inlets for the air supply should be located and where the contact point between the gases and air should occur. However, I express my firm opinion that the air inlet should be above the fuel bed, no matter what type of heating boiler is used. The air inlets should consist of openings with shutters which could be closed after the smoke is burned off. In ninety-nine cases out of one hundred, this is not done and, as the heavy smoke burns off in about fifteen minutes and the average firing period is two hours, the cold air may do more harm than good.

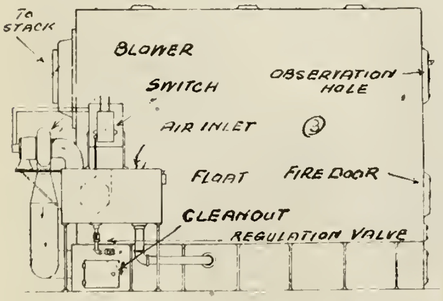


Fig. 3.—Blower type of automatic air control for sectional cast iron boiler, arranged for smokeless combustion.

My experience is that it is easier to prevent smoke by manipulating the fire door, giving a large amount of air at first, gradually diminishing and then closing it off entirely. As all the abovementioned air inlet methods produce a delayed combustion in the boiler flues and chimney, the writer has compiled the following rules to achieve a good and smokeless combustion:

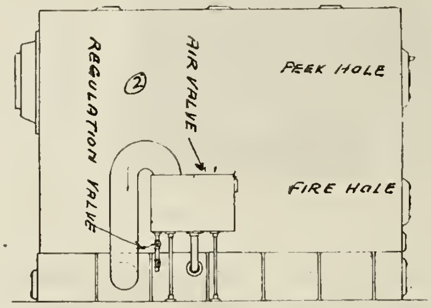


Fig. 2.—Automatic air control for sectional cast iron boiler arranged for smokeless combustion.

Suggested Rules for Smokeless Combustion

1. The introduction of hot excess air above the fire, first in large quantities, gradually dimishing, and shutting off entirely in 10 minutes.

2. Methods to compel a thorough mixing of the heavy smoke with the heated excess air above the fire, allowing a certain period of time to complete the consuming of the heavy smoke.

3. The presence of heat-storing materials which absorb a part of the high heat generated during the smoke-consuming period above the fire, which storage heat may be used to ignite the lighter combustible gases.

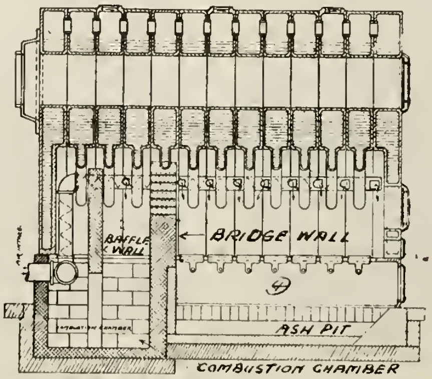


Fig. 4.—Sectional cast iron boiler arranged for smokeless combustion.

4. Means to insure a thorough mixing of these lighter gases with the unavoidable air inleakage along grate supports, fire holes, doors, etc.

Acting on these principles the writer constructed an apparatus shown in the accompanying illustrations which he installed in a 36-series, 9-sectional National Radiator Company boiler. The coal burned comes from a Belmont County (Ohio) mine containing about 39 per cent. volatile matter, 47 per cent. carbon, 4 per cent. sulphur and 10 per cent. ash, having a heat value of about 12,900 B. T. U. This coal is burned on 15½ sq. ft. of grate surface, with draft produced by a chimney 18 in. x 18 in. x 55 ft. high. The direct radiation attached to the usual vapor system piping is in excess of 4,000 sq. ft.

To fulfill the principle of the first requirement, we installed 4-in. heavy cast-iron piping on both sides of the furnace. These pipes are supported by the extended water tubes found in these boilers. The method adopted for introducing the excess air is shown in Fig. 3. This apparatus consists of an enlarged toilet tank, the water contents being discharged into the ashpit before the fireman begins to add fuel or stoke the fire. The copper float sinks with the water level, closing an automatic float switch which supplies current to a direct-connected blower, as shown. The air discharge is connected to the 6-in. cast-iron pipe leading inside the furnace. An orifice in the city water supply line to the flush tank fills the tank in from 10 to 20 min., lifting the float which breaks the current to the motor. The partition of the tank being submerged partly in water closes the air inlet to the blower. The partition is made with a V-cut opening, diminishing the air supply gradually during the blower operation, giving a large amount of excess air at first.

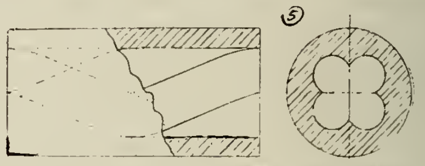


Fig. 5.—Fire brick for furnace bridge wall.

The second requirement is solved in the following manner: The outlet openings in the blower discharge pipes inside the boiler (Fig. 4) are slanted sidewise so that the escaping air stream blows against the fuel bed. The max-

(Continued on page 27)

Means of Measuring Capacity of Refrigeration

Value and Use of Instruments in Analyzing the Operation of a Complete Refrigeration Plant, With Comment Upon "the Unit of Measurement" Used on Gauges

By JOHN E. STARR*

IT HAS always seemed to the writer that the proper way to regard a refrigerating machine is from the basis of the number of pounds of liquid that heat applied at a low temperature will evaporate or boil into a gas under certain given conditions of pressure. So much for capacity.

For efficiency the calculation would be the number of pounds it will condense back to a liquid under certain conditions of pressure and temperature. There is, of course, nothing new in this statement of the case, except that it is an indication of a more simple attitude of mind in approaching the subject and getting a proper perspective of the process as a whole.

Instruments that will measure the steps of this operation are necessary to use in order that we may properly control the steps and have knowledge as we proceed that we are proceeding properly. It is, therefore, of the utmost importance that we know the weight or the number of pounds of liquid circulated per unit of time, for in any liquid whose physical properties are well known, such as ammonia, if we know the temperature at which it is fed to the boiler and the quantity boiled by our refrigerating temperatures in a unit of time, we know the amount of heat taken up. To this end I would regard the instrument showing the temperature of the liquid just before passing the expansion valve, or the liquid thermometer, as the most illuminating instrument of capacity measure. Coupled with this an accurate instrument for showing the pressure at which the liquid is boiled is, of course, necessary, also an instrument showing the number of pounds per unit of time.

Having accurate instruments to show these three conditions the actual capacity is quickly, easily and accurately determined. Where brine is used as a heat carrier, a check can be made but it is hardly necessary, as the before mentioned method of arriving at capacity has proven satisfactory within a small per cent. of calculation from the brine and is imperative in direct expansion work. It follows the very familiar routine of calculation of steam boiler efficiency and capacity, for if we know the temperature of our feed water the pressure of our boiler and the pounds fed to it we are in a position to calculate exactly how much heat is put into it.

An oil filled well on the feed line about one and one-half or two feet before the expansion valve and an accurate glass thermometer can be made to give an accurate record. An accurate recording thermometer can also be used, subject to the usual objections here mentioned attending the transfer to the record (which is, perhaps, less liable to error in thermometry recording than some other recording instruments).

Mercury Pressure Gauge

For a pressure instrument for such low pressures as usually obtain in refrigerating work a mercury pressure gauge will prove on the whole more accurate and less liable to get out of order and frequent readings insure a reasonable average. Sometimes an accurate recording gauge is found that will give results comparable to a mercury gauge and although the readings are necessarily coarser they may be sufficiently commercially correct. On the whole a mercury pressure gauge is preferable as giving surely accurate results and a fine scale. For measuring quantity, the Venturi meter has been perfected so as to give results from one to three per cent. of calculation by brine load with the chances for this small error all in favor of the meter, but in any event commercially close. The writer would not hesitate to assign capacity from data obtained from the weight, temperature, and pressure of the liquid used and would feel particularly safe with ammonia, the properties of which are almost as well authenticated as those of water.

Considerations given above, of course, cover capacity. The burning question of H. P. per ton requires a different set of instruments.

Where Electricity is Used

Fortunately where electricity is used for conveying power a direct relation can be almost instantly established between H. P. and capacity and if such results are satisfactory and as good as the best nothing more need be investigated. A reliable ammeter and volt meter, checked with a reliable wattmeter, which can be supplied by any reputable electric concern, gives with the calculation of capacity the proper figures for H. P. per ton.

These instruments, of course, should be checked occasionally for accuracy the same as one would check any other instrument of accuracy.

To insure that the condensing process is being properly conducted and as a guide to operation a number of instruments of measure are employed, and all should be of the best—for it must be always kept in mind that a lying instrument of measure is worse than none at all.

Pressure Gauges

For every day convenience a pressure gauge to register the back pressure and one to register the head pressure are placed in plain sight of the operating engineer. If an accurate mercury gauge is used as before mentioned (for the purpose of closely estimating capacity), the working gauge should be compared to it from time to time to insure that it keeps fairly accurate. For head pressures, reliance is usually placed on the working high pressure gauge and insurance of its accuracy should be had by periodical accurate tests. The temperature of the liquid thermometer is the guide of pressure. It is recommended that a separate scale be added showing corresponding saturated temperature.

The head pressure shown by the head pressure gauge in most instances should not be more than eight or nine per cent. numerically greater than the pressure called for by the temperature of the liquid and sometimes runs even closer. Perhaps with very high head pressure it might run a little more but a difference of ten or twelve pounds is commercially attainable.

If it is farther away than this, it is time to look for foul gas in the condenser surfaces or insufficient surface.

An indication of any particular make of gauge would be out of place here, as there are a large number on the market. But be sure they are reasonably accurate.

For complete information, a thermometer to record the temperature of the compressed gas as it leaves the compressor is desirable. It is impossible to expect that it will indicate accurately the state of the gas immediately when it has reached full compression, as many heat transfers may happen before the compressed gas reached the thermometer, but these thermometers may indicate that it would be well to more intimately examine the compressor and a "stitch in time" may be taken, on the gentle hint that may be given by this instrument. It may show a temperature so at variance with the calculated outlet temperature, notwithstanding jacket influence, if there be any, that an examination by use of an indicator may be called for.

The Indicator

Of the use of the indicator and the lessons to be drawn from its use one cannot do better than refer to Mr. Voorhees' little book on "Indicating the Compressor" where the subject is treated simply and to a much greater extent than can be allowed in the scope of this paper.

The indicator is an X-ray photograph of the interior of the compressor in action and a sure exposition of its faults, if any it has, and a suggestion of cure.

For commercial convenience the volumetric efficiency of the compressor is often referred to as the relation of its swept displacement (clearance considered) to the evaporative volume. This is really what we desire to know in the final analysis from a commercial standpoint, but taken alone is not always fair to the compressor. Therefore, to get at the real facts affecting compressor performance a thermometer on the suction near the inlet valve is desirable.

A whole lot of things might happen to the gas on its way from the boiler to its arrival at the suction valve and inevitably it might occupy a much larger volume per pound by the time it reached the suction valve over its volume per pound at the evaporator. If the difference is only seven or eight degrees we might commercially neglect it, but if it runs large it is unfair to charge against the compressor acquisition of heat that has probably done nobody any good. The heat so acquired has, in all probability, not come from the brine or any other place where its removal benefits anyone.

The heat that is thus unprofitably taken up between the evaporator and the suction valve has, of course, to be raised to a higher plane and eliminated just as if it had done useful work and represents, therefore a dead loss.

To keep track of this loss so that if possible a means can be devised to prevent it, at least partially, it is desirable to place a thermometer where indicated as showing the temperature of the suction gas when the compressor takes hold of it and compare with the evaporation temperature. Differences of 20 to 25 degrees are not uncommon and this means an appreciable increase of volume and its amount can be estimated in dollars and cents.

Recording Gauges

Recording gauges (except perhaps temperature recorders) are very apt to get out of order and to present lying information on their charts. The trouble is not in the instrument that gives the information, but in the mechanism that attempts to convey this information to a chart. If the error is a constant one, the chart if not valuable for specific information as to the true state of affairs at any one time, may be valuable for qualitative analysis or comparison, but unless one is very sure of the accuracy of the transmission it is perhaps doubtful if the charts will form a correct basis of estimate. Original readings of the original accurate instruments are better and surer, especially in a test, and a person making frequent readings often sees things that a chart will not tell him.

As a result of many tests the writer feels almost safe in relying on the amount, temperature, and pressure of the working fluid as a measure of capacity, but many plants are equipped for measuring capacity by quantity and temperature of brine, which is of course a reliable method in itself, and also gives opportunity for a check on the other method. Both methods are, of course, subject to another check by calculation of gas volume. Aside from estimation of tonnage and H. P. per ton it is desirable to keep track of the temperature and often the quantity of brine. Sight thermometers of the separable socket-type are made that are closely accurate, and, if the expense is warranted, there are pretty reliable recorders on the market. A continuous record is of use to the engineer, and especially of value to the managers. Care in placing them is, of course, to be taken to insure that they give the average temperature of the brine.

As to the brine meters, it can probably be said that there are few recording brine meters that can be absolutely relied on. A Venturi type of meter, carefully calibrated for the density of brine employed and the average temperature, would be considered accurate if original readings of pressure differences were taken at the meter tube, but a great chance of error lies in the transmission to the integrator and chart. Measure by pump piston displacement with allowance for slip as shown by calibration by a measured test at the same temperatures and pressures, is perhaps as reliable as any method and is usually convenient as the brine circulator is also the meter. Record of specific gravity is better taken by a hydrometer with a widely marked specific gravity scale than by some arbitrary scale as the salometer or Baume hydrometer. Errors and time in translation are thus avoided.

Checking Efficiency and Capacity

Measurement of inlet and outlet temperature of condensing water and weight of same is, perhaps, the quickest and surest way of arriving at efficiency and checking capacity. Where a water pump is used, an occasional calibration by discharging into a tank where known weight or volume can be easily ascertained is desirable and a well placed inlet and outlet thermometer completes the data. A check on the capacity and reasonableness of the H. P. per ton is instantly made by this method.

The working of the condenser is also quickly arrived at.

The head pressure should show a corresponding temperature very close to the temperature of the hottest or outgoing water.

Of the tests shown by Denton in Kent's book:

No. 1 showed 1.09 degrees condenser temp. over hottest water.

No. 2 showed 0.3 degrees condenser temp. under hottest water.

No. 3 showed 2.26 degrees condenser temp. under hottest water.

No. 4 showed 5.79 degrees condenser temp. over hottest water.

Three tests by Horne showed condenser temperature 7.8 degrees hotter than hottest water on the average.

Four other tests by Horne with colder water showed an average of 10.6 degrees hotter condenser temperatures than hottest condensing water.

As a general rough rule one should be pretty well satisfied if the temperature corresponding to condenser pressure is say, not over five degrees above the temperature of the hottest or outgoing water. He should congratulate himself if it was nearer or under and in summer weather should look to his condenser conditions if it showed more. The heat of the liquid might show in some condenser of the double pipe type as very near or even fully as cold as the coldest or inlet water. For a few degrees difference either in condensing temperature or heat of liquid the final item is small but is worth attention.

The reasonableness of the figure obtained for capacity is also easily checked by this method. For example, if the reputed tonnage or tons shown by test per minute are divided into heat per ton per minute removed, as shown by the condensing water, the reliability of the tonnage data may at once be shown to be ridiculous. Tests have been made where the heat out by water showed less than 200 B. t. u. per minute. As the heat added per ton is 200 B. t. u. per minute the water test must have been wrong or else the tonnage calculation was wrong. Or suppose that a machine at 180 lbs. head and 20 back showed only, say, 230 B. t. u. of heat removed by condenser per ton per minute. It is clear that 200 B. t. u. must be only 30 B. t. u. for heat added by power. A horsepower is 42.44 B. t. u. per minute. Hence the H. P. per ton on the gas would only show about .7 H.P.

Now common experience shows it would require about 1.2 H. P. on the gas under these conditions of pressure in a simple compressor. Hence the only conclusion is that water measurements of quantity and temperature were wrong or else the figures for tonnage and H. P. per ton were wrong. If the I. H. P. of the compressor was not taken on the test it is easy to approximate it by its usual percentage of H. P. in at the engine or on the wire. Eighty per cent. is close enough. So figures obtained from thermometry and quantity of condensing water are of immediate and great value. The measurement of heat out is equivalent to the measurement of heat in. Absolute fine correctness is little disturbed by reception or loss of heat from the atmosphere in machines over 5 tons in capacity.

The heat influx to and outflow from the apparatus is seldom calculated at much more than three per cent. of the entire amount accounted for.

In the Horne test of Oct. 21, 1922, which was a very careful one, the heat out was calculated at 27.2 B. t. u. per ton. The available heat in for refrigeration was, of course, 200 B. t. u. per ton, leaving 72 B. t. u. for power or

$$\frac{72}{42.14}=1.68 \text{ H. P. on gas.}$$

The actual I. H. P. on gas was shown to be 1.666, or an agreement of less than one per cent. Numerous other good tests show results nearly as satisfactory.

Scaling of Gauges

Here opportunity is taken to register again the century old protest against the scaling gauges. Why use an artificial scale on any instrument? Why not use a specific gravity scale or a hydrometer? Specific gravity is what you want to use finally. Why use some other scale? And then hunt up a table for translation and lose the time and run the risk of making an error. Why do not our pressure gauges tell the literal truth and when we have a real pressure of 35 lbs. why do they read 20.3 lbs?

Even our manufacturers of CO_2 gauges habitually give their record in atmospheres above the atmosphere and when they say 20 atmospheres they really mean 21 atmospheres or when their gauges read 64 atmospheres for head pressure it really means 65 atmospheres.

Only the other day the writer, who has devoted some thought to methods of making things plain, found it difficult to convince a life long ice manufacturer that 30 lbs. gauge represented 1½ times the pressure of 15 gauge instead of twice the pressure as the old-timer's habit of thought had fixed in his mind, and while the writer was able on logical grounds to explain step by step the true meaning of absolute pressure, gauge pressure, and inches vacuum it was apparent at the end of the discussion that while the old-timer was amenable to logic he was hazy on the results as a whole and still clung to his lifetime habit of thought. How few of us could offhand, and without considerable mental effort, state the relative pressure of 21.78 inches of vacuum and 25.85 inches, except to say it represented a difference of 4.07 inches? If the correct expression was used, to wit, the difference between two and four pounds, the mind would at once perceive that twice as much pressure was involved in one case over the other. Or if the smaller unit and coarser scale of pressure was used (omitting decimals) of four inches mercury pressure and eight inches mercury pressure how quickly the mind would appreciate the numerical magnitude of two to one. The present method of scaling gauges with the zero at a point that only exists in nature in limited areas of the globe is responsible for the universal idea in the minds of many that a vacuum does something, which is quite different from the true statement that if a vacuum or less pressure is created something may be done. Why not have our gauges convey the literal truth and start the zero at the true zero?

The same might be said of thermometry. Why should not our thermometers be gauged numerically so as to tell the direct truth? Instead they oblige us to get at the truth by a more or less laborious process of figuring.

Owing to habit it might take some time before the world at large would appreciate that say 520 F. meant the same degree of heat as 60 F., but why oblige one to consider 460 and add or subtract 460 almost every time he wants to make a calculation that will get him anywhere? It is true that there is an infinitely small error in placing our absolute zero, but it is too small to affect any practical end and we might just as well regard our freezing point of water of 492 as an incident to be classed with the freezing point of other fluids instead of a starting point as in the centigrade scale or the rather clumsy expression of 32 degrees more than our F. zero or starting point.

If we cannot have a universal spoken language we may have at least a universal technical language instead of confining it to the small word of technicians.

This article confines itself closely to a discussion of instruments used in analyzing the operation of a refrigerating machine and does not attempt to discuss instruments dealing with the production of motive power except in the mention of delivery of power by electricity.

NEW DEVELOPMENTS IN SMOKELESS COMBUSTION

(Continued from page 24)

imum amount of the air is released at the pipe ends blowing across the fire door, preventing to a certain extent, the inrush of cold air as the fireman starts the blower before the fuel charge. This forced-in air creates above the fuel bed a very lively commotion, burning the soot and smoke above the fire and not in the flues.

Introducing the heated air above the fire checks, to a certain extent, the rapid flow of air through the fuel bed, retaining the combustible gases, such as methane, ethane, acetylene, etc., within the fuel bed, these being burned off later on.

The partitioned-off bridge wall prevents the rapid flow of the smoke which is given time to burn above the fire, thus developing a high temperature at that point.

The third and fourth principles are mostly covered under the second requirement, with the addition of utilizing the thread-like inside formation of the round fire-brick as a mixing medium for the gases. Fig. 5 shows the firebrick construction.

The above-described method has been found to produce very satisfactory results:

1. The smoke or soot is actually consumed, producing and maintaining exceptionally clean furnace walls and flues.
2. A higher temperature is maintained within the furnace, found especially after a banked fire.
3. A steadier steam supply.
4. Less and smaller clinkers due to the wet ashpit.
5. Clouds of light gray smoke, at first with a small continuous escape of vapor-like smoke curling from the chimney.
6. A saving in fuel.

Figs. 1 and 2 show the automatic arrangement which may be applied to single-grate boilers with side air inlets. The writer has developed a similar apparatus for use in firebox steel and return tubular boilers.

Helpful Advice Needed on Smokeless Combustion

Referring to the smoke ordinances of cities which permit only the use of down-draft boilers, these, in the writer's opinion, are laws which do not comply with the spirit of our Constitution. These laws should not stand in the way of improvements which are bound to come, nor should a community compel a man to burn a certain grade of fuel. What a community should do is to give to the plant owners, which emit objectionable smoke from their stacks, helpful advice. This helpful advice can be given by competent combustion engineers, but to the shame of our city governments, men with little knowledge of combustion principles in many cases, are appointed as chief smoke inspectors. Lack of finances is given as the cause for this condition. If every community with a smoke problem would have expended its money on real education, consisting of an appeal for cleanliness, the money expended would have been saved one hundred fold through the saving in trees, flowers, washing of buildings and in freight rates.

The law as it stands, operates only during the office hours of the inspectors. Everyone who is acquainted with large and small boiler operations knows that most of the objectionable soot is deposited on the damp and wet surfaces of buildings and vegetation, in the early morning hours.

The smoke and soot blown over a city in the morning does the real harm on account of the low furnace temperatures prevailing after a banked fire. These low furnace temperatures cannot burn the sulphur, etc., out of the flaky smoke, which will burn out of the fuel after the boiler capacity is reached.

The time is coming fast when certain steel-producing districts will be able to furnish coke at less cost than soft coal, owing to the valuable by-products gained. Lucky will be the owners who provide large coke-storing space, so that he may buy his fuel requirements during the summer months when great quantities are available at a reduced price. —"The Heating and Ventilating Magazine."

---

*Paper read before National Association of Practical Refrigerating Engineers at St. Louis.

Proves Engineer May Aspire to Important Post

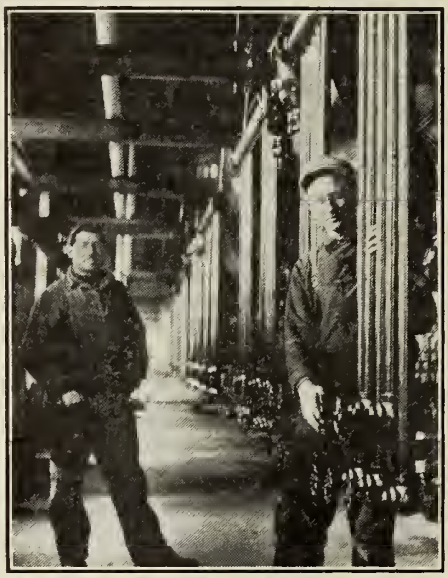
Fred Gonyou, Master Mechanic and Chief Engineer Dominion Sugar Co., Has Charge of Extensive Equipment—Responsible for All Buying—Says Technical Training Useless Without Ambition

IT IS not surprising to find Fred Gonyou, master mechanic and chief engineer, in charge of the mechanical and engineering departments of a $2,000,000 concern like the Dominion Sugar Company, Chatham, Ont., when it is found that he is the son of a master mechanic who spent some 54 years in the trade and is the brother of five licensed engineers. Fred Gonyou is a master mechanic and chief engineer by heredity as well as by practice—and his practice is of the most extensive nature.

Mr. Gonyou's start in the mechanical and engineering world dates back to the year 1879, the year after he had reached his majority. Born in Wallaceburg, Ont., he was a resident of that town until he was 22 years of age, and in '97 journeyed to West Superior, Wisconsin, to secure a thorough foundation in engineering in the employ of the American Steel and Wire Company of that city. Here he was engaged in overhauling the steamer "Empire City" and remained at work of this nature for a period of four years—four years of an apprenticeship which he considers was invaluable to his education. The end of the four years saw him stepping down a notch in the game signing on as a fireman on one of his company's ships which plied between the head of Lake Superior and Lake Erie and stopping at intermediate points.

When the winter had set in, Fred Gonyou went in for more practical experience. This time, his company placed him at the work of boiler making and tank building in their shops at Duluth and West Superior. He remained at this work until the year 1900.

The beginning of the 20th century found the Kilby Manufacturing Company erecting the large sugar factory of the Wallaceburg Sugar Company at Wallaceburg and also found Mr. Gonyou back in his home town helping with the construction of this plant and assisting in the placing of the multitude of machines which were soon turning out the finished product from the sugar-beet crop. The factory completed, Mr. Gonyou started on the ground floor in charge of the mammoth boilers. Six years spent in the Wallaceburg plant watched the young man move from the boilers to house foreman, from house foreman to machinist and, finally, from machinist to assistant chief engineer.



View of Battery of 12 Wickes Vertical Water-Tube Boilers, total capacity 4,000 h.p. During an operating campaign, eleven of the boilers work continuously at 120 lbs.

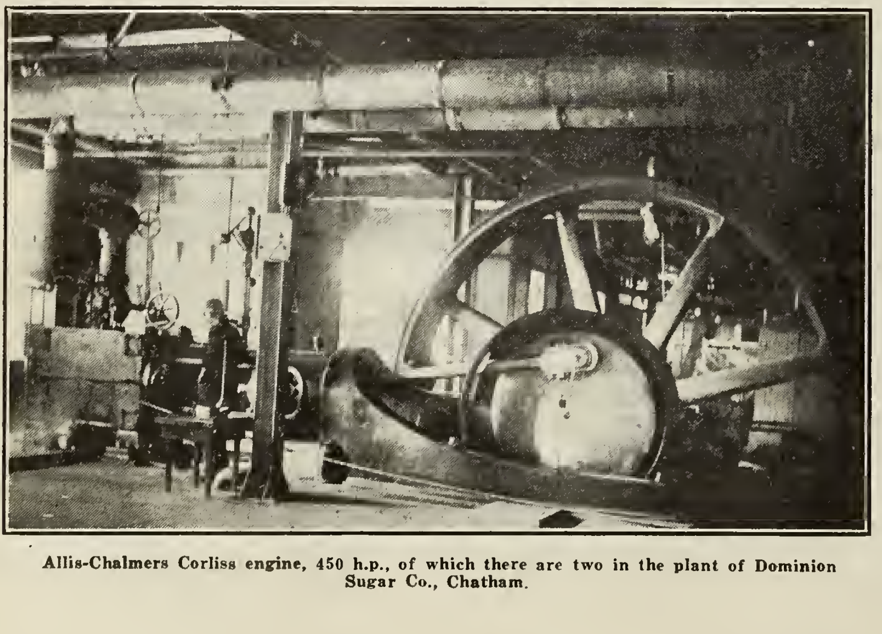
At the termination of his years in the Wallaceburg plant, Mr. Gonyou was sent by the Dominion Sugar Company to their plant in Kitchener to take the post of machinist and assistant chief engineer. He watched the old year out and the new year in, twice in Kitchener before he was sent back to his home town once more. This time it was in the capacity of master mechanic and chief engineer. Seven years spent in this capacity in the Wallaceburg plant, qualified him to take a similar position in the Chatham plant of the Dominion Sugar company. In this plant and in this capacity he has remained.

Mr. Gonyou's work in Chatham is very unique for a stationary engineer, and greatly exceeds the duties usually undertaken by a man of this position. He has full charge of all mechanical work in and around the factory which includes the mechanical work of a fleet of locomotives, locomotive cranes, tugboats and the machinery of the powerhouse and the main plant. In addition to this he has complete charge of all repair work and for this purpose he has under his jurisdiction fully-equipped boiler-shops, machine-shops and tin and pattern shops. His department does all of the machine repair work in this great factory and keeps the equipment in first-class working order. Mr. Gonyou states that this practice is very economical both in time and money.

Responsible for Buying

Instead of just operating and looking after the machinery as is the customary job of a stationary engineer, Mr. Gonyou is in charge of the general upkeep of the machinery in the entire plant as well as the tinsmithing and millwrighting. One remarkable feature of his position is the fact that he is responsible for practically all of the buying for his department with the exception of the coal. He is responsible for the purchase of all packing, belting, machinery and repair parts.

In combination with a large variety of powerful machinery, he naturally has a large staff of men under his supervision. The personnel of his staff consists, for the main part, of two assistant chief engineers with two assistants, eight station operators, a chief electrician and two helpers, one tin-and-coppersmith, a boss boilermaker and two helpers, three machinists, three carpenters and millwrights, two boiler-house



Allis-Chalmers Corliss engine, 450 h.p., of which there are two in the plant of Dominion Sugar Co., Chatham.

foremen, two steam tenders, eight firemen, four locomotive crane operators and locomotive engineers, a blacksmith, two factory oilers and about 15 labourers.

Power Plant Equipment

As for the machinery under Mr. Gonyou's control, one glance at the most important factors in the power-plant will give an idea of the responsibility resting on his shoulders. The powerhouse boasts of a battery of 12 Wickes vertical watertube boilers, with a total capacity of 4000 h.p. and a consumption of 225 tons of slack coal every 24 hours. The boilers are equipped with Westinghouse-Rooney vibrating grate stokers of 333 h.p. each. The main plant is driven by two Allis-Chalmers Corliss engines of 450 h.p. each, while the power for driving the machinery is generated by C. H. Brown engines connected direct to Bullock generators.

When the plant is working full capacity, eleven of the boilers are kept constantly at work under a working pressure of 120 lbs. of steam. The boiler house, as we might expect, is unusually well supplied with measuring and recording instruments, and with the various automatic devices, Mr. Gonyou states that the boiler room is practically under automatic control.

The Worthington feed pumps have a heavy duty to perform and are capable of pumping 60,000 lbs. of water against the boiler pressure, at a temperature of 210 degrees Fahrenheit in 24 hours. The lighting of the plant is provided for by a 200 h.p. engine connected direct to the generator. The plant in general is installed with the usual vacuum pans, pumps and usual equipment that are used in the process of the manufacture of sugar.

In the pump house there is a veritable battery of pumps, twenty-three of which are single acting reciprocating pumps, each having its own particular duty or function to perform in the process of sugar making. The fire pump is however, of a different class, it being a Worthington duplex reciprocating heavy duty pump, and evidently of a very large capacity.

Views on Technical Training

Referring to the grading of stationary engineers, Mr. Gonyou, who has been in charge of engineers and practical men for a period of 16 years, states that technical training is valuable, if it is not forced upon the machinist and engineer too aggressively. As a rule they have not the chance to accumulate the technical training asked for by examining boards. His idea would be to let the man with the practical education take a first-class trade journal or magazine for three or four years and then go in for technical work. This would give him a chance to understand just what is necessary and what the technical education means to him.

"In my estimation a thorough stationary engineer is one who understands everything in the manufacture of the product turned out by his company," said Mr. Gonyou. "For a man to stop at the work asked from a stationary engineer only means that he lacks ambition and is not the man wanted by the up-to-date firms."

Who could expect a man like Fred Gonyou to have any hobbies except those in connection with his work? He spends a great part of his time outside of the power house, in looking for improvements to his machines, money-saving devices and the general welfare of his men and his plant. That his men are satisfied with the conditions of the plant and the good-nature and manliness of their "boss" is evinced by the fact that he has two assistant engineers that have been working with him in Wallaceburg and Chatham for a period of 11 years.

Fibre in Metals

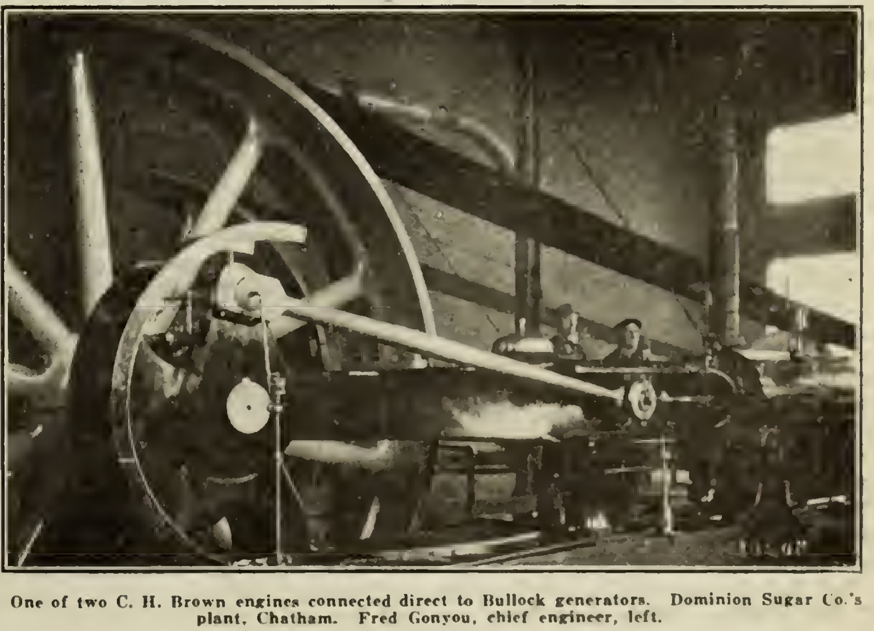
THE association of a fibrous structure with strong and tough materials, such as wood and rope, and the corresponding association of crystalline character with weak and brittle materials, such as sugar or bismuth, has produced in the minds of many men, and even of competent engineers, the conception that all really strong and tough materials must be fibrous, and that all crystalline substances are likely to be weak and brittle.

A study of their microstructure, however, shows, that all metals in a normal condition—i.e., when not severely cold-worked—are entirely crystalline, and that the minute crystals of which they are composed show no orientation of predominant length. There is, theremore, nothing in the nature of a "fibre" in the metal itself. The individual strips or bars into which a thick bar or plate becomes more or less completely divided by the presence of "slag" bands can never be any the stronger on that account. The metal itself, in fact, possesses no real fibre; its longitudinal strength appears greater than its transverse strength only because in the transverse direction the enclosure bands make their weakening presence felt far more actually than in the longitudinal. Were they entirely eliminated, the metal would be equally strong in all directions, and yet there would be no sign of "fibre."

It would thus seem that the desire for a "fibrous" structure is in essence a mistaken one, and that the cause of the fibrous appearance is in reality a weakness and not an advantage. It is true that under certain bending tests in which the power of the metal to undergo a large amount of plastic bending constitutes the main factor, the "fibrous" material shows higher results. Here the fibrous material gains a spurious advantage from the fact that it is enabled to behave very like a bundle of bars or thin plates rather than as a single piece of material. Owing to the weakness of the slag layers, the various rods and plates are approximately free to slide over one another and a large amount of bending occurs before fracture takes place. But this is no real gain for practical use. The Engineer (London), Nov. 10, 1922, pp. 499-500.

Meaford, Ont.—An offer of $35,000 was made to the town on January 31st, this year, for the power plant and lighting system of the Georgian Bay Power Co.

St. John, N. B.—Mr. C. O. Foss, chief engineer of the New Brunswick Electric Power Commission, recently stated that while the full development of the Grand Falls near the head waters of the St. John river, will likely involve international considerations, it is possible to develop some 60,000 horse power without having to tap any of the storage areas which lie in the state of Maine.



One of two C. H. Brown engines connected direct to Bullock generators. Dominion Sugar Co.'s plant, Chatham. Fred Gonyou, chief engineer, left.

Corrosion and Oxidation of Iron and Steel

The Cause of Corrosion, Showing Some of the Earlier Theories Advanced to Account for These Phenomena—Composition of the Metal Has Much to Do With This Action

By T. S. FULLER

THE corrosion of iron and steel is a very old and broad subject, and one which has puzzled mankind throughout the centuries. It is because of this active tendency of things made of iron and steel to corrode and eventually to disintegrate that the early history of the metal is so much in doubt, and that it is so difficult to determine to what extent it was used by the ancients. The Pyramids of Egypt, which have been standing for five thousand years, were built of granite blocks probably hewn out with iron tools; and records show that during the blasting operations in one of the pyramids in the year 1837, a wrought-iron tool was discovered. Iron is mentioned in the Holy Scriptures in connection with the date 1200 B. C., and was known to the Chinese as far back as 2357 B. C. Probably the best known classical example of ancient iron, we are told by the General Electric Review, is the pillar standing at Delhi, India, said to have been erected in 912 B. C. Nevertheless, in the face of this evidence the early history of the metal is very much in doubt because of its disappearance through corrosion and subsequent disintegration.

For many years we of this country and the inhabitants of other countries have heard much of the so-called Conservation of Natural Resources, and of the substitution of materials which are found in large quantities for those which are less plentiful. May I ask what can be more important in the light of conservation than the saving of the materials iron and coal? When we consider that four tons of coal are required for the smelting of every ton of finished iron, and the coal supply in the United States is estimated to be sufficient for our needs for the next six thousand years, at the present rate of consumption, or for but one hundred and fifty years if the present rate of increase continues, the importance of the problem becomes immediately apparent.

To those of us who may not have been initiated into the various problems of corrosion, that yellowish-brown substance which forms when moisture is allowed to act on the surface of articles made of iron or steel is rust; and that is very often as far as our inquisitiveness takes us. To the person who has carefully observed and studied the mechanism of corrosion, the nature and the distribution of the rust are of the greatest importance.

But first let us consider briefly some of the theories which have been advanced in efforts to explain the various corrosion phenomena.

Corrosion was first considered to be a case of simple oxidation, similar to that taking place when iron is heated in air. It was soon discovered, however, that not only was the presence of oxygen necessary, but also the presence of liquid water.

This discovery led to the acid theory of corrosion, which takes into account the necessary liquid water and oxygen, and postulates, in addition to these, the presence of an acid, usually carbonic. The acid is assumed to unite chemically with the iron, forming a soluble ferrous salt, which is later oxidised to ferric hydrates or rust, liberating the acid radical for further attack upon the iron. By this method it is quite evident that very minute quantities of acid will be sufficient to cause corosion.

In 1903 Whitney announced the results of experiments which led to the electrolytic theory of corrosion. Distilled water was boiled in test-tubes to expel all the air and CO_2; polished samples of iron were added and the tubes sealed while the water was boiling. These tubes were left in this manner for weeks without the slightest appearance of rust on the surface of the iron or appearance of a corrosion product on the glass or in the solution. At the end of several weeks the tubes were opened and a small aomunt of air admitted. A precipitate of ferric hydrate quickly settled out. Dr. Whitney's interpretation of the results follows:—

Iron goes into solution in pure liquid water until the water becomes saturated with iron ions and a state of equilibrium is established. Until oxygen is admitted no precipitation of iron takes place. The conclusion is reached that iron goes into solution in liquid water in the absence of both an acid radical and oxygen, and that corrosion is, therefore, essentially an electrolytic phenomenon.

The hydrogen-peroxide theory postulates the presence of this substance as an intermediate product in the formation of rust, and the biological theory regards the corrosion of iron as a phenomenon due primarily to micro-organisms.

A brand new assumption in the list of corrosion theories is that recently announced by J. Newton Friend, presented at the last meeting of the American Electrochemical Society, and called by him an "auto colloid catalyaic theory of corrosion." Friend regards corrosion of iron as a colloidal phenomenon, corrosion taking place by alternate reduction and oxidation of ferric-hydroxide hydrosol.

Friend's theory is of too recent origin to have attracted a great deal of discussion at this time, and of the others only two—the acid and electrolytic theories—have been seriously considered by students of corrosion. It is a very difficult matter to say which of these two views is correct, because of the difficulty of getting extremely pure substances to work with, but the writer believes that it is safe to say that 90 per cent. of the students of the corrosion of iron prefer to regard it as an electrochemical phenomenon.

Considerable impetus was given to the study of corrosion by the experiments of Whitney, which led to the electrolytic theory. Later, Cushman and Walker developed a reagent which became known as ferroxyl indicator, which demonstrates quite clearly the nature of ferrous corrosion.

The indicator has been described in detail in a book by Cushman and Gardner, entitled "Corrosion and Preservation of Iron and Steel." Briefly, it may be prepared by mixing dilute water solutions of phenolphthalein and potassium ferricyanide. If a more or less permanent record is desired, the solution is thickened with gelatin or agar-agar. The action of the ferroxyl indicator is this: a solution containing phenolphthalein becomes pink in the presence of an excess of hydroxyl ions; potassium ferricyanide in the presence of ferrous ions forms the characteristic Turnbull's blue compound. Therefore, with the indicator in contact with an iron surface, the positive areas—e.g., points where iron is going into solution in the ferrous condition—are coloured blue, and the negative areas, where there is a predominance of hydroxyl ions, are coloured pink by these ions.

The writer suggests that those who are inclined to doubt the electrolytic nature of corrosion phenomena try a few experiments with the ferroxyl indicator. The results are startling.

The rate of corrosion of every piece of iron or steel depends upon the individual conditions existing in the particular localty in which the metal is in use, as well as upon the means which have been taken to prevent corrosion.

Bearing in mind that the two substances besides iron necessary for ferrous corrosion are water and oxygen, corrosion phenomena are of many types. Iron samples, wholly immersed, corrode faster if the water is moving rapidly than they do if it is in a state of rest. The rate of corrosion of iron tanks or pipes holding water is much less if they are kept full than if they are alternately wet and dry. Atmosphere corrosion proceeds much more rapidly in districts where the atmosphere is chemically polluted by sulphur vapors and the like, than it does in districts where the atmosphere is free from contamination. The corrosion of iron or steel is accelerated by contact with an element, such as copper or tin, electropositive with respect to iron, while on the other hand, corrosion is retarded by contact with an element more electronegative than iron, such as zinc. The corrosion rate increases with rising temperature.

The rate of corrosion is also dependent upon the character of the steel as determined by its chemical composition and heat treatment. Steel containing small amounts of copper or nickel resists atmospheric corrosion better than pure iron. The well-known stainless steels, containing large amounts of chromium, are highly resistant to corrosion.

The writer has found that much may be learned in a very short time about the corrosion-resisting properties of a steel by observing the action of a drop of water upon the polished surface of the metal. These experiments were described in detail before the meeting of the American Electrochemical Society in April, 1921, and will be briefly reviewed here.

Drops of distilled water in equilibrium with the air of the laboratory were placed upon various steel surfaces. In the case of pure iron, corrosion began almost immediately, and at the end of a few minutes the corrosion product could be seen distributing itself, always according to the same pattern. Three distinct zones developed: an outer one, which has been called by us the "immune" zone; an inner one, which occupied a large part of the area of the drop; and a "wall" zone, which lay between the outer and the inner zones. The outer zone was perhaps a half millimetre in width, and the wall zone was best described as a line. The iron rust was evenly distributed over the level on the wall zone, and the outer or immune zone was entirely free from deposits of any kind. Ferroxyl indicator showed pink over the outer zone, indicating a negative area, and that at this point no iron was going into solution, and blue over the inner zone, showing that corrosion was taking place over the entire central portion of the drop.

The length of time elapsing before the first appearance of rust, and the amount of rust present after the drop has evaporated, vary greatly with different steels and form the criterion for judging the corrosion excellence of the particular steel under examination by this simple test.*

Much has already been accomplished in the manufacturing of rust-resisting steels, or at least steels which rust less than pure iron, and much remains to be done. Examples are the steels containing chromium and the copper-bearing steels which have been mentioned elsewhere in this article. Of course, the ideal steel would be one having a low cost and showing no corrosion—a goal to be striven for, but probably never to be attained.

Protective coatings for iron and steel form an important section of metal technology. Various specially prepared paints are in use together with coatings of zinc, tin, or copper applied in different ways.

Of late, much has been said and written about the deactivation of water. In general, the scheme consists in passing the water to be used in a given closed system over scrap iron, to remove the dissolved oxygen. Once the oxygen has been removed, theoretically the water may go on circulating indefinitely in the system without corrosive action. Such installations have proved to be very successful.

Iron may be made immune to corrosion by making it cathode—that is, by making it the negative pole in a cell, with a potential just sufficient to balance the solution pressure of the metal. This method is not used extensively, because it is costly.

The general problem of corrosion is one which should be of the very greatest interest to all users of iron and steel —and that includes all of civilised mankind,—and it is most desirable that all should have as comprehensive an understanding of the subject as possible. There are many things which are as yet unexplained, but certain facts are so well established that they may be wisely borne in mind as follows:——

Two substances, water and oxygen, are necesary for the corrosion of iron.

The rusting of iron may be best regarded as an electrochemical phenomenon.

The rate of corrosion of every piece of iron or steel depends upon its composition, upon the means taken for its protection, and upon the individual conditions existing in the particular locality in which it is in use.

Much may be learned in a very short time about the corrosion-resisting properties of any sample of iron or steel by observing its behaviour under the action of a drop of water.

It is to be hoped that the efforts of those now at work on the various problems of corrosion, and the efforts of the investigators to come, will help to clear up the anomalies which yet stand in the way of a complete understanding of the subject.

WATER AND TIDAL POWER

(Continued from page 23)

able for tidal power development. A scheme had seriously been put forward recently for the development of power from the tides in the Severn, and the French were proceeding with the erection of a tidal power station near Brest at a cost of 28,000,000 f. The President referred to the many objections to erecting barrages in connection with tidal power schemes across navigable tidal rivers, and stated that it would seem necessary if tidal power were to be utilised to select places on the coast where navigation and other important interests would not be interfered with.

Few things were, he continued, more essential to industry and the welfare of the community than cheap power, and he therefore urged the necessity for engineers to give the question of utilising water and tidal power their closest attention. Coal was too valuable and would probably be too much in demand for other purposes to be burned under steam boilers if other economic sources of power were available.

REGULATING ELECTRIC PRESSURE

There is a multitude of forms of small plants for producing electric light by means of oil engines, but most of them are liable to a weakness which may under certain conditions prove rather troublesome. If the demand for electricity varies considerably—as it might do if the plant is driving a motor which is switched on and off—the electrical pressure will fall considerably. The engine governor is supposed to take care of this difficulty, but it does not always do so in time. A British firm has therefore devised a special pressure regulator which is suitable for plants up to about sixty horsepower. This regulator is so efficient that it will keep the pressure constant even if the governor on the engine is of a very primitive character. It is quite a simple little appliance and can be fitted to any existing machine.

A HUGE BRITISH TURBINE FOR CHICAGO

In 1912 the Electric Supply Undertaking in Chicago installed a British made steam turbine for the generation of electricity. This turbine was of 25,000 K. W., and was then almost the largest in the world. The results achieved by this British-made machine have been so satisfactory that the same undertaking has now ordered another steam turbo-generator of double the size from the same makers. This machine will be of record size and is confidently expected to maintain the reputation established for British electrical plant by its giant predecessor.

Somebody must pay for the conservation of the nation's human resources. If left to demand and supply, the most valuable resources are not conserved.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

S. S. MOORE - - - Managing Editor
W. B. ROBERTS - - - - - - Editor
B. G. NEWTON - - - - - Manager
H. D. TRESIDDER - Advertising Manager

SUBSCRIPTION RATE
Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year, other countries, $3.00. Single copies, 25c. Advertising rates on request.
THE MACLEAN PUBLISHING COMPANY, LIMITED
143 UNIVERSITY AVENUE, TORONTO, CANADA
JOHN BAYNE MACLEAN, President
H. T. Hunter, Vice-President.
H. V. Tyrrell, General Manager.

The Indicator

It has long been recognized by engineers that the error in a diagram taken from a high-speed engine with an ordinary indicator, is unavoidable due to the design of the mechanism. Of late years, this instrument has been receiving very close attention and every effort has been made to devise a means of overcoming the inertia due to the weights of the working parts. The error caused by this condition is one of the principal drawbacks in the design of this form of indicator and although the weight of working parts has been reduced to a minimum, the error cannot be totally eliminated. An electric indicator was invented a few years ago that very materially reduced the error due to inertia and although its advantages for high speed work are not wholly unrecognized, it was not found altogether suitable for ordinary use.

There has also of late been much attention paid to the optical indicator, which instrument very materially reduces the error due to inertia, and also totally eliminates the error due to friction caused by the movements of the pencil and piston. The price of this instrument, however, which is about five times that of the ordinary indicator, makes it prohibitive from a commercial standpoint, and, furthermore, the extreme delicacy of the mechanism and the heavy weight, makes it quite unsuitable for ordinary engine room use. These are obstacles of a very serious nature to fight against in commercial competition and it is therefore most unlikely that we will find an instrument of this description in any place other than the test room or the laboratory. The micro-indicator is an instrument that appears to offer a solution to some of the above difficulties, but unfortunately the diagram produced is so small that it can only be examined under a power microscope, and cannot be measured at all by a planimeter. It can, however, be magnified by optical projection when the diagram produced is very similar to that of the optical indicator. This additional process is a great disadvantage since the diagram, to be completed, must be treated in a separate apparatus. There is apparently only one point that can be raised against it apart from the smallness of the diagram, and that is, the effect or influence of the scriber friction upon the celluloid disc. This friction is evidently not very great but it cannot be overlooked, that whatever error does exist originally, will be very greatly magnified in the enlarging process.

The diagram that we are so familiar with, based on pressure and piston displacement, has prevailed since the days of Watt and to which engineers have become so accustomed that they rarely think of any alternative method. The ordinary pencil indicator is no doubt quite accurate for speeds up to 300 revs. per minute, but it must be borne in mind that when the speed is increased to 2,000 revs. per minute the difficulties caused by the effects of inertia have been magnified thirty-six times. The outstanding advantage of the pressure volume card, is that horsepower can be measured directly from it, but when this form of indicator is used with the internal combustion engine, the most important part of the stroke is crowded into the very portion of the card where the displacement is least. This difficulty, however, can be overcome by setting the paper half a stroke or 90° out of phase with the piston. The diagram under such conditions remains the same length but the part of the stroke that we wish to analyze is drawn out, whilst the less important part of the card, as far as this particular investigation is concerned, is compressed. This however, only applies to low-speed internal combustion engines, otherwise the error due to inertia will invade our diagram results.

An Important Test

Most engineers are familiar with the knowledge that overstrained steel or iron has the power to automatically recover its elastic properties if allowed to remain at rest for any length of time. This fact is very noticeable in rolling mills, wherein the physical properties of steel bars vary very materially, comparing those that have been rolled, and those that have stood for several days. This, however, does not give us any definite information upon the actual time it takes steel to recover from a very definite overstrain. Some very interesting tests have just been completed by the Research Department at Woolwich, which were commenced some thirty years ago by Sir Alex. Kennedy. These were commenced with a view to making a systematic test and obtaining reliable information upon the auto-recovery of structural materials. The work has been completed by R. H. Graves, B. Sc., in whose report some very interesting facts have been recorded.

Mr. Graves has shown that during the thirty years that have elapsed since commencing these experiments, the specimens of steel and iron have completely recovered their elasticity, except in the case of some very hard steel specimens which had only shown signs of slight recovery. The recovery of these bars, however, was rendered complete by subjecting them to a temperature of 175 deg. Cent. for a period of one hour. In the case of crucible steel, the recovery in thirty years was about as much as would be brought about by subjecting the specimen to a temperature of 100 deg. Cent. for one hour, and considerably less than if it had been kept for the same length of time at a temperature of 125 deg. Cent.

One very curious fact that was observed, was that wrought iron extended less for a given maximum load, beyond its elastic limit, when loaded slowly, than when the load was instantly applied. The explanation given is that the auto-recovery of iron is very great, and that this process goes on even when the specimen is under an overstraining load, provided the load is only applied gradually.

Our Question Box

Question.—There is a slight bulge in the crown sheet of the fire-box of a locomotive boiler that is under my charge. It occurred prior to the boiler being purchased by my firm, and was evidently caused due to the boiler at some time being short of water. The plate, although this must have overheated, was not burnt, and furthermore, the stay at this part, that was fractured, was renewed. The boiler appears to me to be safe but the point is, how far could such a defect go to and cause the boiler to be unsafe?—R. J. B., Forest.

Answer.—We are not informed the manner in which the crown sheet is stayed, which we must say is a factor that affects the situation very materially. If the crown sheet is supported by sling stays attached to the shell or barrel of the boiler, we could allow the defect to go much further than if the crown sheet was supported with girder-bars only. We will analyze both methods of staying so that we can actually see the effect a bulge would have in each case.

To understand the situation properly, it would be best to consider the fire box without any form of stays whatever and to note its behaviour under pressure so that we will know exactly how far it is self supporting. Let us imagine there is 20 lbs. of steam on the boiler and the crown sheet of the fire box begins to bulge at the centre. We could fit a stay at this part and attach it direct to the shell of the boiler in which case the shell is supporting the load. We could, on the other hand, fit a girder bar across the crown, the feet of which would be resting on the front plate and tube plate of the fire box. By staying the crown plate to this girder bar it will be seen that the load on the girder bar comes directly on the front plate and tube plate of the furnace. Suppose we increase the pressure in the boiler to 40 lbs., the crown sheet will again commence to bulge at a distance equi-distant between the centre stay that we have just fitted, and the edge of the plate. This bulge will in turn have to be supported by several additional stays placed in a circle around the first one fitted. If these stays are attached to the shell of the boiler, the load is supported by this plate, but if attached to the girder bar, the load is taken on the front plate and tube plate of the fire box.

It will, therefore, be seen that by using a girder bar, the total load of the fire box crown comes directly over the front and tube plates of the fire box. If these plates are perfectly straight, they can carry the load without trouble, but if they become slightly distorted or drawn in, due to the crown sheet bulging, the situation becomes dangerous.

It is therefore evident that the bulging of a fire box crown, from a structural standpoint, is not serious providing the plate is not damaged and the stay is not broken. If the boiler is fitted with girder bars and the bulging of the crown plate has been sufficient to drag or bend in the front or tube plate, then the situation immediately becomes serious, as these plates must be straight to withstand the load.

It must not be overlooked that in the above we are only speaking from a structural standpoint. A bag or bulge in a fire box crown is a receptacle for scale, mud or other impurities in the water, which, if allowed to deposit in the damaged portion of the plate, would be sure to cause further trouble. It is advisable in the case of a bulge in the crown sheet of a fire box, to have it set back as soon as it is conveniently possible.

Question.—What is the advantage of using zinc in a boiler in preference to soda, to arrest the corrosive pitting of a plate?—T. H. D.

Answer.—When zinc slabs are placed in a boiler to arrest corrosion, it is usually on account of some special reason, to prevent the water from being contaminated with chemicals. It may be possible that in the process of manufacture, it is imperative that the steam from the boiler should be unpolluted with the small particles of the treated water being carried over in suspension with the steam. In this case zinc slabs can be used to great advantage to arrest any galvanic action that is taking place in the boiler. They should be given a metallic contact, and firmly secured in a position where the corrosion is most active.

Question.—Is it just as economical to heat the feed water of a boiler by direct contact with exhaust steam, as it is to use a surface heater?

Answer.—It is perhaps a little more economical to heat water by the first method although it is not always advisable, on account of the possibility of there being oil in the exhaust steam passed over from the engine, which is liable to pollute the feed water and cause overheating of the boiler plate. It is a difficult matter to separate or intercept oil that has become emulsified with the water. It is, therefore, for this reason that the surface heater system is the best. An engineer will be well compensated for the small loss in heat units, by the greater efficiency and less trouble with his boilers, which is a factor that he must study before deciding upon any system of feed water heating that he intends to instal in his plant.

TITANIUM STEEL ALLOYS

The use of titanium as an alloying element for steel is shrouded in secrecy. According to information supplied to the United States Bureau of Mines, carbon-free ferro-titanium has been employed in Europe for making an electric steel containing 5 to 7 per cent. titanium. Rumors of the use of titanium-alloy steels for armor plate have been circulated, but so far as is known, no merit has been found in the addition of titanium to steel as an alloying element, and experiments with steels containing 0.1 to 1.0 per cent. titanium have shown no special advantages. A more interpretative investigation than any so far carried out, is required to distinguish clearly the merits of titanium-alloy steels, and it must be assumed now, pending exact proof to the contrary, that these steels are of no particular value, or at least yield no advantages not provided by other steels. It is rather difficult to get the carbon-free ferro-titanium to alloy with steel without much loss of titanium, and this fact, coupled with the high price of carbon-free alloy has tended to discourage experimentation by steel makers in this direction. It is possible, however, that if the cost were less, some combination of titanium, either alone or with other metals, might produce valuable steels for some purposes. Titanium increases the hardness of steel, and experiments on titanium steels have been made by Guillet, Braun, and Lamort. It has been shown recently in Bulletin 199 of the Bureau of Mines that fair recoveries may be expected with carbon-free ferro-titanium, provided the alloy is added at the end of the heat, and the steel is very hot.

Tenders are being asked on the first unit of a power plant to be erected at Powell River, B. C., for the Powell River Company, Ltd., Vancouver. Tenders will be received by N. R. Lang, manager, for a power house and a smoke stack.

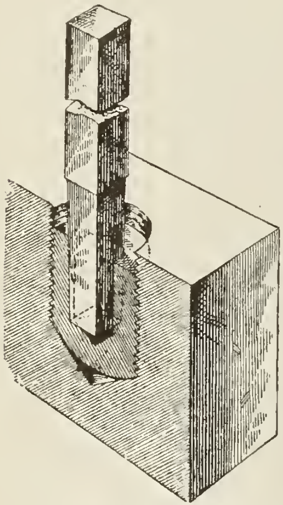
Operators' Point of View

REMOVING BROKEN STUDS

By E. Lytton Brooks

The accompanying sketch shows a quick and simple method or removing broken studs or setscrews having either right or left hand threads. It is more efficacious and workmanlike than the three-cornered file stunt; the file having a nasty habit of splintering up or breaking off in the hole.

A piece of square tool steel (conditions governing the length and size) is chosen and the square ground to a gradual taper toward one end. A hole is then drilled in the stud which will not quite admit the tapered end of the square steel. The square piece is then driven in tight and the stud can be unscrewed by the application of a wrench.



REMOVING BROKEN STUDS

A WORD ABOUT SMALL vs. LARGE ENGINES

By N. G. Near

We have all heard people express astonishment at the immense power developed by small engines, such as the automobile and aeroplane engines. They are the most powerful of all prime movers per pound weight. The average engineer therefore ponders in his mind the question, "Why won't an engine ten times as big as an aeroplane engine, develop ten times as much power? by 'ten times as big' he means, 'with piston area ten times as large'."

This brings us back, in a way to the old paradox of models—if it can be called a paradox. It has long been known, for instance, that a model of a bridge 1 100 as long as the bridge itself and with all other dimensions correspondingly reduced, will hold a much greater load in proportion to its size than will the large bridge. The ratio of this increase in strength is also well known. A small model of a water tank, would be far too strong for water. It could hold mercury, if necessary. For water the thickness of shell and size of struts can be much reduced in the model, and it will still hold its proportionate volume of water.

A small engine, if run at the same speed as large engines, however, would not develop its rated or computed power because the smaller engine has a larger proportion of friction to overcome. The mechanical efficiency of small engines is generally low and the reason therefor is easily explained: For example, the circumference of a 10 inch cylinder is 31.4 inches, while that of 1 inch cylinder is 3.14 inches. The piston areas are 78.54 sq. inches and .78 sq. in. respectively. Therefore, where the drop in areas is 100 to 1 the drop in circumferences is only 10 to 1. Now since friction in a cylinder, piston rod, valve rod, valve, etc., is dependent on the "friction surface" and not on the areas of the piston and rods the mechanical efficiency must be considerably less for the smaller engine.

Besides, large engines cannot be operated at the speed of the small engine. The large reciprocating parts are too heavy. There is too much inertia to be overcome. The energy in reciprocating masses is always equal to

$$\frac{W\ V^2}{2g},$$

where W is the weight of the reciprocating part, V is the velocity of the part in feet per second, and g=32.16. It is clear that enormous forces would be necessary to constrain such energy, for the ponderous reciprocating masses would have to be stopped and started several thousand times per minute where the engine must run at 2,000 r. p. as is common in small gasoline motors. The connecting rod would have to be correspondingly long, and it is on this rod that most of the stress would fall. At the "out" end of the stroke it would be subjected to a severe tensional force. At the "in" end the force would be compressive with the same vengeance. And at the same time the connecting rod would tend to bend or "whip" due to its own mass and high speed in lateral directions. A big connecting rod is much weaker in proportion to its size than is a small one. Hence, in many more ways than one it is almost a physical impossibility to make a large engine operate at the speed of a small one.

The large engine is valuable mainly because it is most economical. It consumes less energy in friction, as I have already pointed out; steam and gases are not in a "hurry" in and out and thus expend energy in "bombardment," expansion of the gases is more complete; there is less back pressure; and the large engine is usually longest lived. There is less wear and tear.

For these reasons then the two types find their respective places. Although inefficient and short lived, the light engine is used in aeroplanes and automobiles, and although expensive as to first cost and a great consumer of space the large engine is used in the stationary power plant.

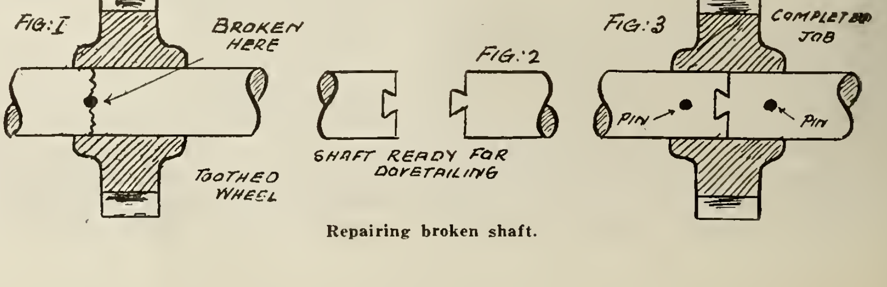
A BROKEN SHAFT

A shaft which had a small gear wheel pinned on to it, broke right across the pin-hole, putting it out of action, at a time when I could least spare it. Seeking to save time and expense I employed the following method of repairing it.

I removed the gear-wheel and filed the broken ends of the shaft true.

I then cut a slot, with two hack-saw blades, about a ¼ of an inch deep in one of the trued up ends of the broken halves, and filed a projection in the other half

(Continued on page 36)



Repairing broken shaft.

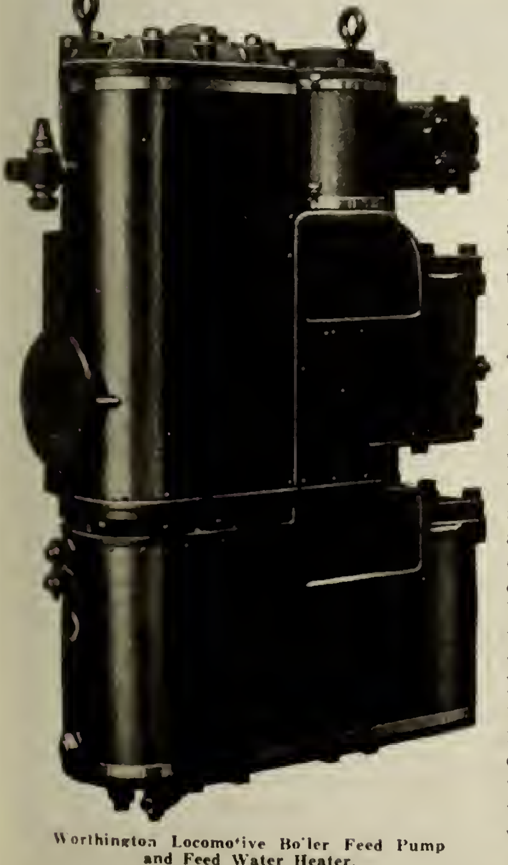
Progress in New Equipment

THE WORTHINGTON HEATER AND PUMP

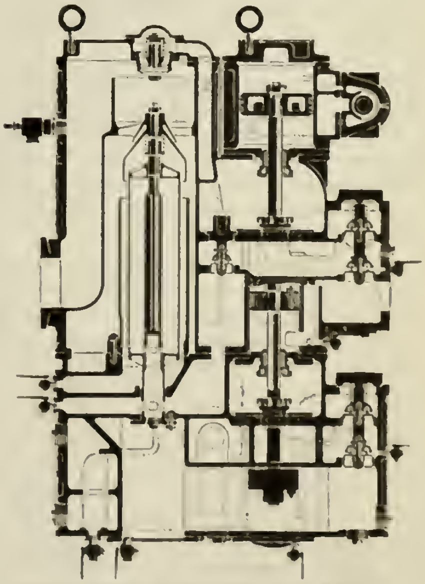
The general construction of the heater and pump is shown in sectional view. The heater is a simple cast iron box, to one side of which the pump is attached. The large opening in the side of the heater is connected by a pipe to the exhaust ports of the locomotive through holes cut into these ports through the back of the cylinder saddle. The open space in the top of the heater is, therefore, supplied with exhaust steam from the locomotive at practically exhaust port pressure. This pipe leading the exhaust steam to the feed water heater has in it a check valve and an oil separator. A small hole in the bottom of the oil separator provides a continuous drip for the oil which is separated from the exhaust steam, effectually preventing this oil from entering the heater and reaching the boiler.

The feed pump is of the vertical, direct-acting piston type, with the steam cylinder above and two water cylinders below. The upper or cold water cylinder takes cold water from the tender through the usual hose and pipe and delivers it to a spray valve in the top of the heater which sprays the water into the exhaust steam filling this part of the heater. This cold water condenses as much of the exhaust steam as is necessary to heat it and, mixing with the water resulting from the condensation of this exhaust steam, drops to the bottom of the heater. The lower pump cylinder takes this heated water from the heater and delivers it to the boiler.

The bucket is shown in the sectional view of the heater on this page. When there is too much water in the heater the bucket fills and sinks. In its low position the bucket opens ports in the central stem, allowing the excess water to reach an extra suction valve in the cold water cylinder. The water thus returned to the cold water pump meets a correspondingly reduced amount of water coming from the supply through the main suction valve and is delivered with it to the heater through the spray valve. After the excess of water has been pumped from the heater and the bucket is partly emptied, the bucket rises, closing the return passage so that the return valve is then out of commission and all of the water is taken from the tender through the main valve.



Worthington Locomotive Boiler Feed Pump and Feed Water Heater.



Section through Feed Pump and Heater.

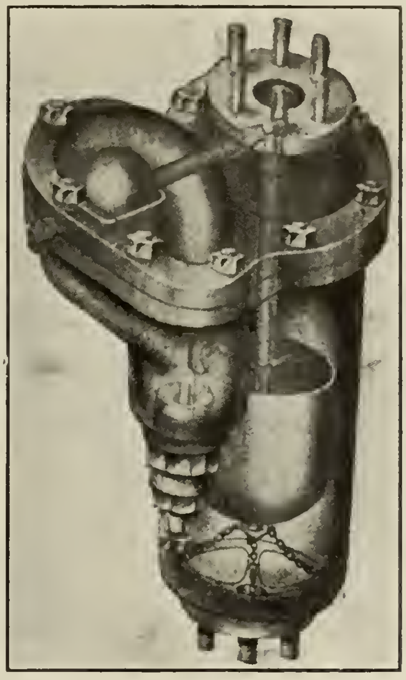
TODD GUARDIAN

The Todd guardian is an invention resulting from the increasing use of oil as fuel, being designed to automatically shut off the oil supply to the burners, when through any unforeseen condition the water has become dangerously low in the boiler.

The action depends on the water level in the boiler, which causes a bucket to fall. This movement sets a cradle in motion, permitting steam to escape to an oil supply stop valve.

The device consists of a cast-iron body having two chambers. In one is a bucket float with anchor and chain suspensions to prevent the bucket from touching the sides of the chamber. The float is connected to a spindle. The steam connection is at the top and the water at the bottom. The bucket is always full of water, and it balances when four-fifths of its height is immersed in water.

When the water level falls in the boiler, it also drops in the float chamber, and the weight of water in the bucket will, at the danger level, produce by its weight a strong downward pull on the spindle and cause the cradle to tip, whereupon a ball falls out and strikes the ram head on top of a cartridge. The ram has a peculiar shaped point which perforates a copper disc and allows steam to escape through the opening thus made. The steam enters a stop valve above the diaphragm, which auto-



Todd Guardian.

matically shuts off oil fuel supply to burners.

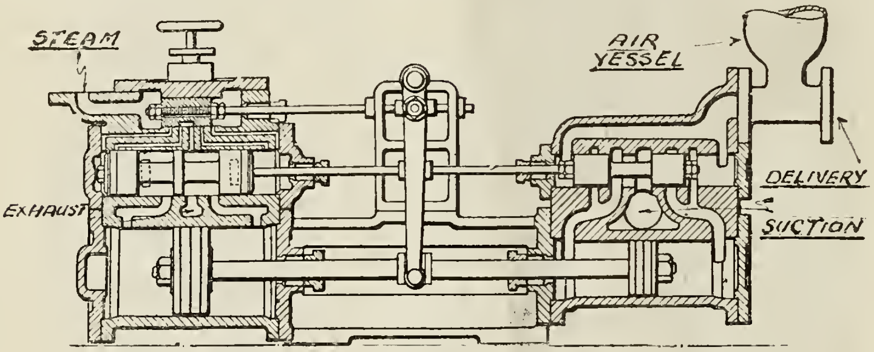
As the cartridge is a complete unit, it is easily inserted, but not until the ball has been pushed back into the cradle by means of a rod.

The above economy and safety devices must appeal to the modern engineer, who on account of his special training demands a high factor of safety together with efficient and economical operation.—The White Fuel Oil Engineering Corp., 742 East Twelfth St., New York City.

VISCOS FUEL PUMP

The accompanying diagrammatic illustration shows a special design of pump made by the Moorlands Engineering Co., Ltd., Leek, Staffs., and 37, Moorfields, Liverpool, for dealing with oil fuel, molasses, and all liquids of high viscosity.

The pump, as illustrated, is of the direct acting type, having a steam piston and pump piston connected to the same piston rod. The steam to and from the steam cylinder is controlled by a steam operated piston valve. The steam to and from the steam operated valve is controlled by a mechanically operated slide valve in the steam chest. The slide valve is operated by means of gearing from the crosshead on the piston rod.



Pump for heavy oils.

Whereas, in the ordinary types of pumps the passages to the pump cylinder are controlled by some form of lift valve or disc, mitre, or ball type, in the Viscos pump these passages are controlled by a piston valve which is connected directly to the steam operated valve controlling the passages in the steam cylinder. By this unique arrangement the pump valve is positively operated, no matter how viscous the liquid being dealt with.

A very important feature of this arrangement is that the suction or inlet passage to the pump cylinder is full open at the very commencement of the stroke of the pump piston, due to the fact that the pump valve which controls the passages in the pump cylinder being connected to the steam operated valve, shoots over instantaneously immediately the pump piston reaches the end of its stroke. The only correct arrangement is to have the inlet passages full open at the very commencement of the stroke, as the acceleration of the piston is greatest at the commencement. In pumps fitted with lift valves the suction valves are shut at the commencement of the stroke of the piston, as the valves rely for their action upon the difference in pressure created by movement of the piston. This defect becomes very pronounced when liquids such as heavy fuel oils at low temperatures have to be dealt with, so much so that the pumps refuse to function.

The type of pump illustrated, deals positively with heavy fuel oils at 32 deg. F., cold colloidal fuel consisting of 50 per cent. Mex. fuel oil and 50 per cent. coal dust, petroleum jelly, and all liquids of high or low viscosity.

A regulating valve is fitted in the steam cylinder, which ensures the steam operated valve being supplied with steam at the full available boiler pressure, regardless of the working pressure in the steam cylinder.

Another unique feature is that the Viscos pump will work equally as well horizontally as vertically without change of design.

Although the illustration only shows the single cylinder type, Viscos pumps are also supplied in the duplex type, for dealing with the fuel oil, etc., in large quantities. The pumps are made suitable for any capacity, and to work against any pressure.

WEIGHING ATTACHED IRREGULAR PARTS

W. F. Schaphorst

Occasionally it is desired to know the weight of some part or other on a machine, but the part cannot be detached easily for weighing and it is too irregular to compute with ease. In such case the weight can be found indirectly by weighing the water displaced by the part, if the part projects in such a way that it can be made to displace water.

For example the writer once had to determine the weight of a flywheel governor weight, which was made of cast iron, and which could not be detached without removing the whole governor from the engine.

I turned the flywheel to such a position that the weight was at its extreme low point. I then procured a rectangular sheet metal vessel and filled it with water. I weighed the vessel when it contained as much water as could be held in it.

Then I carried the vessel of water over to the engine and raised it so as to envelope the weighted end. Water was displaced, of course, but that is what was wanted. I raised the vessel until the water level cut the governor arm, being sure all the while that the vessel was still holding as much water as possible while raised to that height.

Then I removed the vessel and again weighed it, this time with the remaining water. The weight of the governor end was then computed in this manner:

The first weight was 45.5 pounds and the second weight was 39.25 pounds. The weight of the water displaced was therefore

45.5 — 39.25 = 6.25 pounds.

Now to compute the weight of the cast iron that displaced the water all that is necessary is to multiply by the specific gravity of cast iron, which is 7.207 or 6.25 × 7.207 = 45 pounds.

The remainder of the arm was of rectangular cross-section, whose weight was very easy to compute on the basis of 0.26 pounds per cubic inch, which is the weight of cast iron.

In case other metal parts are to be weighed in this manner, here are the specific gravities of metals most commonly used in mechanical constructions:

Cast iron	7.207
Wrought iron	7.78
Soft steel	7.833
Steel castings	7.917
Cast aluminum	2.60

Should it be desired to know the volume of the piece of metal in cubic inches, divide the difference in weight (which is equal to the weight of the displaced water) by .0362. The result is the volume of the part in cubic inches.

This latter test will come in handy for finding the volume of any irregular substance that can be submerged in water without harm or without any absorption of water. Or, should one wish to find the specific gravity of coal, brick, rock, etc., this method, reversed, will serve the purpose. Weigh the rock, say, and then weigh the displaced water (which can be done by subtraction as already explained). Divide the former by the latter and the quotient is the specific gravity of the rock or other substance.

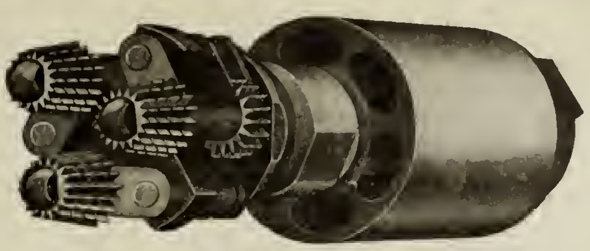
A BROKEN SHAFT

(Continued from page 34)

to fit in the slot and dovetailed the two together making them a snug fit. (See Fig. 2.)

The gear-wheel, which had only one pin-hole, I then replaced on shaft, carrying the existing pin-hole through the shaft, so as to clear the dove-tail joint. On the other side of the boss of the gear-wheel I drilled a corresponding pin-hole.

I then drove in a couple of steel taper pins, cutting off the ends level with the boss of the wheel, which served the double purpose of holding the gear-wheel and strengthening the dove-tail joint at the same time (See Fig. 3). The shaft was put into service and has run quite satisfactorily since.—H. Godfrey.



Standard Water Driven Tube Cleaner

KEEP YOUR BOILERS CLEAN

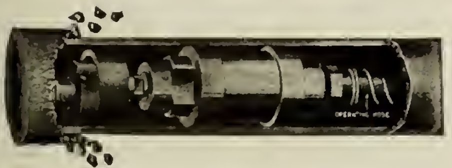
All natural waters contain some impurities which, when introduced into a boiler, may appear as solids deposited on the heating surface. No matter what the substance consists of, it must be removed at frequent intervals or it will decrease the capacity and efficiency of the boiler and may cause it to be badly damaged by over-heating.

Some waters, notably well waters, deposit such quantities of scale that they should be purified before going into the boiler, thereby preventing an accumulation of incrustation and consequent damage to boiler parts, and at the same time effecting a large saving in fuel by keeping all parts of the heating surface in a clean and efficient condition. If you have bad feed water it is a case for the chemist, for the scale is probably composed of several substances which must be known before the exact treatments necessary to get rid of them can be determined upon. The use of treatment without technical advice is poor policy.

Stony and vegetable matter in suspension can be removed by FILTERS, which we supply in various sizes and designs to suit all requirements. In most Canadian plants, lake or river water is used for feed, and these waters seldom carry large quantities of scale-forming materials in solution. Scale can be allowed to form in boiler for a considerable period. Experience in each individual plant determines the limit at which tube difficulties will begin or a perceptible falling off in efficiency will take place. With such a limit of scale formation fixed, and the danger of allowing it to be exceeded, well understood, probably the most economical and efficient method of keeping the heating surfaces clean is by use of the LAGONDA TUBE CLEANERS.

Lagonda Water Driven Cleaner for Curved Tubes

Lagonda Air Driven Cleaner for Straight Water Tubes



Cleaner Removing Scale from Outside of Fire Tube

The cleaners are designed and so constructed as to thoroughly remove all the scale, in the shortest possible time, at the lowest cost of operation, and they require a minimum amount of repairs, reducing both the waste boiler time and labor cost of cleaning.

They are made to operate by either water, air or steam. In every case a swing head is furnished so designed that three sets of cutters are thrown out by centrifugal force against the scale in such a manner that they make straight line contact with the tube and they do the work without damage to it.

You can be supplied with LAGONDA tools for cleaning Economizers, Condensers, Evaporators and other tubular plant.

We shall be very glad to furnish full particulars

BABCOCK & WILCOX, LIMITED

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE, BANK OF HAMILTON BUILDING

The Welding of Cast Iron

IN the course of a discussion on the subject held by the American Welding Society it was poited out that cast iron differs widely in composition and characteristics. It always contains about 3 per cent. of carbon, but this may be in a combined graphite state, and it may hold widely varying amounts of other elements, such as silicon, manganese, sulphur, and phosphorus. Not only the presence of these elements, but also the rate of cooling of the casting, profoundly affect the physical characteristics and weldability of the metal.

In making a weld in commercial cast iron, the surfaces which are to be joined must again be melted. These surfaces consist of iron which contains carbon in both the free and combined states. When these surfaces are melted, several things happen. First, both the graphitic and combined carbon go into solution in the molten metal. Second, some of the carbon, silicon, and manganese is burned out by the heat, while the amounts of sulphur and phosphorus are practically unchanged. Silicon is most easily burned out, so the tendency is to produce cast iron in the weld that will be white when cold, owing to its low silicon and carbon content. Third, the surface of the molten metal oxidises, making a slag, which in a measure prevents further oxidation. As soon as the welding heat is removed, the melted iron solidifies very quickly, owing to its proximity to the comparatively cold mass from which it has been melted and to its being exposed freely to the air. This sudden cooling causes a large amount of carbon to be retained in the combined state, resulting in a white, hard metal in the weld. Of course, if the casting has been preheated before welding the cooling of the added metal will not be so sudden, and a softer machinable weld may be secured. Experience has shown that the grade of cast iron which is most difficult to weld successfully is that which is soft and has an open grain. However, little difficulty is encountered when the metal is of comparatively thin section (½ in. or less.)

When iron is molten, or even red hot, it oxidises very readily if exposed to air. In welding, the surface of the molten metal becomes covered with iron oxide, which may be deposited in the weld by mixing with the molten metal, or by being tapped between two layers of metal at different times. In either case the result will be a weak, non-homogeneous weld, for the oxide particles segregate and do not form a junction with the adjacent metal.

The shape of the castings also has an influence on the method of welding to be used. A casting comprising both light and heavy parts is subjected to more external stresses than one of homogeneous cross-sections. The stresses are caused by the different rates of cooling, light sections cooling more rapidly than heavy. There are also internal stresses set up at sharp angles.

When in the welding of cast iron a filler metal of different composition than that of the casting is used, serious consideration must be given to the fact that the co-efficient of expansion, and consequently the shrinkage of the metal in the weld, may be different from that of the rest of the casting. The different shrinkages of the two metals will cause one to slide on the other as they pass from the liquid to the solid state. The shrinkage sets up internal strains which the ductility of the welding materials must take care of. Altering the carbon content from the combined to the graphitic state helps to increase the shrinkage. If the iron contains a weakening agent, the internal strains set up by shrinkage often cause cracks to appear.

Utilization of Waste Fuels

IN VIEW of the decreasing supply and the increasing cost of high grade fuels, the efficient utilisation of fuels of low grade, including what are known as "waste fuels," is becoming a problem of major importance to many industries and to commercial progress. Important sources of "waste fuel" include sawdust, shavings, scraps, edgings, tanbark, wood extract chips, paper mill refuse, bagasse or spent sugar cane, and city refuse.

Perhaps one of the most important waste fuels has been spent tanbark. A rough estimate would indicate that in the United States this material generated a few years ago an amount of steam that would have otherwise required the yearly consumption of about 2,000,000 tons of high grade coal. Yet at one time this valuable fuel was considered a mere detriment and an expense to the leather industry. It was disposed of by dumping it into rivers, by filling in waste ground, and by making roads with it, often necessitating the payment of large sums for its disposition. The improvement of a furnace converted a substance supposedly incombustible into a valuable waste fuel and an enormous waste was converted into an equally great saving.

Sawdust and wood waste are of course largely available in many districts. With sawdust the saw mills produce waste wood in the form of edgings, end cuts, shavings, and various forms of blocks and scraps. At many plants in lumbering districts the bulk of this material is so great that it not only supplies power and heat for the mill but furnishes electric lighting for towns, and even then in order to prevent its accumulation a large destructor is kept constantly in operation as well and the heat from the burning wood is wasted to the atmosphere. If there were a market for electric power within a reasonable distance, this waste could be converted readily into an economy. Even now plans are being considered to prevent such waste, and at least one plant is in operation for producing wood alcohol and other chemicals from such material. Plans have for long been considered intended to make possible its use also for wood pulp in the paper industry. Sawdust and wood waste are of course readily convertible into gas that may be used as fuel in gas engines.

Bagasse is the by-product fuel resulting from the manufacture of cane sugar. The juice from the cane is extracted by crushing and the remaining fibrous material, known as bagasse, is conveyed to the boiler house, where it is fired in special furnaces and is made to produce all or part of the steam required to operate the plant. The fuel is in the form of strips 3 to 8 in. long, but much longer pieces may sometimes come through the mills. There is said to be much room for improvement in the design and in the control of furnaces in many plants burning bagasse; these two factors often make the difference between running the boiler plant on very little or no purchased fuel and of spending large sums annually for coal, oil or wood.

Coke breeze is another by-product fuel which can be effectively used under proper conditions, while city refuse belongs to the class of fuels that, by proper application of the principles of combustion, have been promoted from semi-combustible to auto-combustible fuel. Though this heterogeneous material can be disposed of by dumping at sea or on waste land—sometimes in an inexpensive manner—the consensus of opinion is strongly in favor of its disposition by burning. The strength of this opinion is largely due to comparatively recent improvements made in the design and efficiency of destructors or refuse burners. Furthermore, when combustion is complete, burning is by far the most sanitary method of disposing of offensive materials. Some of the collected matter, chiefly the house garbage, contains so much moisture in comparison with its low heating value that to burn it alone is impossible, but by mixing this with all the other refuse, the calorific value of the mass is made high enough not only to evaporate its contained moisture but to produce effective evaporation in a boiler as well. Even when this is done, however, it is necessary to depend for efficiency on correct design and careful operation of the furnace.

Results of a special study of the economic combustion of waste fuels have recently been published in Technical Paper 279, compiled by Mr. D. M. Myers, and can be obtained from the Bureau of Mines, Washington, D. C.

The Conveyors Corp. of America, 326 West Madison St., Chicago, Ill., has issued a new folder describing the American air tight door. This door is largely used in ash pits and boiler settings and is made in five sizes: 15 x 16, 18 x 18, 22 x 26, 24 x 24 and 24 x 36. The door is of unique design, strong and substantially built of cast iron. When closed and locked it is air tight. Copies of the new folder will be sent to interested readers.

The modern fire box demands binding cements of higher fusion resistance with the physical strength and elasticity to give and take under temperature stresses in the brickwork.

Don't blame your fire-brick

—they last longer if you lay them up properly

APPEARANCES make it easy to blame good fire-brick for premature furnace lining failures—for even the best brick fails if it is left in the lurch by its binding cements.

Ordinary fire-clays and cements fuse or are crushed from the brick work by the great temperature stresses set up by present-day firing. The sides of the brick become exposed to the flame. The brick "heat soaks" and fuses or spalls away.

Careful research shows that the life of fire-box walls can be economically prolonged by the use of better cements, which give their fire-brick proper support. A complete line of such cements has been developed by Johns-Manville together with a method of application known as Johns-Manville Heat Treatment.

The use of Johns-Manville High Temperature Cements and Heat Treatment brings a direct saving in lower maintenance cost and an important indirect saving through less frequent boiler shutdowns.

CANADIAN JOHNS-MANVILLE CO. Ltd.

Toronto Montreal Winnipeg Vancouver
Windsor Ottawa

Johns Manville Service
Covers the Continent
Through—
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
High Temperature Cement

ENGINEERS' COUNCIL

Hamilton council, No. 60, of the Universal Craftsmen Council of Engineers, is fast becoming a live organization. Membership is increasing rapidly and the executives are energetically promoting its social and educational features.

Those who were present at the regular meeting were fortunate indeed in the opportunity afforded to enjoy the illustrated lecture by C. A. Price, of the Canadian Westinghouse company, on The Maintenance of Electrical equipment from a Manufacturer's Standpoint.

Refreshments were served and an hour of sociability and mutual discussion ensued around the festive board.

Past Worthy Chief W. A. Sweet supplemented a few remarks on the subject in moving a vote of appreciation as did Worthy Chief Alex. Leckie in extending the same to the speaker.

A vote of thanks was also extended to Bro. Gill, who provided the lantern.

At the next regular meeting in March, Brother G. Lindgrin, of the Steel Company of Canada, will speak, giving an insight into the steel and iron industry.

A SAFETY BELT MOUNTER

One of the commonest things to occur in a workshop is for a belt to slip off a pulley. The operation of replacing the belt requires a certain amount of skill, particularly to avoid accident. If the pulley happens to be placed rather high there is quite a serious amount of risk in getting the belt back again, to say nothing of the time lost in fixing ladders and other means of reaching the pulley. All these troubles and dangers are now a thing of the past, thanks to the invention of a safety belt mounter by a British engineer. This device consists of a flexible jointed arm fixed on a rod and carrying at the top a horizontal arm on which is mounted a small wheel. This arm is slipped under the loose belt (which is prevented from slipping off by the wheel) and a special spring arrangement inside the flexible arm enables the user to stiffen the arm sufficiently to pull the belt over the pulley. The arm is then carried round by the pulley until it reaches the point where the belt leaves the pulley and is thus released. With this ingenious appliance the operation of belt replacing is carried out in a few seconds without the slightest difficulty.

Conveyors Corporation of America, manufacturers of coal and ash handling equipment, Chicago, announce that they have acquired all rights to the Green steam jet ash conveyor, formerly owned and controlled by the Green Engineering Co., East Chicago.

SELLS AMERICAN RIGHTS

Major Forbes Keith, who recently succeeded in inventing and patenting a small domestic motorless refrigerator that works on the absorption principle and is operated by electricity, has sold his American rights to the Delco Light Products Co. of Dayton, Ohio, for an amount involving millions of dollars. The Canadian rights for making these refrigerators he retains himself.

A contract has been awarded by the Toronto Transportation Commission for four 6 x 20 feet horizontal return tubular boiler, 125 lb. working pressure, built to Ontario codes, to the Engineering and Machine Works of Canada, St. Catharines. A large breeching construction, 7 feet by 5 feet, and 60 feet long, connects the boilers to the stack. These boilers will be installed in the new $1,000,000 repair shops being erected on Bathurst St., by the T. T. C.

OBITUARY

C. W. ANDREWS.

C. W. Andrews, well known as an operating engineer, who for the last 13 years has been associated with the Boiler Repair & Grate Bar Co. of 86 Church St., Toronto, died recently and is survived by two sons and one daughter. He was in his 67th year when he died and was well known throughout the country. Many engineers will remember him as the compiler of the "Engineer's Lamp." He had been an operating engineer previous to his connection with the above concern.

Three Underfeed Stokers, multiple retort, A. C. type, are being installed in Chateau Lake Louise, Alberta. This is the 6th C. P. R. hotel to instal this equipment.

C. A. S. E.

On February 20, 1923, The Toronto No. 1 C. A. S. E. held an educational meeting which was very largely attended. The subject for the evening was—"Makers and Types of Engines." A number of papers were prepared and presented by members of the Association and the one which was prepared by Mr. R. McLaren, chief engineer of Massey Harris Co. was the one selected for discussion. The engineers in attendance evidenced quite an interest in the various types of turbines and the description of the Uniflow engine, with its modifications.

Several new members were introduced, and from the number of applications on hand it would appear that the membership was going to increase as a result of the educational campaign which has been carried on so consistently all throughout the season.

The question of the Board of Examiners of the Province of Ontario issuing special licenses for plants which are only operated temporarily either in the nature of canning factories, creameries, etc., was taken up and discussed very thoroughly and the consensus of the opinion of the meeting was that the Board should be given power at its discretion to issue such temporary licenses; however, it was considered best that certain safeguards should be introduced along with such a bill as the provision that such special licenses were not to be issued in buildings employing more than seven people and in no case in densely populated districts.

A large number of members were reported sick; however, the members were pleased to see that the patron of the organization "Daddy" Turner was on hand with his usual smile. Mr. C. B. Turner, better known as "Daddy" Turner, has been appointed chairman of the Exhibitors Committee in connection with the coming convention to be held at the Toronto Technical School on June 25-26-27-28.

NEW PUBLICATION

Mechanical World Electrical Pocket Book, 4 in. x 6 in., cloth bound, 390 pages, price 1/6, published by Emmott & Co. Ltd., "Mechanical World" office, 65 King St., Manchester. Among the new features of this issue is a newly-written section on Electrical Measuring Instruments and Power and Alternate Current Circuits. The new additions to various sections are notes on Mercury Rectifiers, Lead Hydrate Cells, Cyc-Arc Welding and one on Transformers. There are many other minor additions that have been made in various permanent sections that has brought this book thoroughly up to date.

Meaford industries are busy, and with one exception all are running 10 hours per day. Seaman-Kent Company's plant is now working to capacity.

"SAFETY" Plastic Metallic Packing

For steam, water, air, gas, etc., is practically indestructible and may be used over and over again. It is

Packing in Cotton Tubes.

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL

Packing in Bulk.

It is made of an alloy of the finest anti-friction metals, just hard enough for long service but not hard enough to damage any rod.

The metal is combined with the best lubricating material, making it practically SELF-LUBRICATING AND FRICTIONLESS.

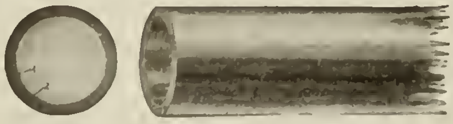
Send for full particulars also about our "Safety" Superheat Sheet Packing.

STEEL MILL PACKING Company
Windsor *EST. 1899* Ontario
AGENTS WANTED

SONDERGLASS

"The Unbreakable Boiler Gauge Glass"

Two Glass Tubes in One

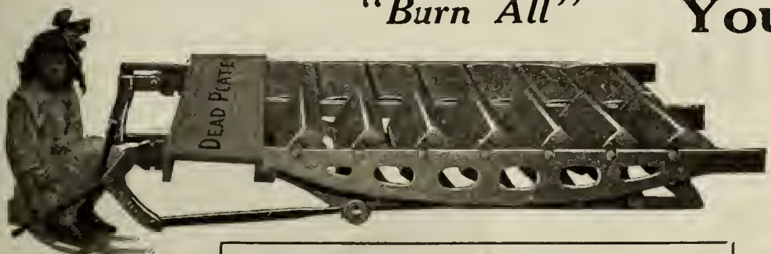


The different metals used allow for expansion and changes of temperature to which the glass is subjected, and add greatly to its pressure-resisting qualities, as each of these metals has different degrees of expansion. The inside of the tube expands in proportion to the temperature of the steam or hot water and the outside according to the temperature of the air.

There are no others "Just as Good"

LYTLE ENGINEERING CO. LIMITED
404-406 St. James Street, Montreal
VALVE ENGINEERING COMPANY
174 King Street West, Toronto

"Burn All"



A Child Can Operate it

Let "Safety-First" Sexton Handle Your Repairs

He's a specialist in Renewals and Repairs for all Kinds of Grates for Boilers. He does the job RIGHT and does it to LAST.

You Take No Chances *with* "NONPAREIL" Shaking and Dumping Grates

Every installation has proved a practical demonstration of the fact that they reduce fuel expenses by at least 10%.

65% air space and 95% underdraft are two good reasons. Let us tell you about our trial offer.

Manufactured Solely By:

The W. R. SEXTON Boiler Setting Co.
114 Grenadier Rd. Toronto
Junction 2765W. Established 1900.

Bronze to Bronze

DART

At the Joints

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

How Much Coal Are You Wasting?

Blindfolding yourself to the fact that your boiler room is different, because you can see no pipe line leaks, or the water alarms don't blow very often—doesn't help to pay for the needless fuel waste caused by the invisible losses within the boiler furnaces.

Get at the REAL FACTS and at the same time give your men a positive and simple guide that will enable them to keep the plant at top notch efficiency—by installing the

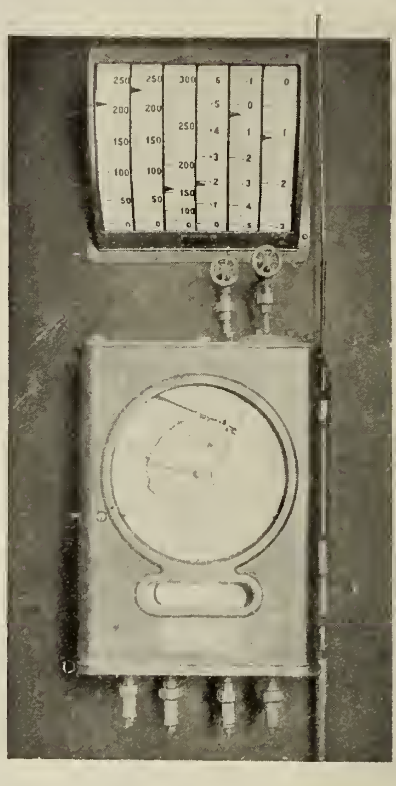
BAILEY BOILER PANEL

The Bailey Boiler Panel is a combination of the Bailey Multi-Pointer Gage and Bailey Boiler Meter.

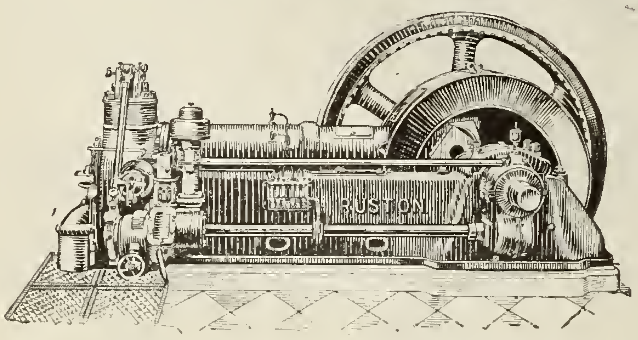
It shows, almost immediately, the effect of improper furnace adjustment and enables the men to make the necessary correction before a large amount of preventable fuel waste has taken place. Good work on the part of the men is shown up by the charts as well as any inattention. The engineer can check the efficiency of his men as well as that of the individual boiler.

Let us send you fully descriptive Bulletins.

BAILEY METER COMPANY Limited
177 DELORIMIER AVE. - MONTREAL, QUE.

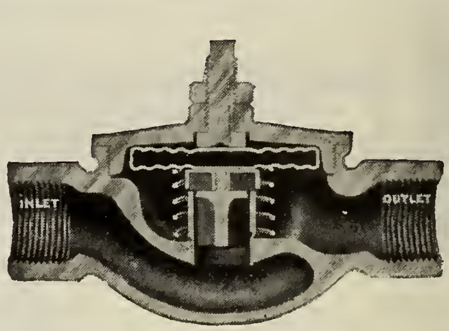


Ruston & Hornsby Ltd.
Lincoln, England



CRUDE OIL ENGINE

Uses cheapest grade oil.
Best fuel economy.
Starts instantly from cold.
May we send you catalogue?



Welldeck Steam Trap
(Standard Type)

Suitable for 150 lbs. pressure. Cannot get out of order. Price reasonable.

Stock in Montreal.
Made in England.

Agents:
LAURIE & LAMB BOARD OF TRADE BUILDING **MONTREAL**

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer
Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W

VICTORIA FOUNDRY COMPANY LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations
Write for our latest catalogue
Patterns **Machine Work**

FOR SALE
Fuel Oil Storage Tank
10,000 GALS. CAPACITY

This is a new tank. We have not yet taken delivery of it, and offer it at a very attractive price.

MR. VOGAN, The MacLean Publishing Co., Ltd, 143 University Ave., TORONTO.

FOR SALE

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order Apply Box 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

SAWMILL MACHINERY—MODERN DESIGN most satisfactory to operate. Apply Box 105, Power House.

SAWMILLS—PORTABLE—DOUBLE EDGES; also all kinds sawmill machinery. Apply Box 106, Power House.

WELDING

ELECTRIC AND ACETYLENE WELDING of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

BELTING BARGAIN

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES & $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines--the Indicator--Lubrication--PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers.--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught--HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers--Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________________
Occupation ____________________
Employed by ____________________
Residence ____________________
Reference ____________________

THE VENTURI METER

Measures hot and cold water, sewage, brine, chemical solutions, oil, gas, air and steam. Bulletin on request.

BUILDERS IRON FOUNDRY, PROVIDENCE, R.I.

Canadian Representatives: General Supply Co. of Canada, Ltd., Ottawa, Montreal, Winnipeg, Vancouver; Allen General Supplies, Ltd., Toronto, Ont.

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING
Oil Burning Systems Installed

Full line of Power Plant Equipment and Supplies.

LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL.

SUPERHEATERS
ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES/

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

WESTERN REPRESENTATIVES:
THE TAYLOR ENGINEERING CO., LTD.,
VANCOUVER, B.C.

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

MADE IN CANADA
WORKS AT SHERBROOKE, QUE.

Now *any* plant can have multiple retort stoking—

Trade-Mark

Advantages

Coal is underfed throughout—not overfed on to side grates. This is the only truly *underfed* side-cleaning stoker.

One simple moving unit for five or more retorts—The feeding mechanism of the *"lateral retorts"* is controlled independently of main feed, permitting ideal fuel distribution under all conditions.

Simplest cleaning mechanism—a perfectly balanced dump plate easily operated by hand.

No need for basement ash pits—A trench 6 to 18 inches below the floor line is sufficient excavation for ash pits. This greatly reduces installation cost and makes the stoker adaptable to boilers already in service.

Plate tuyeres—reduce siftings and lower replacement cost.

High air cooled front and rear tuyere blocks—keep fire and clinkers away from front wall and bridge wall, reducing furnace maintenance.

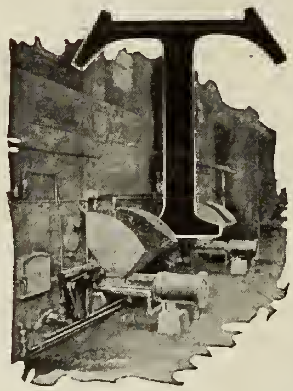
Ask for catalog

Alta. and West Sask.:
Mr. J. Twomey
Camrose, Alberta

Man. and East Sask.:
W. W. Hicks & Co.
Winnipeg

British Columbia:
E. A. Earle, Limited
Vancouver, B. C.

Quebec:
The Cleaton Co.,
(Canada) Ltd.
Montreal, Que.



THE superiority of multiple retort stoking is generally conceded. There is only one factor that has kept certain plants from adopting it—its greater first cost.

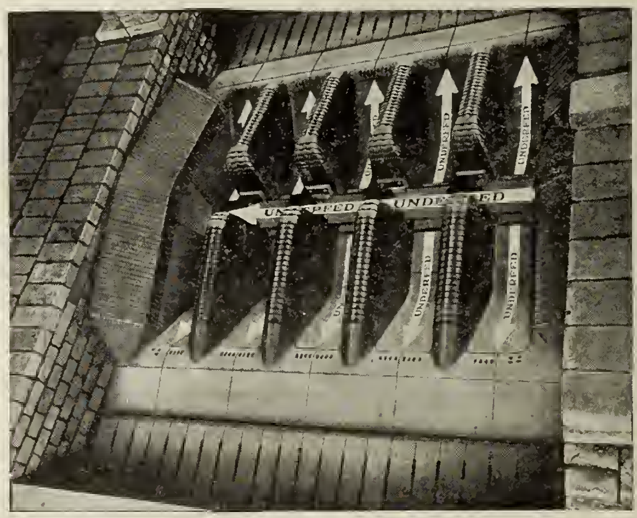
Such plants were formerly compelled to accept a stoker of inferior range—but this is no longer necessary.

The *"Lateral-Retort"* Stoker combines the simplicity and the lower first cost and installation cost of a simple side-cleaning stoker with the high capacity and excellent combustion efficiency of the more complicated and higher priced multiple retort type.

The top view of the *"Lateral-Retort"* Stoker, below, shows how this is accomplished—the many advantages are listed opposite, and are covered in greater detail in the *"Lateral-Retort"* Catalog—*Ask for it.*

The Under-Feed Stoker Co. of Canada, Ltd.
146 King Street, Toronto

Sales Agents for Jones Stokers, Riley Stokers, Murphy Furnaces



RILEY JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

The "Lateral Retort" Stoker
TRADE MARK

HINTS TO BUYERS

McDaniel Improved

STEAM TRAP

FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa

"Pop Off" Steam
Carries Ashes Away

"Into the hole and away they go" describes ash removal with a Green Steam Jet System. At the Kewanee Boiler Co., they use "Pop off" waste steam to do the work.

Write to Dept. X for descriptive literature.

GREEN ENGINEERING COMPANY
175 Kennedy Avenue
EAST CHICAGO INDIANA

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - St. Louis. Mo
Eastern Office: 71 Fulton St., New York.

LADD
WATERTUBE BOILER

LADD
WATER TUBE BOILER
COMBINES PERMANENT ECONOMY OF OPERATION WITH UNUSUAL ADAPTABILITY TO ANY INSTALLATION REQUIREMENTS.
DESCRIPTIVE CATALOGUE ON REQUEST.

GEORGE T. LADD COMPANY
First National Bank Bldg. PITTSBURGH, PA.
CHICAGO OFFICE [illegible] McCORMICK BLDG CHICAGO, ILL.

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T. J. CUNERTY** *Company*
Room 240 17, Queen St, East Toronto

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we willtell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Penhertby Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairhanks-Morse Co., Ltd., Montreal.
Laurie, Lamh, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

AMMONIA PLANT EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
Under-feed Stoker Co. of Canada, Ltd. Toronto.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durahla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co.,: Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairhanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd., Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. McLaren Limited, Montreal, Que.

BELT HOOKS
Bristol Co., The, Waterbury, Conn.
D. K. McLaren, Limited, Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLareu, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd.

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, FABRIC
D. K. McLaren Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. McLaren, Limited, Montreal, Que.

BELTING, SOLID WOVEN
D. K. McLaren, Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

CORD CLOTHING
D. K. McLaren Limited, Montreal Que.

CHAIN WHEELS
The Mason Regulator & Eng, Co., Ltd., Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Bolco Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Suply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairhanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co. Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penherthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenherg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren, Limited, Montreal, Que

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

Sturtevant Fuel Economizers have proved a most profitable investment to scores of public utility and industrial plants.

Folder 609 outlines the economical installation for your plant.

B. F. Sturtevant Co. of Canada, Ltd.

Montreal, Galt, Toronto

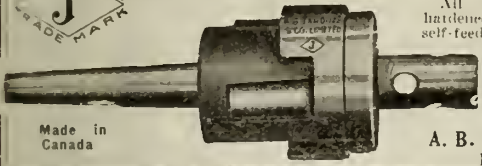
Sturtevant

PUTS AIR TO WORK

NORTHERN CRANE WORKS, LTD.
Walkerville, Ont.

Jardine's Self-feeding Tube Expanders

REGISTERED J TRADE MARK



All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co. Ltd.
Hespeler, Ont.

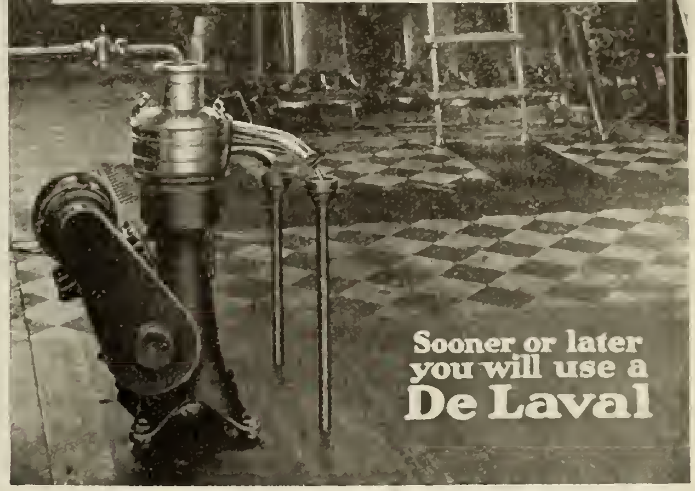
"A De Laval Oil Purifier

makes a decided improvement in the running of the engine," says Chief Engineer Jenkins of the London Guarantee & Accident Co. in his report on the Diesels in the Chester Water Works, Chester, England. Mr. C. W. Bennett, the engineer in charge of the water works, writes: "About 3,000 gallons of lubricating oil have so far been treated and lubricating oil now costs one-third of the amount before the Purifier was installed."

Write for bulletin No. 105, which gives detailed information about De Laval Oil Purifiers.

The De Laval Company Ltd.
PETERBOROUGH, ONT.

Montreal Edmonton
Winnipeg Vancouver



HEPBURN PUMPS

Centrifugal and Reciprocating

The Selection of a Pump

—be it large or small, certainly involves an important responsibility, for few buyers can afford the expense and trouble which usually follows the installation of unsuitable or low-grade equipment.

All we ask is that your judgment be based solely on the performance of our pumps and your verdict given only after the capabilities of Hepburn Pumps have been proven conclusively.

We can also quote attractive prices on Hand and Electric Overhead Cranes, all kinds of Castings and Special Machinery.

JOHN T. HEPBURN, LTD. ENGINEERS AND IRON FOUNDERS **18-40 Van Horne St., TORONTO**

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CARBONIC ACID GAS
Laurie & Lamb, Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLINGS
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd. Montreal

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR DRIVES
Sterling Engine Co., Buffalo, N. Y.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N. Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER HEATERS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Yarnall-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., Erie, Pa.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.

FILTERS, WATER
Frick Co., Waynesboro, Franklin Co., Pa
Graver Corp., East Chicago, Ind.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane, Limited, Montreal.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N. Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Harsey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FUEL ECONOMY DEVICES
The Boiler Repair and Grate Bar Co., Toronto, Ont.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Johns-Pratt Co., The, Hartford, Conn.

Make Canada Prosperous by Buying Canadian Products

If The Pressure Becomes Excessive

Untold damage may result if fixtures are not protected. Preventative insurance by the use of a Mueller Relief Valve can be had at slight cost. Built to give service and satisfaction, each valve adapted for its particular installation it will fulfill the requirements in every instance.

It is dependable under all circumstances, does not stick even after long periods of inactivity and responds instantly when service is demanded.

Highly sensitive, positive in action, easily adjusted—it provides the Factor of Safety for all steam, air, oil or water lines.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Illinois, U. S. A. **Branches, New York and San Francisco**

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HANDHOLE
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Peldam Asbestos (Canada) Co., Toronto
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.

GASKETS, LEAD, COPPER AND SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

HANGES, GAUGES, AMMONIA, OIL, GAS, AIR
Schaffer & Bundenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Bristol Co., The, Waterbury, Conn.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div- Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal
Canadian Steam Boiler & Equipment Co., Toronto.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E. London, Ont.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Toronto, Ont.

GRATE BARS, FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.
The Boiler Repair and Grate Bar Co., Toronto, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicago, Ind.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Graver Corp., East Chicago, Ind.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INDICATING THERMOMETER, SARCO
Sarco Co., Inc., New York.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Bristol Company, The, Waterbury, Conn.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Celite Products Limited, Montreal, P.Q.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

Celite Products Limited, Montreal, P.Q.

INSULATING POWDER

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LACE LEATHERS
Can. Johns-Manville Co., Ltd., Toronto.
D. K. MacLaren Ld., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LINK BELTING
Can. Link-Belt Co., Toronto. Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mo.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MARINE CASTINGS
Mueller Mfg., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

METERS, F.M.
Canadian General Electric Co., Toronto.
The Bailey Meter Co., Cleveland, Ohio.
Can. Johns-Manville Co., Toronto.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.

OILING SYSTEMS
Lunkenheimer Co., Cincinnati, Ohio.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos Canada Co., Toronto.
Beveridge Suppy Co., Montreal
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, H. P. ROD
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont.

PENSTOCKS
W. M. B. Scarfe & Sons, Pittsburgh, Pa

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
The Superheater Co., Limited, Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE STEEL
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE
MEANS ECONOMY
Let us know your requirements. We will solve the problem.
Write us Today
Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.

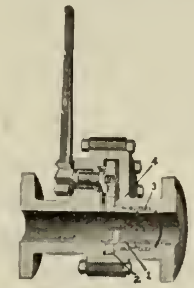
AMERICAN
STEAM ASH CONVEYORS
75% of all steam jet ash conveyors in Canada are American. Satisfactory and economical performance guaranteed. Ask for booklet.
Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Calgary, Edmonton, Vancouver
WM. A. GOOLD, Winnipeg
CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

More than 400 YARWAY BLOW-OFF VALVES used by Cleveland Electric Illuminating Company

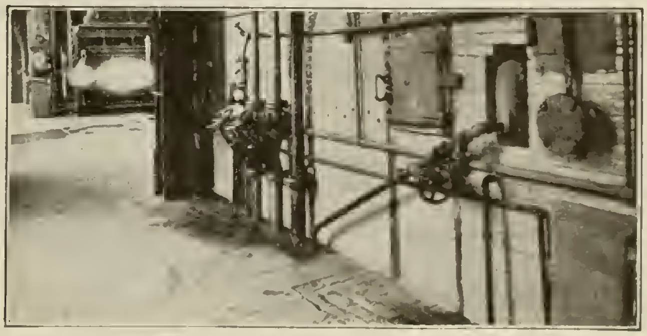
Ten years ago, Cleveland Electric Illuminating Company ordered their first YARWAY BLOW-OFF VALVES—twelve YARWAY SEATLESS. Thirty-three times since then they have sent in repeat orders. They now have in service more than 400 YARWAY SEATLESS and YARWAY DOUBLE-TIGHTENING BLOW-OFF VALVES.

One of their recent orders was for 93 YARWAY SEATLESS to be used on economizers—a service fully as severe as boiler blow-downs, requiring a thoroughly good valve. Repeat orders come only when worth has been proved. A large proportion of YARWAY BLOW-OFF VALVES are sold to present users. The YARWAY SEATLESS BLOW-OFF VALVE and the YARWAY DOUBLE-TIGHTENING VALVE are fully described in an interesting booklet. To get your copy, ask for Bulletin B-410.

YARNALL-WARING COMPANY
Mermaid Lane and Ardleigh St., Philadelphia
207 St. James St., MONTREAL. 400 Penobscott Bldg., DETROIT.



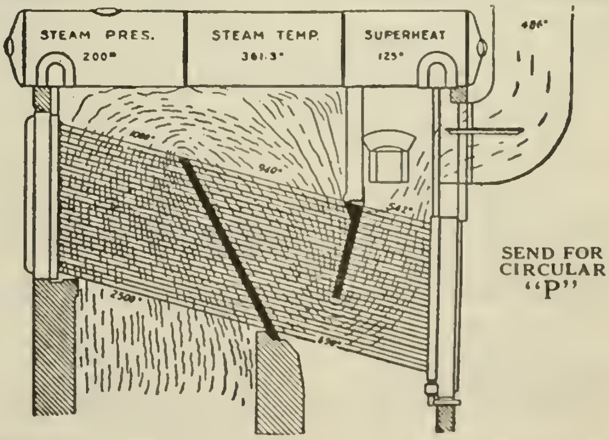
Left: Yarway Seatless Blow-Off Valve. Described in Booklet B-410.
Right: Yarway Double-Tightening Valve.



A few of the more than 400 Yarway Blow-Off Valves used in the Plant of the Cleveland Electric Illuminating Co.

YARWAY
POWER PLANT DEVICES *to save fuel*

"MONO" TRADE MARK REG. U.S. PAT. OFF. BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE
AND ARE NOT DAMAGED WHEN TUBES ARE WITHDRAWN, REPLACED OR BY THE USE OF A TURBINE CLEANER.
OUR ENGINEERS ARE AT YOUR SERVICE TO HELP YOU SOLVE YOUR COMBUSTION PROBLEMS. THE CUT ON THE RIGHT IS AN EXAMPLE OF WHAT WE CAN DO FOR YOU.
KING REFRACTORIES CO.
Sole Canadian Representatives:
GRANT E. COLE CO.
21-23 River St., Toronto, Canada
Represented in Vancouver, Winnipeg, Montreal, Halifax.



SEND FOR CIRCULAR "P"

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairhanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Laurie & Lamh, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton,
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Laurie & Lamh, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Pratt & Cady, Hartford, Conn.
Smart-Turner Co., Hamilton, Ont.
Laurie & Lamh, Montreal.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt,
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamh, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt,
Laurie & Lamh, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, BILGE
Laurie & Lamh, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullocb Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamh, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Alhany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek
Laurie & Lamh, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, GAS
Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co., (Inc., Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairhanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Alhany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton,

OIL PUMPS FOR FUEL OIL BURNING SYSTEMS.
Albany Pump Co., Toronto, Ont.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Can. Fairhanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, ROTARY
Alhany Pump Co., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullcoh Co., Galt.
Laurie & Lamh, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamh, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati. Ohio.
Pratt & Cady, Hartford. Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMP TANK, RECEIVER
American Steam Pump Co., Batle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto,
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Bristol Co., The, Waterbury, Conn.
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Tayor Instrument Co., Toronto. Ont.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamieson Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Inde Can. Refrigeration Co., Montreal.
York Mfg, Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamh, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal,
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Bahcock & Wilcox, Ltd., Montreal.
Can. Fairhanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester Mass.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamh, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.

Goldie & McCullocb Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd. Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch, Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCullocb Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM ENGINES
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM JETS
Green Engineering Co., East Chicago, Ind.

STEAM SPECIALTIES
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd,, Toronto.
Can. Fairbanks-Morse Co., Montreal.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jas. Morrison Brass Mfg. Co., Toronto.
Penherthy Injector Co., Windsor.
The Reliance Gauge Column Co., Cleveland, Ohio.
Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM CALORIMETERS
Schaeffer & Budenhurg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Division, Brooklyn, N. Y.
Sarco Co., Inc., New York.

STEAM TRAPS
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Julian D'Este Co., Boston 14, Mass.
Sarco Co., New York, N. Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairhanks-Morse Co., Ltd., Montreal.

STOKERS
Canadian Planet Engineering Co., Windsor, Ont.
Bahcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd., Montreal.
Green Engineering Co., East Chicago, Ind.
Underfeed Stoker Co., of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
Sturtevant, Co., B. F., Toronto and Boston.

STRAINERS
Bahcock & Wilcox, Ltd,, Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox. Ltd., Montreal.
Wm. B. Scaife & Sons Co, Pittsburg, Pa.

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

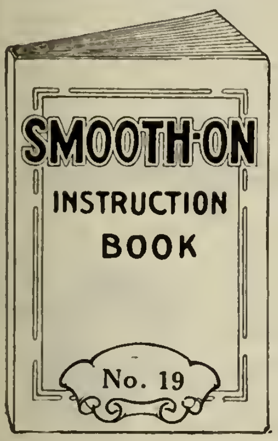
SMOOTH-ON IRON CEMENTS

What Other Engineers Know About Repair Work, This FREE Book Tells You

It is full from cover to cover of practical ideas developed to meet actual engine and boiler room emergencies. There is no theory in

SMOOTH-ON

Instruction Book No. 19



Just 144 pages of real engineering facts—facts that if you knew them might save you hours—or days—and dollars in your next repair job.

Write for your copy of this valuable book—you need it in your work—it's FREE.

Smooth-On Cements are sold in 5-lb., 10-lb., and 25-lb. tins; also in larger sizes.

The Canadian Asbestos Co.
Dept. 52C
36-48 Youville Square
Montreal, Que.

If your Supply House cannot supply you with Smooth-On—write us direct.

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

PACKING THAT LASTS

John Crane packing of spirally wound babbitt foil impregnated with graphite wear as only a non-corrosive, non-abrasive metal can. Its simplicity is its strength—flexible, compressible, easily applied using the piston rings principle of the fluid seal. John Crane packings give length and quality of service previously unequalled in packing. Send for our text book "Metallic Packings."

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, B. C.

When the Leviathan Goes to Sea

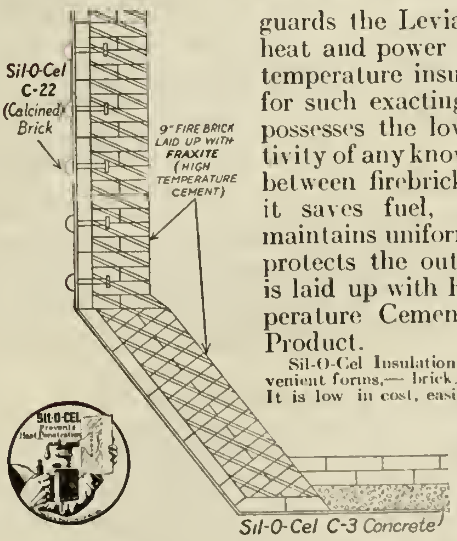
the pride of the U.S. Merchant Marine will represent the best efforts of American science and engineering. Deep within the heart of this magnificent liner, the steady pulse and throb of motive equipment denotes power,—power generated without loss or waste,—power conserved and utilized to the utmost.

SIL-O-CEL

PREVENTS HEAT PENETRATION

TRADE MARK REGISTERED U.S. PATENT OFFICE

A CELITE PRODUCT


Sil-O-Cel C-22 (Calcined) Brick
9" FIRE BRICK LAID UP WITH FRAXITE (HIGH TEMPERATURE CEMENT)
SIL-O-CEL Prevents Heat Penetration
Sil-O-Cel C-3 Concrete

guards the Leviathan boilers from heat and power waste. This high temperature insulation was selected for such exacting service because it possesses the lowest heat conductivity of any known material. Placed between firebrick and outer shell, it saves fuel, increases capacity, maintains uniform temperature and protects the outer shell. Firebrick is laid up with Fraxite (High Temperature Cement), another Celite Product.

Sil-O-Cel Insulation is furnished in four convenient forms,—brick, block, powder and cement. It is low in cost, easily applied,—a permanent insulation.

Write for details on insulating your equipment. Specific data given in Bulletin W-6C, use the coupon.

**CELITE PRODUCTS LIMITED, New Birks Bldg.
MONTREAL, CANADA**

CELITE PRODUCTS LIMITED.

Gentlemen: Send Bulletin W-6C and explain in detail the advantages of SIL-O-CEL Insulation, how it saves fuel, increases capacity and maintains even temperatures. I am particularly interested in the insulation of

____

Name Type of Equipment

Name ____

Firm Name ____

Address ____

The **ANDERSON STEAM SEPARATOR**

will give you dry steam, under practically any working condition, at very low cost. It is one of the most reliable safeguards against the possibility of breakdowns caused by accumulation of moisture in engine cylinders or turbine casings.

The Anderson is made in both vertical and horizontal styles. Let us send you a catalogue.

THE V. D. ANDERSON CO.

West 96th St., Cleveland, Ohio

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

PLIBRICO
JOINTLESS
FURNACE LINING

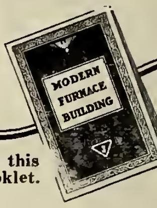
--the long lived furnace lining

A PLASTIC refractory in unbaked form that conforms to all furnace shapes and can be installed by anyone who can use a mallet. This steel container keeps it in perfect condition and identifies the only "Jointless Fire Brick"—the one-piece refractory lining that outlasts ordinary fire brick from 2 to 4 times and resists temperature to 3,100 deg. F. The way to better furnace linings is the subject of the new booklet. Where shall we send it?

JOINTLESS FIRE BRICK Co

1142 Clay Street Chicago, Ill.

Write for list of distributors.



Ask for this free booklet.

SUPERHEATER, STATIONARY
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, LOCOMOTIVE
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STEAM SHOVEL
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N. Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Canadian Johns-Manville Co., Ltd., Toronto
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co. Brantford.

TANKS, OIL, KEROSENE, GASOLINE
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

TANKS, WATER
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

TACHOMETERS
Bristol Company, The, Waterbury, Conn.

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

THERMOSTATS
Sarco, Inc., New York, N.Y.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N. Y.

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Sarco Co., Inc., New York, N.Y.
Wason & McDonald Co., Philadelphia
Taylor Instrument Co., Toronto, Ont.

TACHOSCOPES
The Reliance Gauge Column Co., Cleveland Ohio.
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS
Canadian Sirocco Co., Ltd., Windsor. Ont.
American Steam Gauge and Valve Co., Division, Brooklyn, N.Y,
Schaeffer & Budenburg Mfg. Co., and Am-
Sarco Co., Inc., New York, N.Y.

TRAPS, DUMPING
Grant E, Cole Co., Toronto, Ont.

TACHOMETERS
Bristol Company, The, Waterbury Conn.,

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Sturtevant Co., B. F. Toronto and Boston.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal.
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES OF ALL KINDS
Reading Steel Casting Company, Inc.
Pratt & Cady Division,
Bridgeport, Conn.
Reading Steel Casting Company, Inc.
Reading Valve and Fittings Division,
Bridgeport, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES
Babcock & Wilcox, Ltd., Montreal,
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sbell Bar Boico Supply, Ld., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa,

Value of Business Newspapers Recognized by Daily Press

ONE of the most striking features of journalism of recent years has been the development and rapid advance of the business newspaper to a position of importance in the business world. It was found that the best way to make a paper of benefit to advertisers was to make it of outstanding service to its subscribers, and that the advertiser eventually benefited more by a paper which gave news independently and fearlessly than by one which was merely a write-up sheet, with neither news, opinions, or self-respect.

It is by aiming for this ideal of making the paper of the greatest possible benefit to the subscriber that industrial journalism has come to the honored place it now occupies in the world of business. At the present time the industrial press holds a place of commanding importance in the business life of the country. More that 1,400 papers in Canada and in the United States are in the industrial class.

The business press covers a different field to the daily press and is not in competition with it. Business papers develop a great many advertisers who later use the daily papers and magazines.

The most conspicuous proof of the importance with which the industrial press is regarded as an advertising medium is furnished by the recent action of a society of newspaper men.

Forty publishers in Chicago recently formed an association to promote the morning newspapers' interests in competition with the evening newspapers as an advertising medium. They have announced their intention of employing the business newspapers for publicity purposes in furthering their aim.

This recognition of the place and power of the specialized newspaper coming as it does from the publishers of newspapers, who know better than most people the necessity of discrimination by advertisers in selecting their publicity channels, is a striking tribute to the value of the business newspaper as an advertising medium.

These publishers realize that the business papers reach the most important men in every industry, the men whose opinions count, and who have most influence in the business world. And not only do the business papers reach these men but they are also read by them. Many business men are not great readers, but the papers which they must read—which they cannot afford not to read—are those which deal with their own business and give the news connected with it.

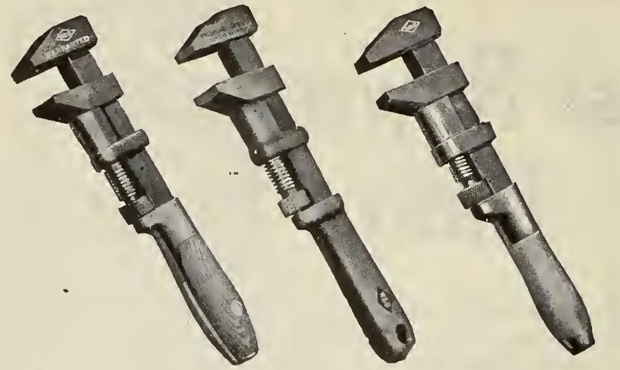
The following MacLean publications are all leaders in their own field and by their means you can send your sales message to the leading men in the industries they cover. All the papers are members of the Audit Bureau of Circulations, which is a hall-mark or guarantee of quality-circulation. Information regarding circulation, advertising rates and fields covered, will be furnished on application.

The MacLean Publishing Co.

143-153 University Avenue, Toronto

Publishers of:-

The Financial Post
Canadian Grocer
Hardware and Metal
Dry Goods Review
Men's Wear Review
Bookseller and Stationer
Canadian Machinery
Canadian Foundryman
Druggists' Weekly
Power House
Canadian Shipping
Printer and Publisher
Sanitary Engineer
Canadian Automotive Trade
MacLean's Magazine



MADE IN CANADA

DEPENDABLE WRENCHES

Williams' line of "W. & B." Screw Wrenches are strong, sturdy, dependable tools.

Machinists' Knife Handle and "Railroad Special" Wrenches are recommended for the heaviest service; 7 sizes; 6 to 21 inches.

Agricultural Wrenches meet the demand for a good tool at a moderate price. 5 sizes; 6 to 15 inches.

J. H. WILLIAMS & CO., Limited
"The Wrench People"
78 Thorold Road St. Catharines, Ontario

Tycos
temperature instruments

Did you know

that for every temperature problem in the power house that the answer can be found by installing *Tycos*. Look this list over. A *Tycos* can be had for each specific point.

Air Ducts,
Bearings Temperature,
Blow off lines,
Boilers,
Coal Pile Temperature and Alarms,
Condensers,
Economizers,
Feedwater heaters,
Feedwater lines,
Furnace temperatures,
Furnace drafts,
Generator temperatures,
Gravity overhead tank heaters, temperature and alarms,
Hot water heaters,
Hot wells,
Pressure lines,
Steam lines,
Superheaters,
Superheated Steam Mains,
Transformer temperatures and alarms,
Vacuum lines and tanks.

Tycos power plant applications will be sent for your reference. Ask for Catalog Part One.

Taylor Instrument Companies
110-112 Church St.
TYCOS BUILDING, TORONTO

INDEX TO ADVERTISERS

A
American Steam Pump Co. 14
Anderson Co., V. D. 54
Armstrong Cork and Insulation Co., Ltd. 13
Audel Co., Theo 43

B
Babcock & Wilcox 37
Bailey Meter Co. 42
Betson Plastic Fire Brick Co.... 16
Bristol Co., The 14
Builders Iron Foundry 43
Buyers' Directory 46, 48, 50, 52, 54

C
Canada Cement Co., Ltd.......Front Cover
Can. Fairbanks-Morse Co. 18
Canadian Ingersoll-Rand Co. .. 5
Can. Johns-Manville Co. 39
Celite Products, Ltd. 53
Classified Adv. Section 43
Cole Co., Grant E............... 51
Conveyors Corp., of America... 51
Counerty, T. J. 45
Crane Packing Co. 53
Crane, Ltd. 11

D
DeLaval Steam Turbine Co. 4
DeLaval Co., Ltd., The........ 47
Dart Union Co. 41
D'Este Co., Julian 8
Diamond Specialty Ltd. 4
Durabla Mfg. Co. 18

E
Elk Fire Brick Co. 51
Engineering & Machine Works of Canada 19

F
Foxboro Co. 9
Flexible Metallic Packing Co. .. 53
Frick Company 12

G
Garlock Packing Co. 6
Garth Co., The 45
Goldie & McCulloch Co. 20
Greene, Tweed & Co. 15
Green Engineering Co. 45
Gutta Percha & Rubber, Ltd.... 2

H
Hints to Buyers 45
Hepburn, John T. Co. 47

I
Imperial Oil Co. 17

J
Jardine, A. B. 51
Jenkins Bros. 7
Jointless Firebrick Co. 54

K
Kerr Engine Co. 13

L
Ladd, Geo. T. Co. 45
Laurie Engine Co. 43
Laurie & Lamb 42
Linde Can. Refrig. Co. 10
Lunkenheimer Co. 3
Lytell Engineering Co. 41

M
McLaren, D. K. Co..........Inside Front Cover
McGowan Co., John H......... 16
Magnolia Metal Co. 8
Moncreiff Ltd., John 55
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Mueller Mfg. Co. 49

N
Northern Crane Works 47

P
Pilley Packing & Flue Brush Mfg. Co. 45
Pratt & Cady Co. 16

R
Reading Steel Casting Co. 16
Refrigeration Dept. 10

S
Schaeffer & Budenberg Mfg. Company 8
Smooth-On Mfg. Co. 53
Superheater Co. 43
Sturtevant & Co., Ltd., B. F.... 47
Steel Mill Packing Co. 41
Sexton, W. R. Boiler Setting Co. 41

T
Taylor Instrument Co. 55

U
Underfeed Stoker Co., of Canad, The 44

V
Victoria Foundry Co. 43
Vilter Mfg. Co. 10

W
Wall, W. J. 55
Waterous Engine Works Co.... 1
Watson, M. Barry 43
Watson & McDaniel Co. 45
William & Co., Ltd., J. H...... 56

Y
Yarnall-Waring Co. 51
York Mfg. Co. 12

MONCRIEFF'S "UNIFIC" WATER GAUGE **GLASSES**

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is **economical.** British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: **W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA**

Detroit V-Type Stokers Selected for America's Finest Public Buildings

McKIM, MEAD & WHITE of New York, and GORDON & KAELBER, of Rochester, Architects. ALLEN S. CROCKER, M. E., Consulting Engineer.

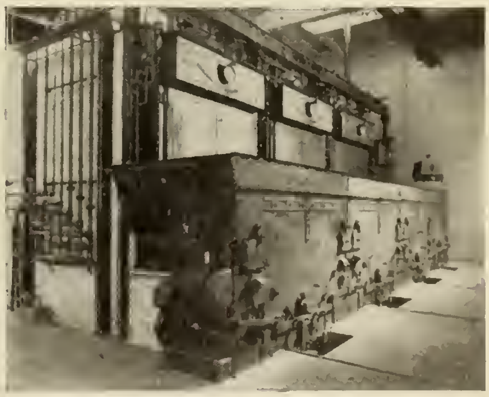
The Eastman Theater stands as a monument to motion pictures. A gift from George Eastman to the University of Rochester, the purpose of this theater is best expressed in an inscription over its portal: "Erected For The Enrichment of Community Life."

The quiet beauty of this structure leaves a lasting impression. A full appreciation of this is only secured after every feature of this theater is thoroughly known. No expense or effort was spared in the perfection of each detail. The quality of workmanship from basement to roof is of the same superb quality. The artist of every profession was given free rein to express his skill in its highest degree.

The Eastman Theater and the Eastman School of Music are connecting buildings and the one boiler house equipment serves for heating both buildings. The boiler equipment consists of three 400 horse power and one 200 horse power water tube boilers, all served with Detroit V-Type Stokers.

Thus there is added another notable structure to the long list of America's famous public buildings served by Detroit V-Type Stokers.

DETROIT NATURAL DRAFT STOKERS may be profitably installed under both tubular and water tube boilers.



Send for your copy of the Detroit V-Type Stoker Bulletin No. 338

DETROIT STOKER COMPANY

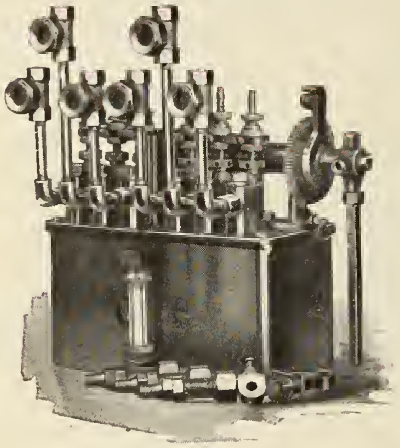
Underfeed Forced Draft and Overfeed Natural Draft Stokers

338 GENERAL MOTORS BUILDING DETROIT, MICH.

SAVE FUEL "DETROIT V TYPE STOKER" AND LABOR

MORRISON

Save 60 to 80% In Oil Consumption



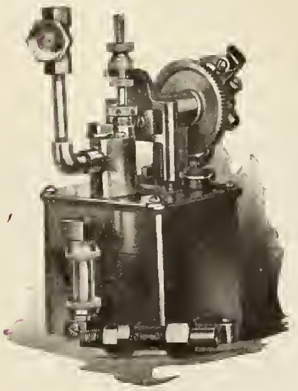
Six-Pint, Six-Feed, Metal Body

—Add to that increased efficiency and assurance of a positive automatic, centrally controlled lubricating system, and you will readily realize why these

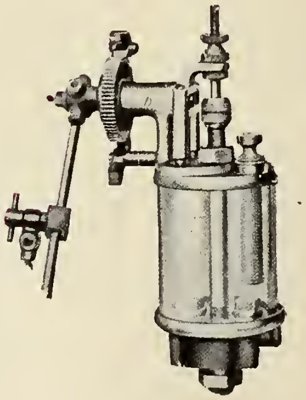
Force Feed Lubricating Pumps

are the choice of all wide-awake engineers.

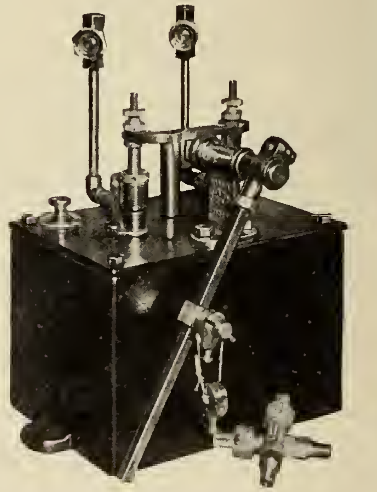
A flexible oiling unit of simple, durable construction, positive action and visible feed. Important working parts outside the reservoir all above board. A real "get-at-able" lubricator. **Let us explain the many time and worry-saving features.**



Two-Pint, Single-Feed, Metal Body



Single-Feed Glass Body



Direct Reciprocating Lever Drive Pump

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Co., Limited

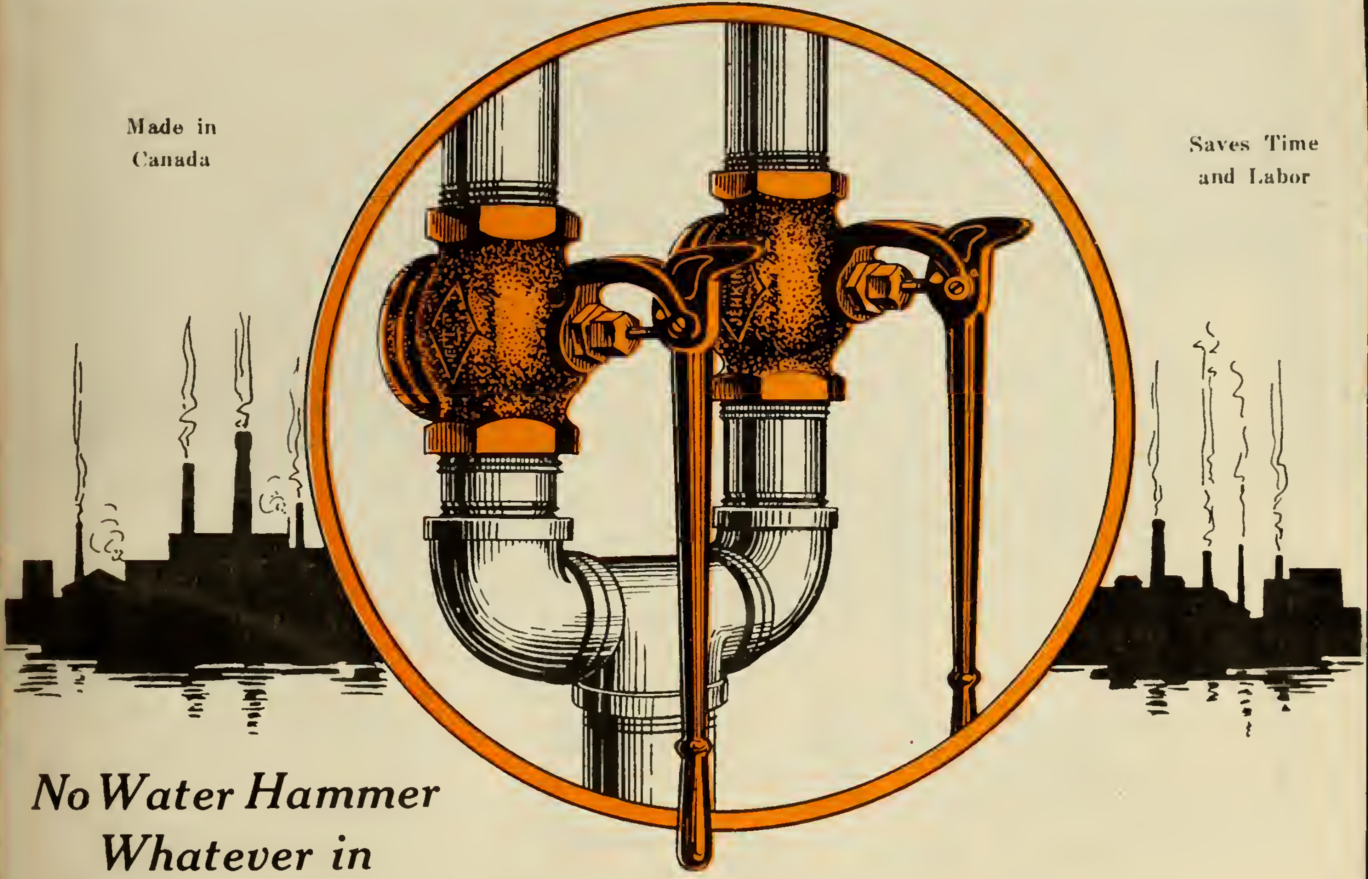
93-97 Adelaide St. West
Toronto

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission and Application of Steam, Gas, Electric Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street. E. C. NEW YORK, BOSTON, CHICAGO.

Vol. XVI—No 6. Publication Office, Toronto—March 20, 1923 Published Semi-Monthly. Canada, $2; U.S. $2.50 a year



No Water Hammer Whatever in

Jenkins Rapid Action Valves

Valves that open fully with a slight pull of hand lever.

Valves that stay open automatically without aid of set screws or locking devices.

Valves that close tight with a slight pull of lever, preventing water waste and saving both time and labor.

These water hammerless valves are absolutely dependable and are ideal for every service where a valve of this nature is required.

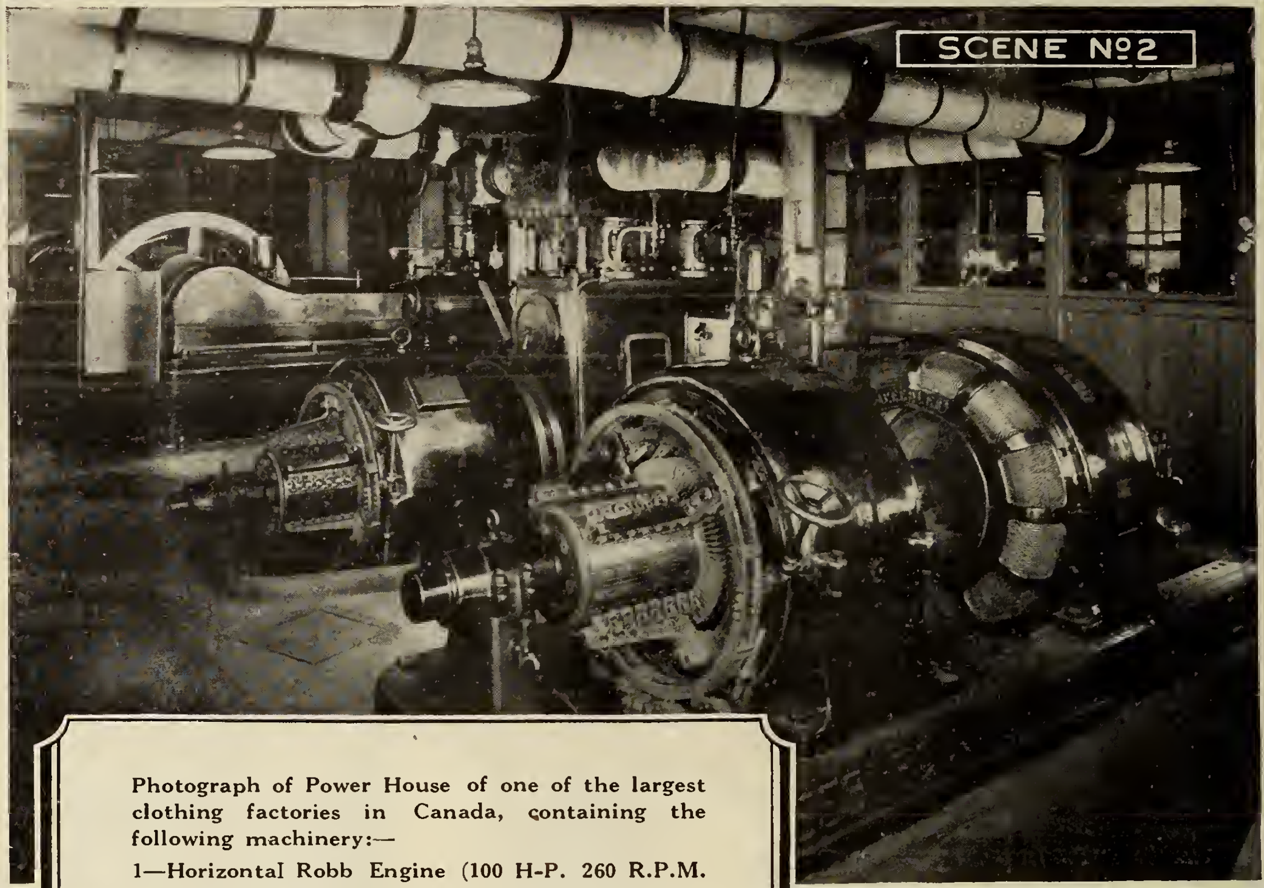
TRADE JENKINS MARK

Jenkins Bros

Write for full particulars

Jenkins Valves SINCE 1864

JENKINS BROS. LIMITED
103 St. Remi Street, Montreal
TORONTO VANCOUVER
EUROPEAN BRANCH: 6 Great Queen St., Kingsway, London, W. C. 2, Eng.



Photograph of Power House of one of the largest clothing factories in Canada, containing the following machinery:—

1—Horizontal Robb Engine (100 H-P. 260 R.P.M. Steam Pressure 100 lbs.) direct coupled to a D.C. Generator.

1—Robb-Armstrong Vertical Crank Case Engine (200 H.P. 425 R.P.M. Steam Pressure 100 lbs.) direct coupled to a D.C. Generator.

1—Bruce Peebles Motor Generator Set (100 K.W., 700 R.P.M.)

Imperial Lubricants in use:—

Imperial Cylinder Oil.
Imperial Solar Red Oil.
Imperial No. 1 Crank Case Oil.
Imperial Renown Oil.

You *know* your machinery—the Imperial Oil man *knows* our lubricants. When the two of you get together you will easily be able to work out a satisfactory solution of the most difficult lubrication problem. Service supplements our years of experience in producing first-class lubricants for every industrial purpose. A letter to our nearest branch will secure for you detailed information regarding any phase of plant lubrication or the services of an Imperial lubrication engineer if you desire.

IMPERIAL OIL LIMITED

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

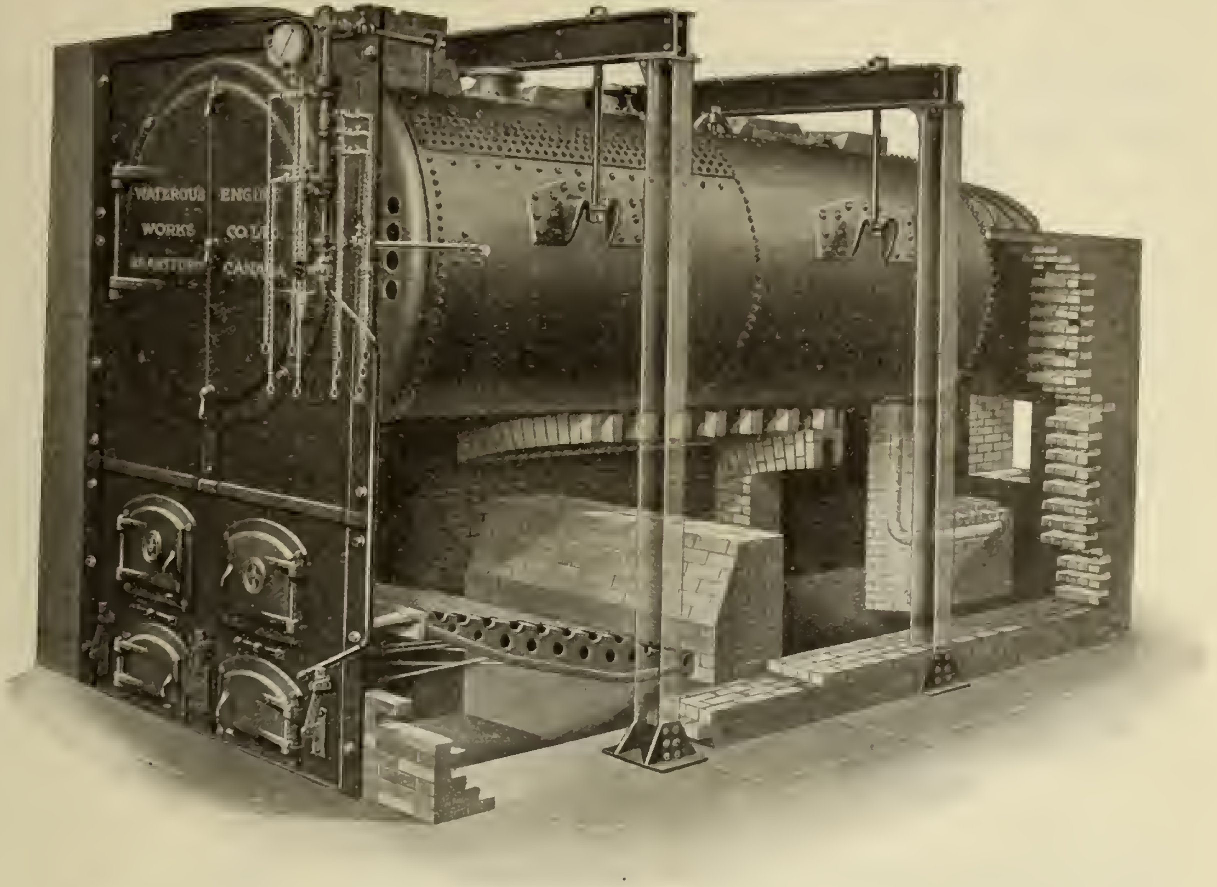
Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

Files Stokers

Hand Operated

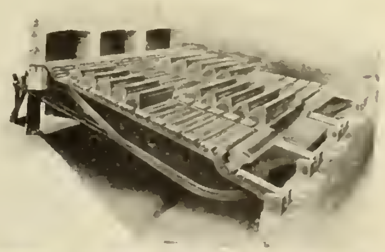


"Are Giving Absolute Satisfaction"—

S. KANN SONS COMPANY, Washington, D.C.

"In answer to your communication of Aug. 1st in reference to our **Files Stokers,** will state that they are giving **absolute satisfaction.** We have them installed under two 250 H. P. Heine Boilers.

"While we have not made a test of the actual saving in coal, would judge from 10 to 15% as our load increased 25%. We were able to carry steam without difficulty, which we could not do when our boilers were equipped with the down-draft furnaces.



"Our smoke laws in this city are very strict and with one or two exceptions we have always been able to comply with same. With careful firing there should be very little smoke. Our expense for upkeep has been very reasonable.

"Hoping this information is what you desire, we remain,

"Yours very truly,

"THE S. KANN SONS COMPANY."

Waterous

BRANTFORD, ONTARIO, CANADA

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unmatched!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

COXE LEADS

23 years ago Coxe Stokers pioneered the efficient burning of anthracite coal on an automatic stoker.

10 years ago Coxe Stokers pioneered the efficient burning of coke breeze on a forced draft traveling grate stoker.

3 years ago Coxe Stokers pioneered the burning of mid-west bituminous coal on a forced draft traveling grate stoker.

To-day Coxe Stokers are giving universal service for all low grade fuels.

Let us send you details of 25 recent tests.

COMBUSTION ENGINEERING CORPORATION

LIMITED

Mr. A. J. T. TAYLOR, President

Mr. John T. FARMER, Chief Engineer

MAIN OFFICE: TORONTO

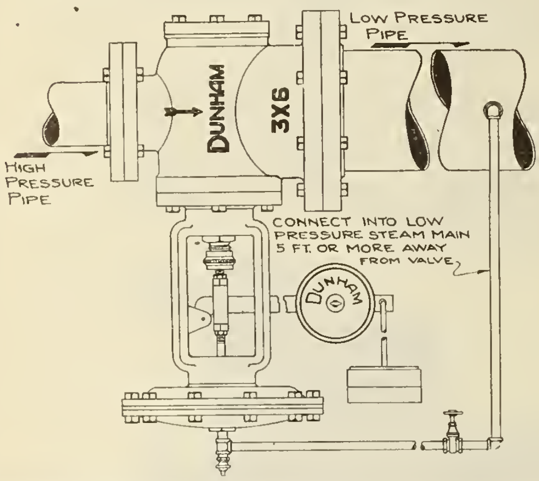
Vancouver Montreal Winnipeg

The DUNHAM
REG TRADE-MARK
HEATING SERVICE

(Made in Canada)

Reducing Pressure Valves

The Dunham Expanded Outlet Reducing Valve shown installed in horizontal steam main is especially designed for steam heating systems which require very low pressure. The expanded outlet permits quick steam expansion and facilitates reduction from high initial pressure to as low as atmospheric pressure.


LOW PRESSURE PIPE
DUNHAM
3X6
HIGH PRESSURE PIPE
CONNECT INTO LOW PRESSURE STEAM MAIN 5 FT. OR MORE AWAY FROM VALVE
DUNHAM

Varying High Pressures Automatically Reduced to Constant Low Pressure

Dunham Reducing Pressure Valves insure an unvarying pressure on the low pressure side of the valves despite a considerable variation in pressures on the high pressure side. Steam, water or air is reduced to the desired pressure (atmosphere minimum) in one step without chattering.

Dunham Reducing Pressure Valves are applicable to a wide range of pressure service. An interchangeability of diaphragms which is permitted by standardized construction takes care of almost any pressure requirement.

Made in Straight and Expanded Outlet patterns. Finest materials and workmanship. Complete data on request.

C. A. DUNHAM CO., Ltd.

TORONTO, ONT.

HALIFAX VANCOUVER WINNIPEG OTTAWA MONTREAL CALGARY
LONDON, ENG., 18 ST. THOMAS ST., S.E. 1.
Also manufacturers of a popular line of heating specialties.

Tanks and Containers for Special Duties

You see us advertising our high grade Boilers so often, you may overlook the fact that we have had wide experience in the manufacture of special tanks and containers for use in chemical plants and for storage purposes in general industry. Our special facilities for flanging and bending plates and the special practice we have developed for rivetting gives our work a quality and finish you will not readily see elsewhere. More than that, our prices are particularly attractive.

Engineering and Machine Works of Canada, Limited

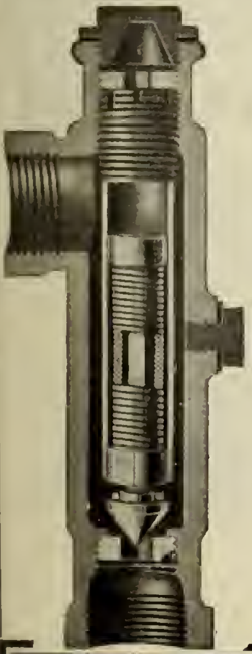
ST. CATHARINES, ONT.

Eastern Sales Offices:
HALL MACHINERY CO., Sherbrooke, Que., and Birks Bldg., Montreal

A BIG SAVING HERE

You can "make a hit with the boss" if you help him in his fight to economize in power and equipment by installing the Steam Trap Sarco.

You can then show him that you saved one-third the price it would have cost to buy ordinary traps. You can point out that you eliminated the expense of building platforms and digging pits—for the Sarco is screwed right into the pipe line. And you can explain that the Sarco will effect a big saving in fuel because, on account of its small cost, you were able to trap every point that required trapping, thus draining off all condensate as soon as it forms.



Furthermore, you can guarantee that Sarco Traps will cut down repair bills, for they have but five parts compared with as many as forty-three in some traps. Consequently, there are fewer parts to carry in stock—fewer parts to wear out and need replacement.

You can safeguard your own judgment until you are sure that the Sarco will do as claimed, as we will ship same on 30 days' free trial.

Write for particulars regarding free trial offer and interesting booklet J-31.

Sarco Co., Inc.

239 Broadway, New York City

Buffalo Chicago Cleveland
Detroit Philadelphia

STEAM TRAP
SARCO

FISHER
TRADE MARK
REGISTERED

A Short Cut to Efficiency

Dry steam is efficient. Wet steam is not. Keep your steam dry. It goes farther—does more work. It means a saving of coal.

Cutting corners in plant economy is urgently necessary in these days of readjustment.

FISHER STEAM TRAP

(Type 33)

will rid your pipe lines of condensation. It will keep your steam dry and hot—it helps it speed along to its goal.

Extra large bucket gives it greater capacity. Shape of bucket insures a permanent water seal at all times.

Valve and seat are made of chemical-resistant monel metal. Therefore, wear is very slow. Replacement or regrinding of valve or seat is seldom necessary. From the illustration you will see the valve and seat are located at the top of trap—away from all sediment.

Let us tell you more reasons why the FISHER TRAP is acknowledged the best. Write for your copy of our interesting, illustrated book—TO-DAY.

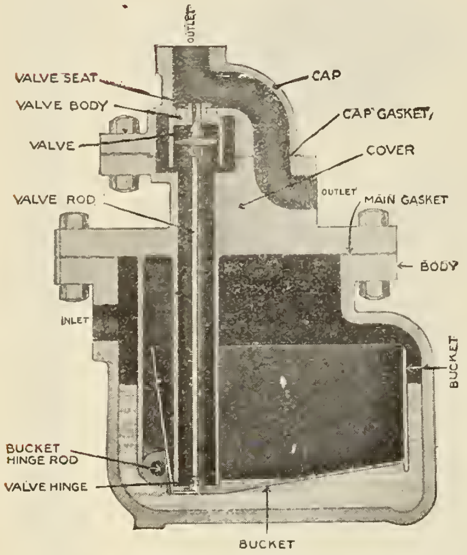
The
Fisher Governor Company

942 Fisher Avenue - Marshalltown, Iowa

Agencies in all principal cities.

The Guardian

of the dwindling coal pile—



THE STRONG TRAP

Serious coal shortages—peak prices, and inferior quality are constant menaces to economical operation of your steam plant.

Don't allow waste of the steam that costs so much to produce nowadays.

Standardize on Strong Traps

These dependable rugged traps effect astonishing fuel savings, while their simple, perfect construction ensures years of satisfactory service.

Do not fail to get our Booklets which explain why Strong Traps are invaluable steam savers. Our nearest Branch will gladly mail them, and recommend the type suited to your needs.

Canadian Agents:

THE CANADIAN FAIRBANKS-MORSE CO.
Limited
St. John Quebec Montreal Ottawa Toronto
Windsor Winnipeg Regina Calgary Vancouver Victoria

29

Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.

DURABLA
TRADE MARK REGISTERED

Strength; Goodness; Quality—these features distinguish durable Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

DURABLA is not affected by vibration or condensation. It will not burn out, blow out or pulp at the points. Let us send you a trial sample. Made in stock sizes 36 in. wide x 144 in. long, and 48 in. wide x 144 in. long, in thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Orders Filled Promptly.

Made in Canada by Canadian Durabla, Limited

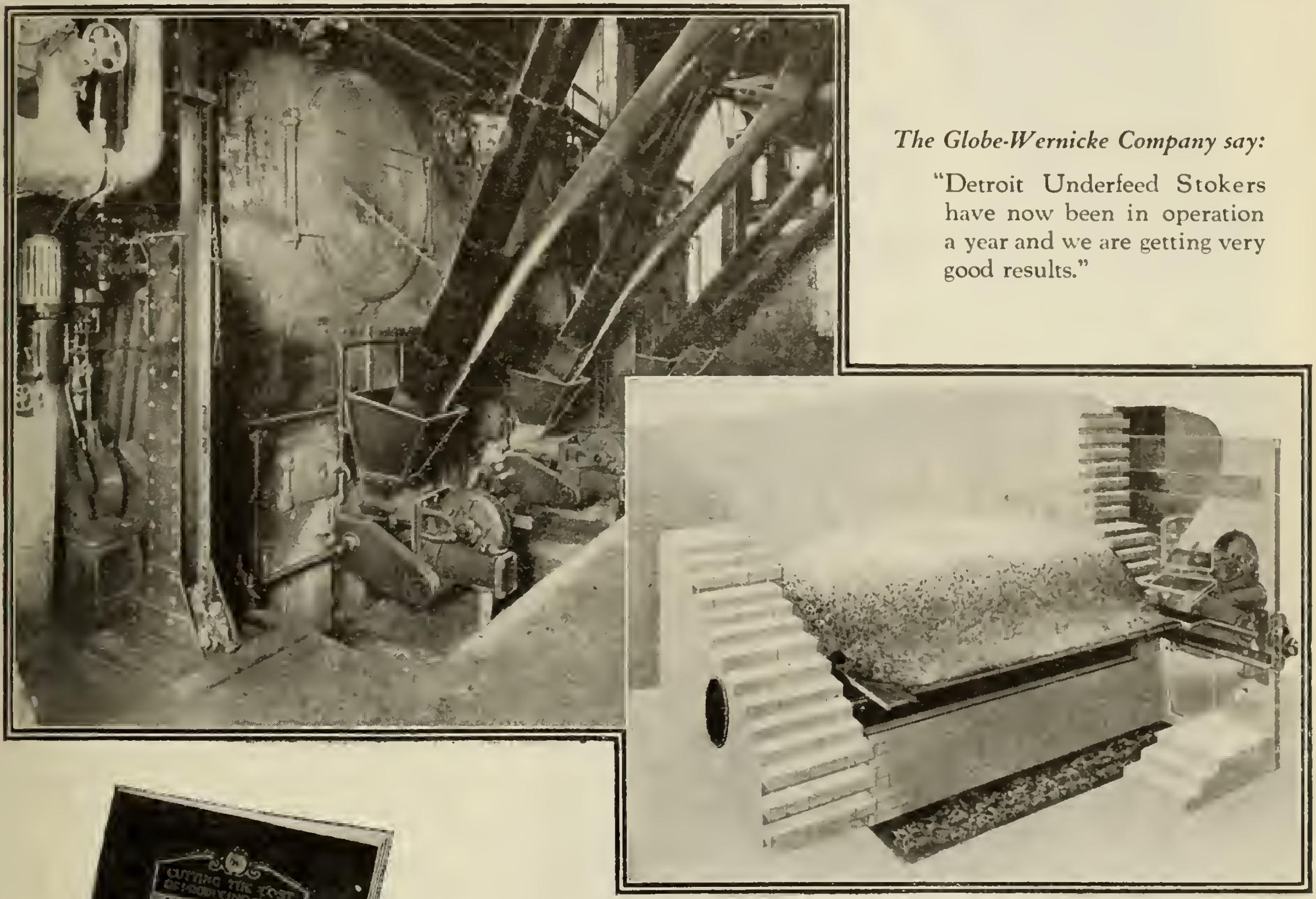
and sold on a service basis by

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

Sales Offices in all leading Canadian cities

DURABLA

Four Detroit Single Retort Underfeed Stokers are Saving Fuel and Labor for the Globe Wernicke Company.



The Globe-Wernicke Company say:

"Detroit Underfeed Stokers have now been in operation a year and we are getting very good results."

Cutting the Cost of Producing Steam
Detroit Stoker Company Detroit Michigan U.S.A.

One of the most interesting bulletins ever put out in the power plant field, "Cutting the Cost of Producing Steam"—is yours for the asking. Request Bulletin 238.

Users of Detroit Single Retort Underfeed Stokers have found in actual practice that installation of these stokers results in the following economies:

1. *Fuel Saving:* Saves eight to twelve per cent of coal — a result due to more nearly complete combustion. Hand-fired plants average fifty to fifty-five per cent overall boiler efficiency, whereas Detroit Stoker-fired boilers average seventy to seventy-five per cent and over.

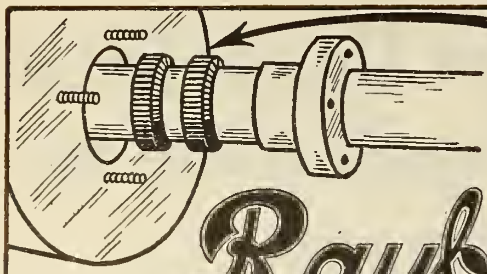
2. *Labor Saving:* Saves approximately fifty per cent of boiler room labor, depending upon plant conditions.

3. *Cheaper Coal:* Burns lower grades of fuel than is possible with hand-firing. Savings thus effected may be of such magnitude as to pay for the cost of the stokers each year.

4. *Increases Boiler Capacity:* Detroit Stoker-fired boilers may be continuously driven to much higher ratings than hand-fired boilers.

DETROIT STOKER COMPANY
Underfeed Forced and Overfeed Natural Draft Stokers
238 GENERAL MOTORS BLDG. DETROIT, MICH.

DETROIT UNDERFEED STOKERS



Secure the utmost in service and reduce your packing cost —by using

Raybestos

PACKINGS

Made at Peterborough, Ontario, by

THE CANADIAN RAYBESTOS CO., LIMITED

The ENGINEER Wants

RAYBESTOS PACKINGS

because he knows they are heat-proof and acid-resisting.

Ring Packing Style 325.

Spiral Packing Style 425.

The Safe and Certain Boiler Cleanser

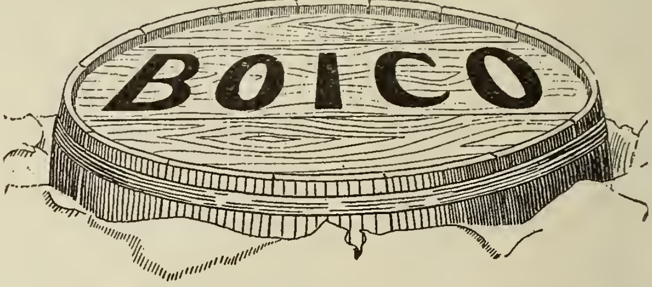
PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

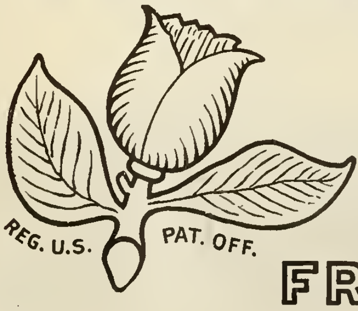
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., **Toronto**

Sales Agents: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

MAGNOLIA


REG. U.S. PAT. OFF.

Magnolia Metal has been a widely used favorite for over a third of a century. Government tests prove it to be superior in bearing qualities to any other bearing metal, and its users know that it is uniform in composition, dependable in service, pours, melts, peens and scrapes in easily. For minimum bearing maintenance expense it will pay you to standardize on Magnolia Metal.

21

MAGNOLIA METAL COMPANY, 113 BANK STREET, NEW YORK
CHICAGO SAN FRANCISCO MONTREAL

ANTI-FRICTION METAL

MacLean Stokers

The MacLean Underfeed Stoker has been developed to give high economy in firing steam boilers under ordinary every-day operating conditions. It is simple in construction and easy to operate.

A constant uniform steam pressure is carried regardless of varying loads on the boilers.

Coal consumption is reduced.

Responds automatically to sudden demands for steam.

No siftings of unburned coal to the ash pit because there are no grates.

The steaming capacity of the boilers is increased.

Cleaner tubes and heating surfaces.

Small cost of upkeep.

A smokeless chimney is maintained with low grades of soft coal.

THE COAL IT SAVES
SOON PAYS ITS COST

MacLean Underfeed Stoker Co. Limited
95-97 King Street East, Toronto

Low Cost Pumping By De Laval Electric Driven Pumps

THE CITY of Barrie, Ont., has installed three De Laval Pumping units, two of which are shown herewith. The 4-in. two-stage series pump in the foreground delivers 600 gal. per minute against 230 ft. head when running at 1,750 r.p.m., while the single-stage pump near the wall has a capacity of 1,200 gal. per min. against 200 ft. head, at the same speed. A third pump, driven by a gasoline engine, serves as a standby or spare.

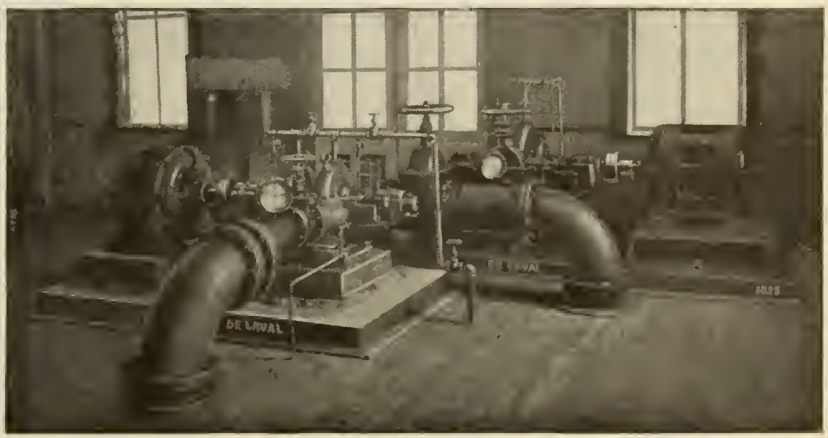
When using purchased electric power, each one per cent. gain in pumping efficiency is important. De Laval pumps not only develop exceptionally high efficiencies on test but also maintain such efficiencies for years. The labyrinth wearing rings reduce leakage, as compared with plain flat rings, and also last longer. The power taken by a De Laval pump reaches a maximum at the rated delivery, and it is not necessary to install an oversized motor in order to provide against emergency overloads, which favors higher average motor efficiency and also higher power factor with induction motors. Due to their low starting torque, De Laval centrifugal pumps can also be driven by self-starting synchronous motors. De Laval centrifugal pumps, driven by geared steam turbines, electric motors, internal combustion engines or water wheels, deliver water at the lowest total cost. Ask for Book W-100, "Ten Years' Progress in Water Works Pumps."

DE LAVAL STEAM TURBINE COMPANY

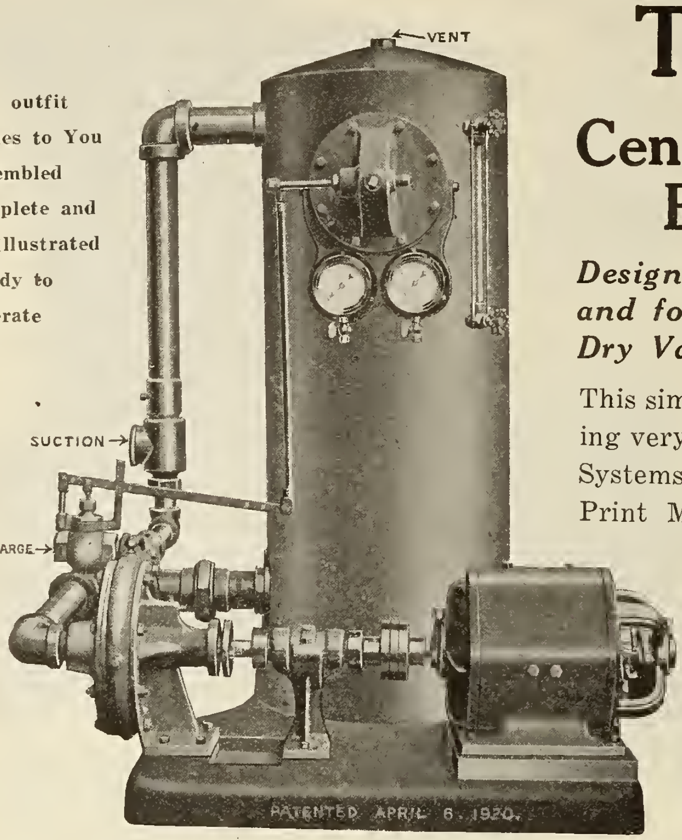
TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

251



The outfit
comes to You
assembled
complete and
as illustrated
Ready to
Operate



The YOUNG

Centrifugal Vacuum and Boiler Feed Outfit

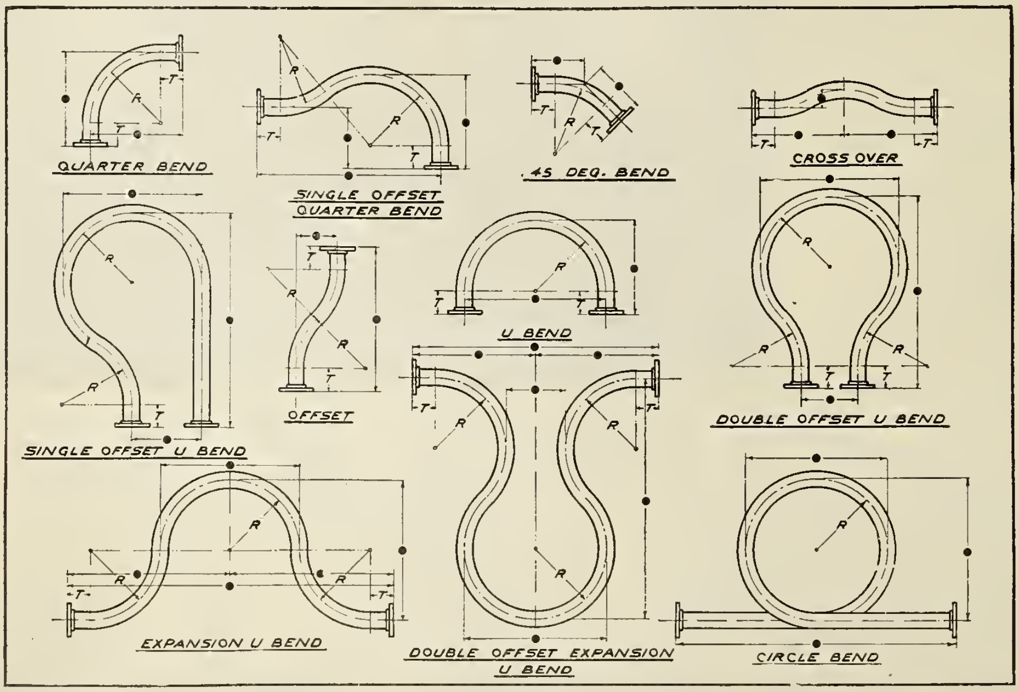
Designed for Vacuum Heating Systems and for All Conditions Where a Wet or Dry Vacuum is Desired—Highly Efficient

This simple, inexpensive and noiseless outfit is giving very satisfactory results with Vacuum Heating Systems, Dry Kilns, Paper Driers, Feed Driers, Print Mills, Cooking Apparatus, Vacuum Pans, etc., for the purpose of effecting a saving by returning the condensate for boiler feed.

Manufactured in Canada by

Young Pump Co. of Canada
96 Mary Street
HAMILTON, ONT.

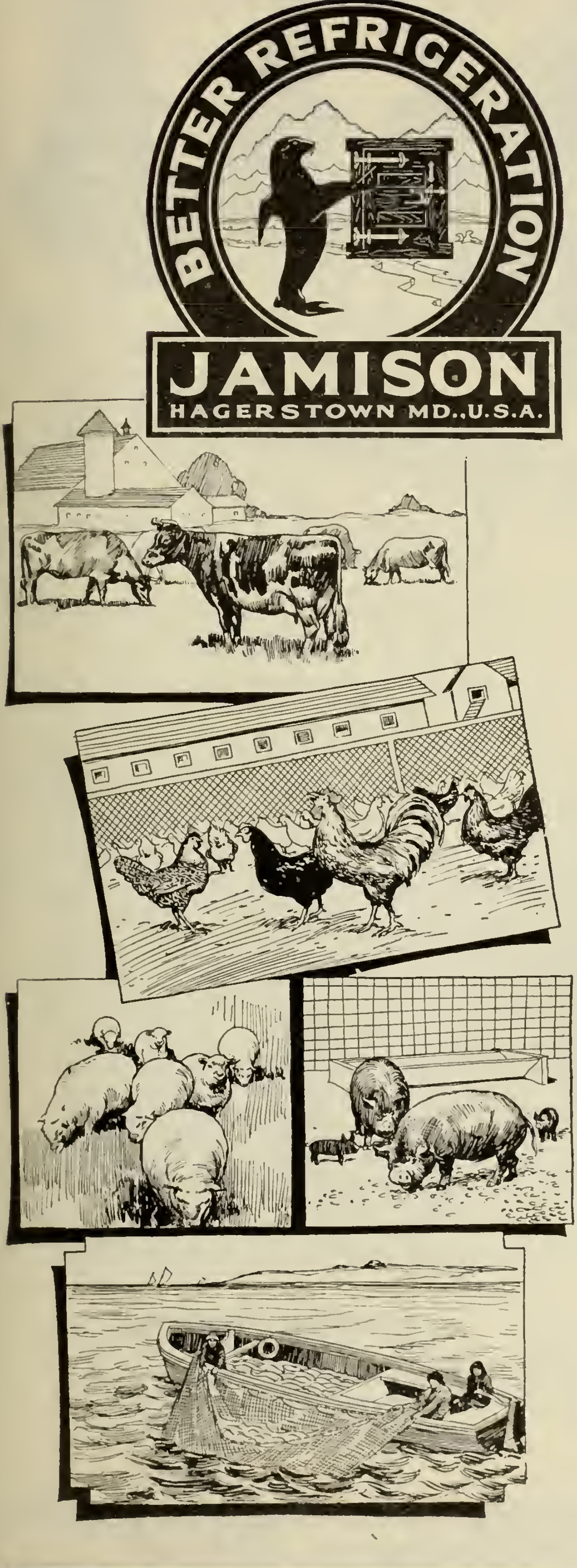
WROUGHT PIPE BENDS



ALL
KINDS
AND
SIZES
UP TO
10"
DIAMETER

MADE
IN
CANADA
BY

PAGE-HERSEY TUBES, LIMITED
100 Church Street, TORONTO, ONT.



What's Behind the Door?

CONSIDER—the science of refrigeration as a universal provider and power for good in the life of the nation. Cold Storage furnishes almost the entire food supply of our modern cities.

Cold storage holdings each month run into millions of pounds of beef, pork, poultry, fish, butter, cheese, eggs, fruit, berries, milk, ice cream, etc.,—all handled and distributed with efficiency and dispatch.

And there—everywhere—stands the **cold storage door,** a guardian of purity and wholesomeness; a silent sentinel barring the ingress of heat and contamination, aiding in the conservation of refrigerating energy and effectiveness.

Remember—"Your plant is only as good as your **door,"** hence it happens that most good plants are equipped with Jamison Doors. There is a Jamison Door for every need, each bearing the mark of merit as shown above, known as "The Seal of Satisfaction."

Architects and Engineers

Jamison Coolers and Freezer Doors, Cold Storage Windows and Automatic Ice Chutes, built in standard sizes and to specifications, meet every requirement of the most exacting demands.

Seventeen years of accomplishment in the perfection of cold storage doors are pictured and described in "Jamison Booklet No. 10." Write for it.

JAMISON
Cold Storage Door Co.
Hagerstown, Maryland, U.S.A.

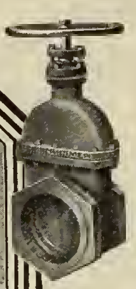


Fig. 647.
Iron Body Bronze Mounted Inside Screw. Screw Ends.

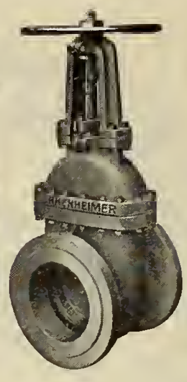


Fig. 892.
Iron Body Bronze Mounted. Outside Screw and Yoke. Flange Ends.

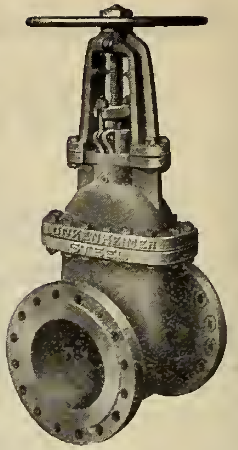


Fig. 1353.
Steel, Monel Mounted. Outside Screw and Yoke. Flange Ends.

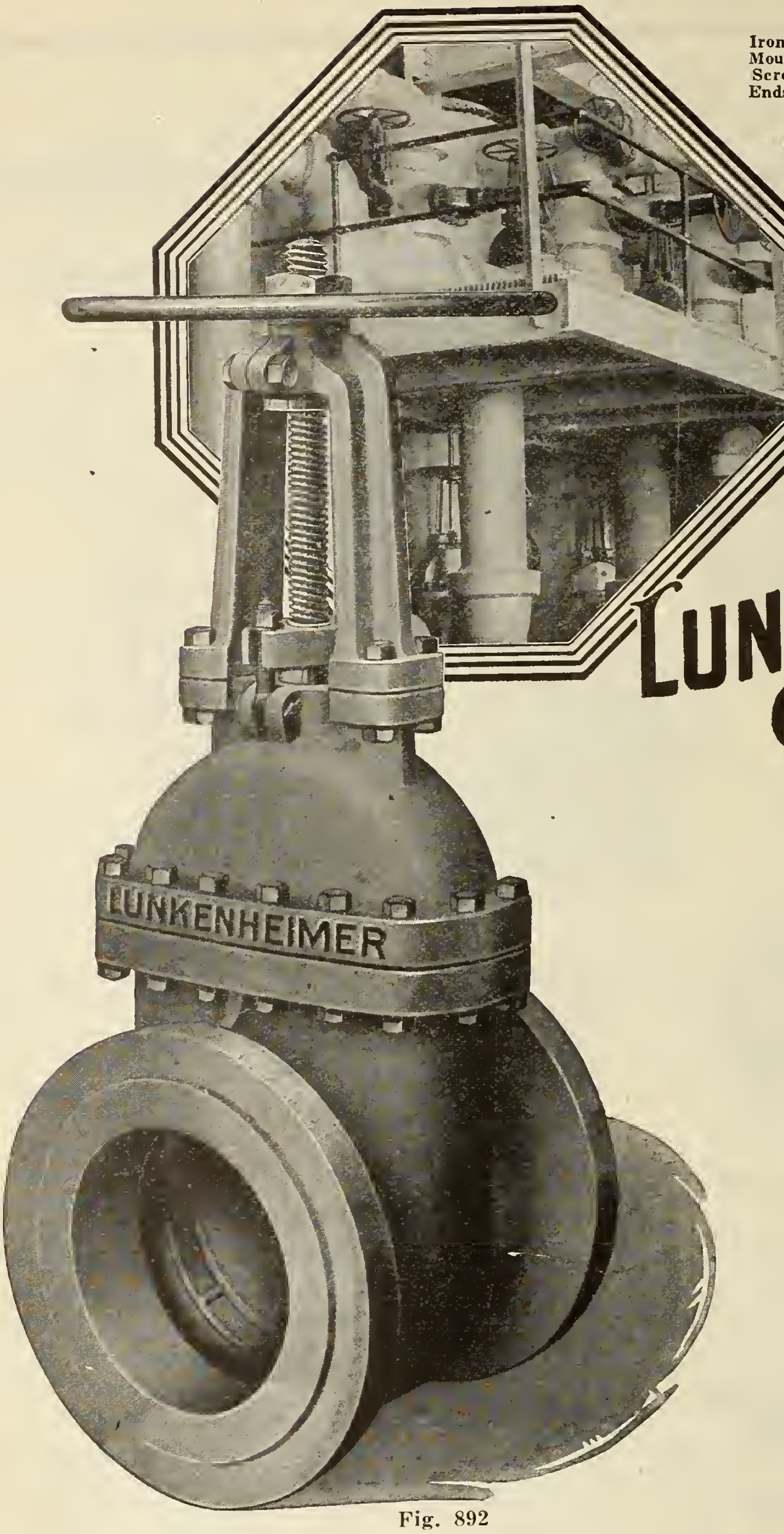


Fig. 892

LUNKENHEIMER
Gate Valves

embody the two essential factors most important in the engineering field—service and economy. Correct design, materials specifically adapted for valve service, unexcelled workmanship and renewability of all parts inclusive of the seat rings, insure the maintenance of these two factors.

The disc is perfectly guided by machined ribs within the body, eliminating dragging of the disc upon the seats; the renewable seat rings are solidly backed and are not dependent upon a frail face flange to withstand the wedging action of the disc; the stuffing box is repackable under pressure when the valves are full open and the stem operates in bronze bushings throughout, eliminating corrosion and insuring ease of operation.

Lunkenheimer Gate Valves are furnished in Bronze, Iron Body Bronze Mounted and Steel Monel Mounted Patterns. They are procurable in either Inside Screw, Stationary Stem or Outside Screw and Yoke Rising Stem Patterns.

Catalog 58-DC illustrating and describing the complete line of Lunkenheimer Products, will be sent upon request.

Solid wedge disc double seated

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO **CINCINNATI, U.S.A.** BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

600-29-43

"America's Best since 1862"

Pressure Fluctuations

cause loss in economy

Protect yourself against such unnecessary loss, by means of the continuous day and night records obtained with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

Recording Pressure Gauges

They are a direct check as to how the men are holding the specified pressures, by showing every rise and fall in pressure.

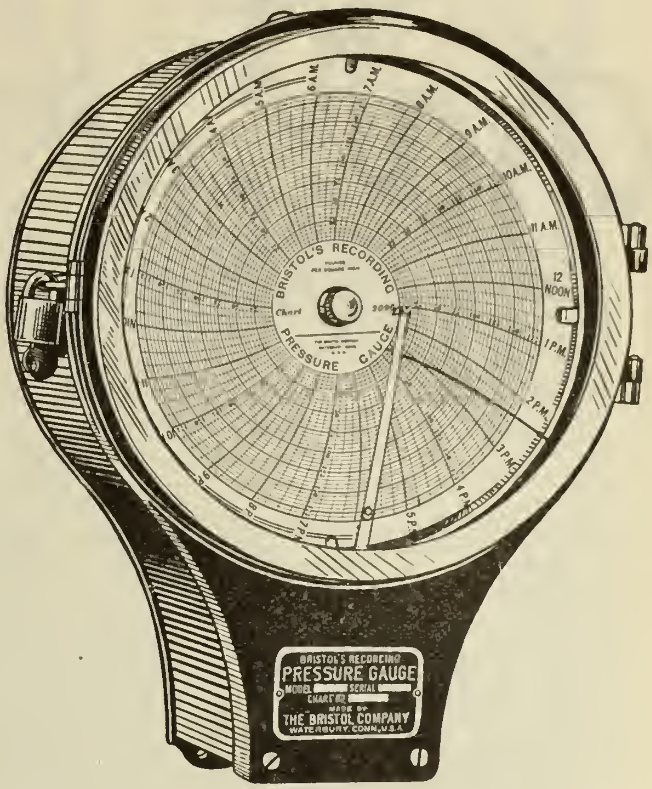
Our line of recorders is very comprehensive—they will furnish accurate, continuous records of the changes in pressure, temperature, current, voltage, kilowatts, water level, production, motion, etc.—and the time, day or night, when the changes took place. Bristol's Recording Instruments are the standard throughout the world.

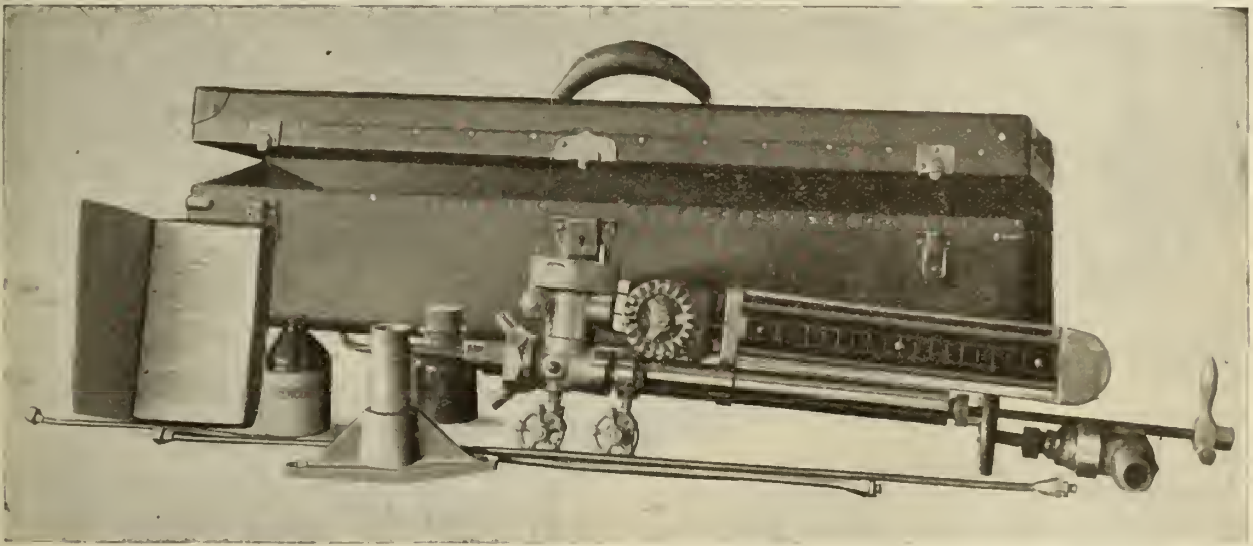
Write for copy of Catalogue 1006-A

The Bristol Company, Waterbury, Conn.

Branch Offices:

Boston New York Philadelphia Pittsburgh Detroit
Chicago St. Louis San Francisco


BRISTOL'S RECORDING PRESSURE GAUGE
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
12 NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
BRISTOL'S RECORDING
PRESSURE GAUGE
MODEL
SERIAL
CHART NO.
MADE BY
THE BRISTOL COMPANY
WATERBURY, CONN., U.S.A.



Cory-Royer Flow Indicator
Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

CHAS. CORY & SON INC.

183-7 VARICK STREET - - NEW YORK CITY

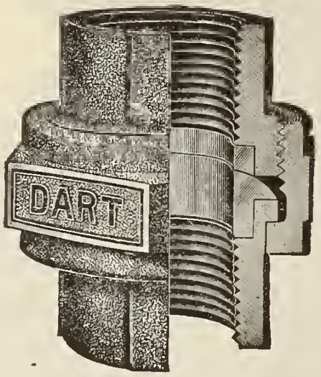
VANCOUVER
P. A. Goepel,
525 Pender St. W.

Est. CORY 1845

TORONTO
The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers

Dart unions

Bronze to Bronze



STAY TIGHT Permanently

Both Face and Seat being Bronze makes deterioration and loosening up at the joint **impossible.** Then, too, there is added security in the heavy iron parts—they will not stretch or pull apart. **Use again and again**—they're always efficient.

Your jobber sells them.

Manufactured by

Dart Union Co., Limited, Toronto

WILLIAMS' Improved "Vulcan" Drop-Forged Chain Pipe Wrench

FEW tools are called upon to stand greater strain and harder wear than the pipe wrench. Because Williams' "Vulcan" Chain Pipe Wrenches have withstood every test during years of hard, continuous service under all conditions, they have earned a well-deserved reputation for dependability and are favorably known the world over. They embody every good feature that Williams' Superior Quality stands for.

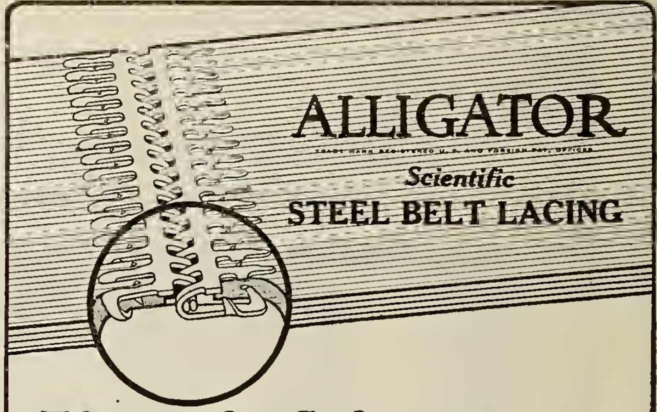
8 Sizes for ⅛ to 18 inch pipe.

Literature on request

J. H. WILLIAMS & CO., Limited

"The Wrench People"

78 Thorold Road St. Catharines, Ontario



There is Science In Belt Lacing

ALLIGATOR teeth penetrate lengthwise of the belt, leaving the long burden-bearing fibers intact. Each tooth clinches down over its group of fibers, compressing them so firmly that there is no internal friction and wear at the belt end.

The sectional steel rocker hinge pin is the only metal pin that avoids wear to the joint.

Keep these vital features in mind when you buy belt lacing, for the cost of any lacing is nothing as compared to the cost of the belt on which it serves.

Sold at Wholesale and Retail the World Over

Flexible Steel Lacing Company

4667 Lexington Street, Chicago

In England at 135 Finsbury Pavement, London, E.C.2

Just a Hammer to Apply It
"Never Lets Go"

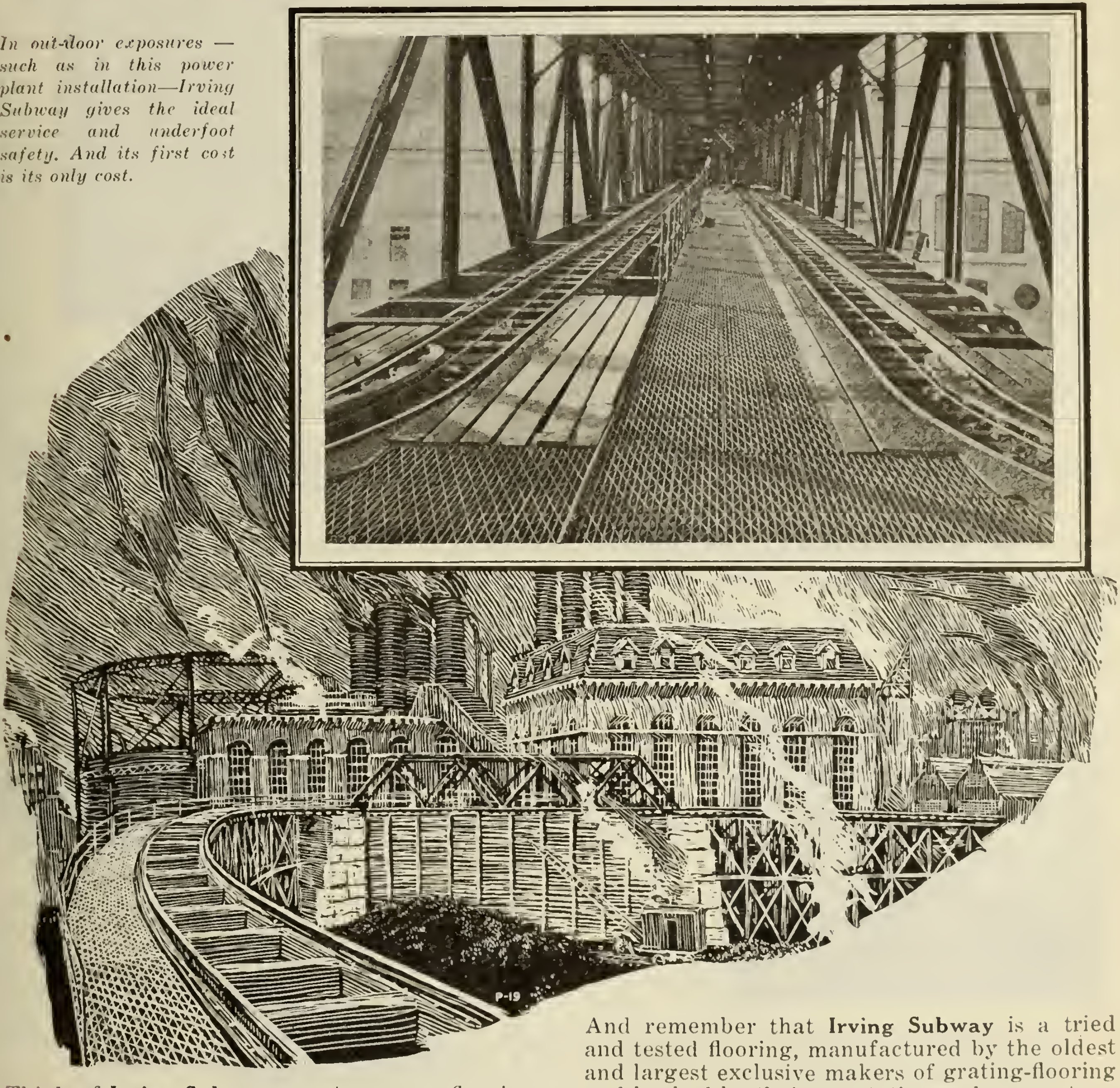
TRADE MARK

IRVING SUBWAY

(PATENTED) REG. U.S. PAT. OFF.

THE FIREPROOF VENTILATING FLOORING

In out-door exposures — such as in this power plant installation—Irving Subway gives the ideal service and underfoot safety. And its first cost is its only cost.



Think of **Irving Subway** as a true open flooring—smooth and easy and comfortable to walk or work or wheel upon—with a permanently non-slipping surface that time or wear cannot impair. Think of it as a permanent investment in service and safety and foot comfort, with a material improvement in plant efficiency.

And remember that **Irving Subway** is a tried and tested flooring, manufactured by the oldest and largest exclusive makers of grating-flooring and backed by their reputation and guarantees. An unequalled experience of 12 years in this specialty qualifies Irving engineers to render an invaluable service on all problems involving industrial flooring and underfoot efficiency. Write for Catalog 3A50. Estimates given without obligation from blueprint layouts.

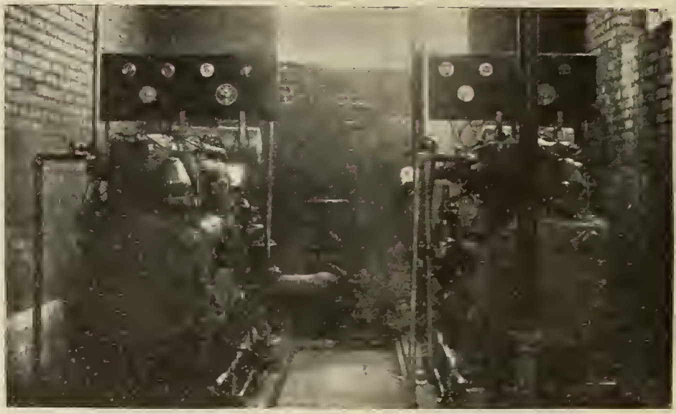
IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

MONTREAL, P.Q.—64 Decelles St. (St. Laurent).
WINNIPEG, MAN.—141 Bannatyne Ave.
WELLAND, ONT.—Standard Steel Cons. Co.

Do these Conditions APPLY TO YOU?

1. Are you paying the primary power rate?
2. Are you paying for power based on maximum demand?
3. Why not use a STERLING and purchase the secondary rate? Use the STERLING for peak load and for dependable standby. Pays for itself in about two years.

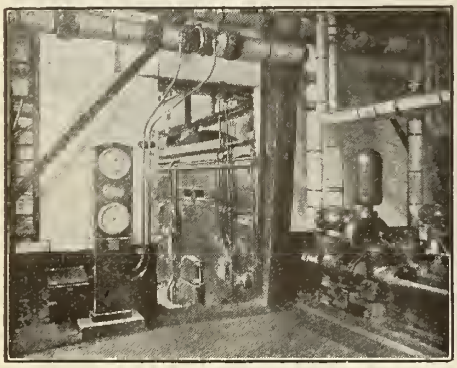
Catalogue on Request.



Reserve pumps, two Lecourtenay centrifugals, driven by two STERLING engines for reserve at Neodesha, Kansas; Black & Veatch, Kansas City, Consulting Engineers.

STERLING ENGINE CO., ***(Dept. C-4)*** **BUFFALO, N.Y.**

What Is Going On In Your Boiler Plant?



With fuel both scarce and costly, this is the question many an owner is asking his Chief Engineer. It is an important business which is carried on in the boiler plant and must be given serious attention. Accurate information of the evaporation of water for the amount of fuel burned each day is essential.

The VENTURI Meter

"VENTURI" Registered.

is furnishing this information in thousands of boiler plants. Over twenty years of service has proved the Venturi to be supreme for boiler feed measurement. It has long since been accepted as the Standard Meter for the boiler room.

Bulletins 93 and 197 give details.

Builders Iron Foundry, Providence, R.I.

Canadian Representatives :

GENERAL SUPPLY CO. OF CANADA, LTD.,
Ottawa, Montreal, Winnipeg, Vancouver.

ALLEN GENERAL SUPPLIES, LIMITED,
Toronto, Ontario.

DRIVING HOME A BETTER WAY TO LINE FURNACES

Everywhere the mallet blows are driving home Plibrico and the idea behind it; better furnace linings that last longer and are easier to install and repair. The new booklet, "Modern Furnace Building," will start you on the road to better furnaces. Say where.

PLIBRICO
JOINTLESS
FURNACE LINING

—is delivered only in steel containers of distinctive appearance as shown below. Warehouse stocks in principal cities.

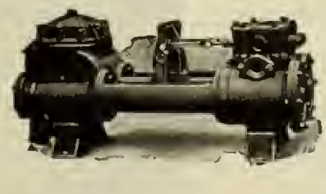
DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's Ltd., Calgary, Alta.

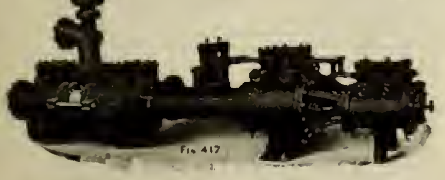
JOINTLESS FIRE BRICK CO.
1142 Clay St.,
Chicago.

The
John H. McGowan Co.
Cincinnati, Ohio, U. S. A.

Builders of Pumping Machinery

Our 70 years' experience in designing and manufacturing pumping machinery places us in a position to analyze any situation and make recommendations as to the type best suited for same.





Simple Duplex Steam Power for all conditions of Service.

SIL-O-CEL
PREVENTS HEAT PENETRATION
TRADE MARK REGISTERED U.S. PATENT OFFICE

HEAT INSULATION
BLUEPRINTS

A SPECIAL set of specifications and blueprints prepared for engineers, superintendents and plant executives interested in lower production costs.

This blueprint series forms an impartial record of the advantages of insulated equipment. It shows how you can save money, secure increased capacity from your present facilities and get the most from your fuel.

It includes construction prints of almost every type of installation,—there are tables covering heat losses for insulated and non-insulated walls,—there is specific data showing exactly what fuel savings are secured with SIL-O-CEL Insulation.

Sent Free

This complete set will be sent upon request without cost or obligation. Mail the coupon or write nearest office for Blueprint Set W-16

CELITE PRODUCTS LTD.
New Birks Bldg.
MONTREAL, QUE.

CELITE PRODUCTS, LIMITED.
Gentlemen:

Without obligation to me, send Blueprint Set W-16 containing tables of fuel savings, thermal conductivity charts and typical installation plans.

Name . . . .

Company . . . .

Address . . . .

85% Magnesia

"Featherweight"

MAGNESIA KEASBEY & MATTISON CO. FEATHER WEIGHT 85% AMBLER, PA. SECTIONAL COVERINGS

Retains its Coal-Saving Qualities

It Never Deteriorates

DON'T be misled! Many pipe coverings made in the past few years show up well under efficiency tests but in practice fail to stand up. Durable qualities are lacking. Cases are on record where such coverings have been shaken to pieces within a year.

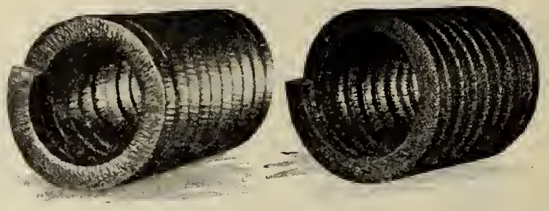
You need pipe and boiler covering that holds its heat-conserving qualities for years. That is the only kind that pays. You want K. & M. "Featherweight" 85% Magnesia Pipe and Boiler Covering.

The same heat-saving efficiency, the same saving of coal is registered, whether 85% Magnesia coverings have been on steam pipes for a week, a month, a year or a quarter of a century.

Let us explain more fully 85% Magnesia.

Keasbey & Mattison Company
25 Front St. East, TORONTO

A COMPLETE SERVICE IN
"John Crane"
FLEXIBLE METALLIC PACKING



AMMONIA PACKING

The combination of styles 100 (left) and 400 (right) shown above to make style 104 special shown below, is the ideal packing for ammonia compressors of speeds up to 400 ft. per minute. It produces a perfect non-abrasive metallic face with wipers that prevent the ammonia film on the rod from reaching the air.

Investigate

With two coils on hand the engineer can cut rings as needed—a genuine economy. Life of a set is often five years or more. Sets also made up to order. Tell us box measurements. Ask for our text book "Metallic Packing" to get the right angle on the value of "John Crane" Packings.

"MADE IN CANADA"

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN. 334 Cordova Street, Vancouver, B. C.

How Much Coal Are You Wasting?

Blindfolding yourself to the fact that your boiler room is different, because you can see no pipe line leaks, or the water alarms don't blow very often—doesn't help to pay for the needless fuel waste caused by the invisible losses within the boiler furnaces.

Get at the REAL FACTS and at the same time give your men a positive and simple guide that will enable them to keep the plant at top notch efficiency—by installing the

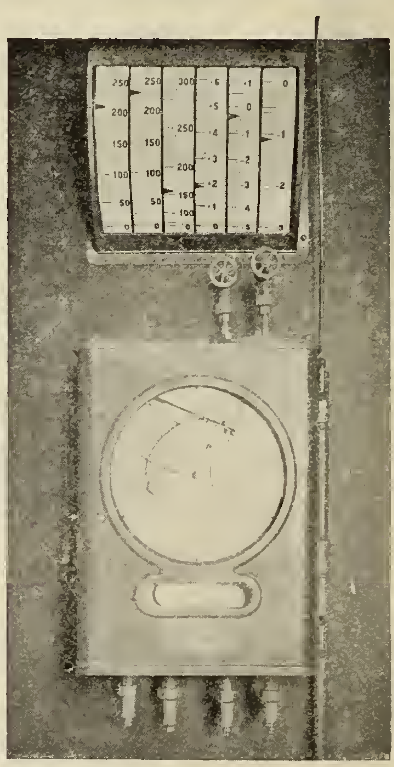
BAILEY BOILER PANEL

The Bailey Boiler Panel is a combination of the Bailey Multi-Pointer Gage and Bailey Boiler Meter.

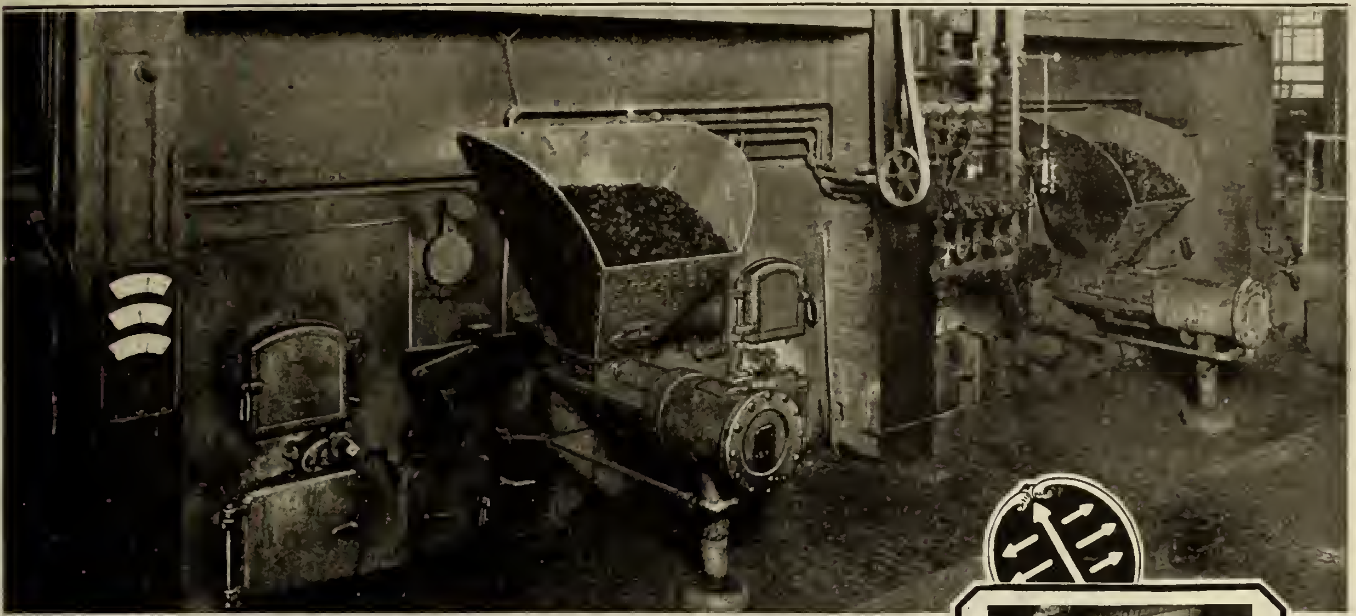
It shows, almost immediately, the effect of improper furnace adjustment and enables the men to make the necessary correction before a large amount of preventable fuel waste has taken place. Good work on the part of the men is shown up by the charts as well as any inattention. The engineer can check the efficiency of his men as well as that of the individual boiler.

Let us send you fully descriptive Bulletins.

BAILEY METER COMPANY Limited
177 DELORIMIER AVE. - MONTREAL, QUE.



The only multiple retort side cleaning stoker



BEFORE the development of the *"Lateral Retort"* Stoker there was no stoker that combined the ease of installation of the side cleaning stoker with the high efficiency and overload capacity of the multiple retort type. Plants that did not consider the expense of the multiple retort type justifiable were forced to install inferior stokers.

Now the *"Lateral Retort"* has changed all this; now any plant can have multiple retort stoking!

This simple, single retort stoker rivals the efficiency and capacity of the multiple retort type; the illustration opposite and the description below it show how the high duty service of the multiple retort is obtained.

And yet the *"Lateral Retort"* can be installed at a fraction of the cost of a multiple retort. There is no need for basement ash pits; trenches 6 to 18 inches below the floor line are sufficient excavation. This makes the *"Lateral Retort"* easily adaptable to boilers already in service and does away with the maintenance costs of complicated ash discharging and dumping systems.

The new 8½x11 standard filing size bulletin describes this revolutionary stoker in detail—and shows illustrations of successfully operating plants in the United States and Canada. Your copy is ready—ask for it.

The Under-Feed Stoker Co. of Canada, Ltd., 146 King St. W., Toronto

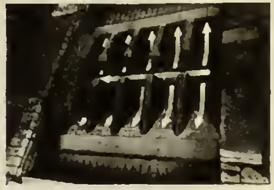
Jones Underfeed Stokers — Riley Underfeed Stokers — Murphy Automatic Furnaces

Alta. and West Sask.:
Mr. J. Twomey
Camrose, Alberta

Man. and East Sask.:
W. W. Hicks & Co.
Winnipeg

British Columbia.
E. A. Earle, Limited
Vancouver, B. C.

Quebec:
The Cleaton Co. (Canada), Ltd.
Montreal, Que.



How it works—

IN the **"Lateral Retort"** the coal follows the path of the arrows in the view above. It is underfed to the main retort—along the path of the large arrow—by a simple steam driven ram. An independently controlled moving unit underfeeds the fuel into the **"lateral retorts"** that branch off at right angles from the main retort. The ash is finally deposited on perfectly balanced dump plates easily operated by hand. The ash is dumped into shallow ash pits 6 to 18 inches below the floor line.

High air cooled front and rear tuyere blocks keep fire and clinker away from the front wall and bridge wall, practically eliminating clinkering and reducing furnace maintenance. Plate tuyeres that form the sides of the retorts reduce sifting and lower replacement costs.

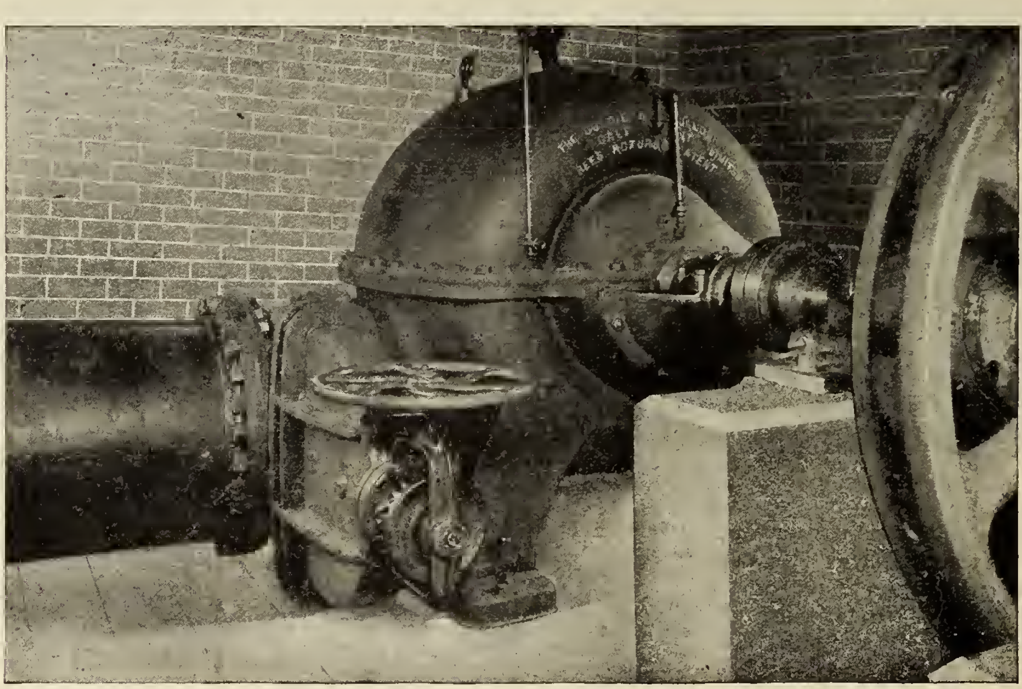
The "Lateral Retort"
TRADE MARK

Trade Mark

RILEY
JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

GOLDIE & McCULLOCH
Dependable Power Plant Equipment

Rees RoTURBo Pumps



Showing a large REES ROTURBO pump installed by the Goldie & McCulloch Co., Galt, for the municipality of Kent, Agassiz, B.C., with a capacity of 20,000,000 gallons per 24 hours.

Embody the Latest Developments in Pumping Equipment

Rees Roturbo Pumps are giving excellent satisfaction all over Canada. They are self regulating, thus assuring a high and constant efficiency over a wide range of duties.

A Really Serviceable and Efficient Pump.
Ask for Catalogue and Further Information.

THE GOLDIE & McCULLOCH CO.,
LIMITED.
Head Office and Works : GALT, ONTARIO, CANADA
Toronto Office: Suite 1101-2 Bank of Hamilton Bldg. **Western Branch:** 248 McDermott Ave., Winnipeg, Man. **British Columbia Agents:** Robert Hamilton & Co., Vancouver, B.C. **Quebec Agents:** Ross & Greig, 400 St. James St., Montreal, Que.

POWER HOUSE

Members of the
Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Plant and Equipment of Trail Smelting Works

Method of Separating the Metal From Impurities by Electro Chemical Process—Pumps, Machinery and Electrical Equipment That Constitute the Makeup of This System

By Geo. R. ARCHDEACON, A.M.I.E.E.

AMIDST the snow-capped mountains of British Columbia, on the Columbia River, 45 miles from Nelson, B. C., is the thriving town of Trail with a population of nearly 4,000 people. Above the town, some 300 ft. is the plant of the Consolidated Mining & Smelting Co.

This Company, of which S. C. Blaylock is manager, is one of the most unique and completely equipped smelting plants in America, if not in the whole world. Certainly, there is no other smelter in existence which smelts and refines gold, silver, copper, zinc, and lead. The company have devoted separate buildings for each of the above mentioned metals, and each metal therefore is provided with a special set of buildings in which it passes through its course of treatment. This naturally involves a separate staff for each metal, and the staffs therefore, becoming highly specialized in the production of these metals.

The refining process is an electrolytic process, and naturally demands the employment of very large volumes of electrolytes, consequently the company have erected a special chemical plant in which the necessary electrolytes are manufactured. Furthermore, as these electrolytes, become contaminated with the impurities from the metals, provision had to be made for treating the used electrolytes, and freeing from all impurities accumulated in their course of refining the virgin metal.

Some idea may be gained of the immensity of this department, from the size of the building in which the contaminated electrolyte is treated. The building which is devoted to this purpose covers an area of two acres.

Other departments are on an equally large scale. On account of the total absence of any local machine shop or foundry, the company had to engage in this business as a sort of a "side line" to enable them to quickly effect any repairs to their extensive plant and equipment. The machine shop, foundry, and electrical repair shop, form a set of buildings considerably larger than most businesses entirely devoted to this class of work. The equipment includes, one 25 ft. lathe, with a 10-ft. face plate handling 7-ton castings; two Brown and Sharpe shapers, and one 36-ft lathe with 5-ft. face plate, boring mills, planers, profilers, radial drilling machines, electric and pneumatic portable drilling and riveting machines.

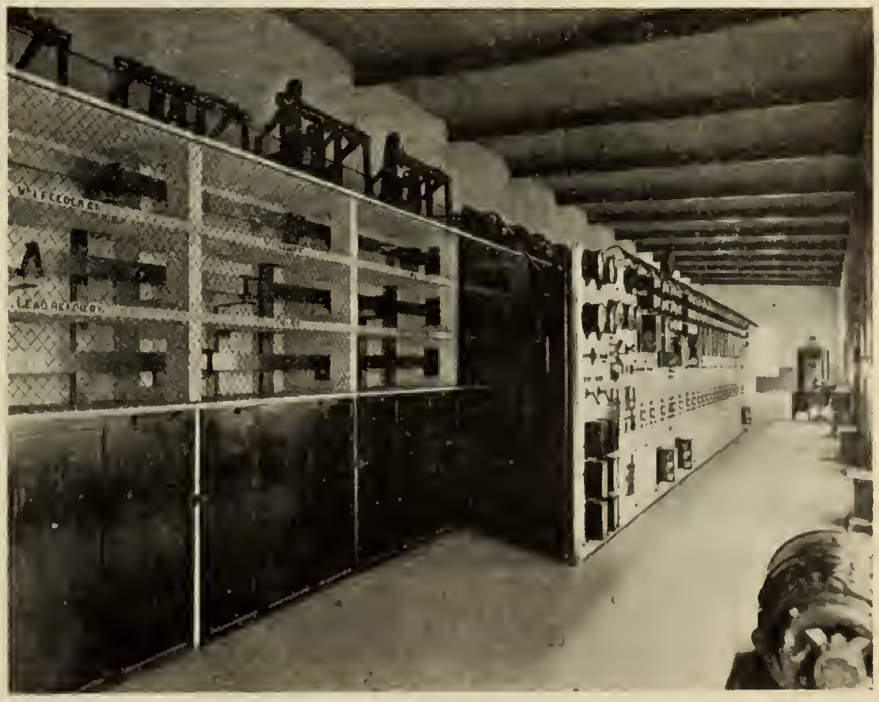
Although the company went to considerable expense to equip these repair shops, they now find that these repair shops not only provide them with a sure and quick source for repairs, but the prices charged to each department using these shops, although about 10 per cent. lower than could be obtained, are sufficient to show a very considerable dividend on the investment, after making the usual provision for depreciation, etc., and the various items of overhead usually associated with a machine shop.

The process of refining is strictly an electro-chemical one and is briefly as follows—

The impure metal is made the anode (positive pole) of an electrolytic bath, the electrolyte of which is a solution of the pure salt of the metal to be refined, whilst the cathode (negative pole) is a sheet of the refined metal.

On passing the current, metal dissolves, along with certain of the impurities. The impurities, which are electro-negative to the principal metal, dissolve; those electro-positive to the principal metal, remain adhering to the anode. When the latter finally drop off from the anode they may be dissolved by free acid; in which case they would be precipitated as an insoluble salt as soon as they dissolve, and are thus removed from the further action of the current.

When it goes into solution, the principal metal is therefore separated from those metals which are electro-negative



No. 1—Main switchboard, showing arrangement of bus-bars with their open panels.

with respect to it. When it is deposited on the cathode, it is separated from those metals which are electro-positive with respect to it. The bath thus becomes contaminated with certain impurities in the anode and these would eventually become deposited on the cathode if the bath is not purified from time to time.

In each department devoted to the refining of a special metal, the metal to be refined is fixed in a large tank, which resembles a storage battery. There are thousands of these large tanks to be observed, all connected up something like a storage battery, and receive a supply of direct current in a similar manner to the charging of a storage battery.

The amount of current required varies from 10 amperes per sq. ft. of cathode surface, to about 30 amps. per sq. ft., depending upon the metal being refined.

The voltage required per bath varies from about 0.30 to about 3.5 volts, depending again upon the metal being refined.

It will readily be seen, therefore, that a large amount of electrical energy must be consumed by a plant of such large proportions, but one is amazed at the figures given. The amount of electrical energy consumed for December, 1922, was 14,772,500 K. W. H.

To provide for such huge demand for power the following electrical plant is required.

Total of motors installed ...30,000 h.p.
Total cty. of motors installed 30,000 h.p.

This power is generated at Bonnington Falls about 33 miles from the smelter.

This power comes in to the smelter by two systems:—

(a) 3 phase 60,000 volts, 60 cycles.
(b) 3 phase 20,000 volts 60 cycles.

It is received by two banks of transformers arranged in set of 3 and each set is isolated in a separate room; the current leaves the transformers at 2,200 volts, and goes direct on to the main bus bars, then through the main switchboard and from there distributed to the various buildings. Illustration No. 1 shows the excellent arrangement of the bus bars with their open front panels, permitting full view and plenty of space in which to effect repairs if necessary.

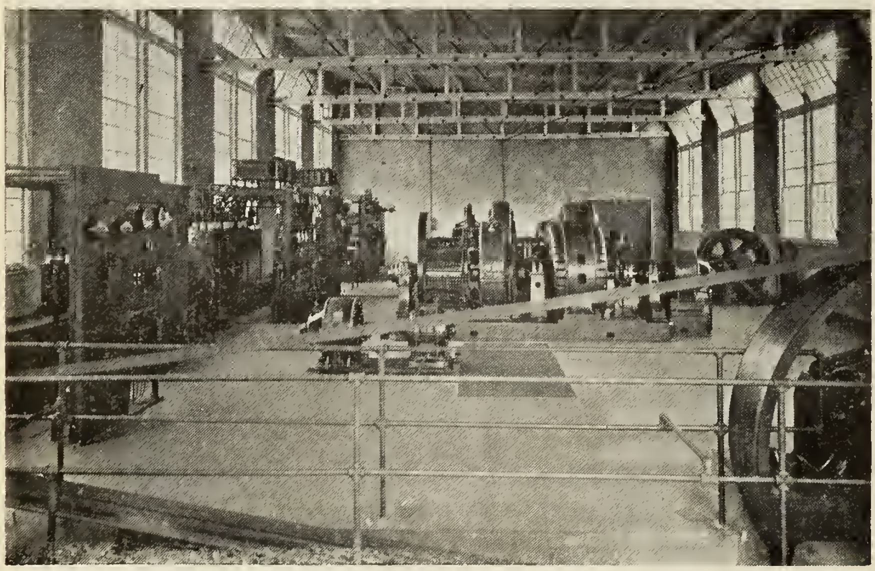
In the main sub-station of the plant, there are 13 motor generator sets, each one operated by a synchronous motor 1,475 h. p. at 2,200 volts, 60 cycles, 3 phase direct coupled to 2 d. c. generators 500 k. w., 50, 125 volts 4,000 amperers at 600 revs.: Six of these motor-generator sets were manufactured by the Canadian Westinghouse Co., and seven of them by the Canadian General Electric Co.

For operating the smelting furnaces many blowers are required and are located in a large blower room. In this room there are arranged: 1 400 h.p., 1 600 h. p., 2 300 h.p., 1 200 h.p., blowers, belt driven by electric motors, and 1 900 h.p. Ingersoll-Rand turbo blowers direct coupled to electric motor.

Several miles of narrow gauge railway track are laid in the yard, and are operated by small electric trolley cars. There are 25 electric trolleys in constant service to maintain the traffic on these lines and this in turn requires 2 300 h.p. motor generator sets for supplying the current to the trolleys.

It is most important that there should be no interruption of the tilting of the cupolas when the metal has arrived at the correct temperature. Should this movement be interrupted at the critical moment, about 70 tons of metal and ore would be ruined. To guard against such a calamity a storage battery has been installed. This consists of 125 cells of 19 plates per cell, contained in large glass jars, the capacity of which is 800 ampere-hours at the 8-hour rate of discharge.

This battery daily receives a "freshening" charge, and consequently is always in a condition to maintain its voltage during a complete discharge. It is so connected, that in the event of the electric power suddenly failing, an automatic switch puts the battery in circuit with the motors operating the tilting gear on the cupolas, and will tilt the cupolas as required, and so prevent any loss of metal.



No. 2—Corner of the Main Sub-Station.

Submerged Pumping Station

An interesting development in connection with the power supply to the smelter is a submerged pumping station. The plan was to pump the water from the Columbia river, and at such point above the town that the water should be quite pure and uncontaminated. This point was finally located about a mile up stream from the smelter as already mentioned. The smelter is about 300 ft. above the river, therefore the pumping of large volumes of water to this height necessitates considerable expenditure of power.

Another difficulty presented itself however, in the varying height of the river, since at this point in the river the rise and fall of the water level is about 50 ft., this being due to the change in seasons. With such differences of level, it was impossible to install an ordinary pumping plant, as the lift would be too high in one season, and the pumps would be flooded during the following season.

The company's engineers have overcome all these difficulties, and have constructed a pumping station of great strength and permanence, at a point low enough to draw up the water, whilst at its lowest stage, with a sloping tunnel entrance running from a point up the river bank high above the highest known water mark, the whole being covered over and made absolutely water-tight.

Through the bottom of the pumping house, three steel pipes, 10 inches inside diameter, lead outward and downward into a covered forebay from which the supply of water will be drawn The whole structure is of reinforced concrete, and is of massive and solid construction, this being necessary on account of the great pressure exerted by the water during its higher levels, which will entirely submerge the pumping station to a depth of about 35 feet.

The station is accessible at all time by the sloping tunnel, the entrance to which is high above the highest known water level. This tunnel also accommodates the 16-inch main delivery pipe from the pump to the smelter some 250 feet higher up the mountain side.

The details of construction are as follows:—

Building is reinforced concrete and water-tight 20 ft. by 30 ft., with an arched roof 14 ft. in height.The tunnel is about 90 ft. long and 7 ft. high by 9 ft. wide.

Pumping installation consists of three 10-inch centrifugal four-stage pumps made by Goldie & McCulloch, Galt, Ont. These pumps have a 10-inch suction and discharge pipe, the discharge of each pump converging into the 16-inch main. Each pump is directly connected to a 200 h.p. electric motor. In addition, there is a small 3-inch sump pump, for the pumping out of the building in case there is any seepage of water into the building.

This pumping plant is certainly unique. It is splendidly conceived, well constructed, and does credit to the engineers of the smelter who have the responsibility of developing this plant as their business increases.

The chief electrical engineer is A. H. Hopkins, A. I. E. E. and member of the Society of Professional Engineers of British Columbia. Mr. Hopkins is an Englishman, having been born in Gloucester. He served his articles with H. E. Neil, contracting engineer in London, Eng., and has specialized in the application of electricity to smelter plants. He has occupied positions in charge of the electrical equipment of the following concerns: B. C. Copper Co., Boundary Falls Smelter Co., and his present position with the Consolidated Smelting and Refining Co. which he has occupied for four years.

Mr. Hopkins has installed a system, which might with advantage be copied by engineers in charge of industrial plants where large numbers of electric motors are in operation. The method is simple, easy, and cheap to operate.

Each motor on the plant is given a card. Upon this card are the full details of the motor, also special details concerning the type of winding, such as wave or lap-wound, number of turns per slot, number of slots, etc. This prevents any delay in pulling it down to get this information, in the event of an armature coil being burned out, and a rush call being sent for spare coils, etc.

On the reverse side of the card are special rulings for date of inspection, condition, and name of inspector. By this method every motor on the plant has a complete record which can be turned up. This permits a detailed history of each motor being kept, and any incipient fault can be carefully watched, and the necessary repair effected before it reaches a final breakdown. It furthermore provides a true indication as to the wearing qualities or other merits of spare parts, renewals, etc., supplied by competitive companies.

In a place somewhat removed from the busy life of the large cities, it is an important work to see that the necessary labour is at all times available. This is still more imperative when considering the subject of skilled labour.

The smelter has therefore instituted a system of apprenticeship. A boy after leaving school may become an apprentice in the electrical shop receiving a merely nominal salary. There he receives instruction in the entire workings of a large electrical repair shop, covering such important subjects as armature winding, armature building, coil making, insulating, winding of transformers, erecting of heavy switch gear, general details of wiring for light and power, testing and fault localization.

Such a course is remarkably comprehensive, and is a most valuable experience, one that appears to be well appreciated locally. The apprentice must gradually pass through his grade, from apprentice, improver, 2nd class electrician, 1st class electrician. His progress and remuneration rest entirely upon himself, and depends how seriously he applies himself to the subjects above mentioned.

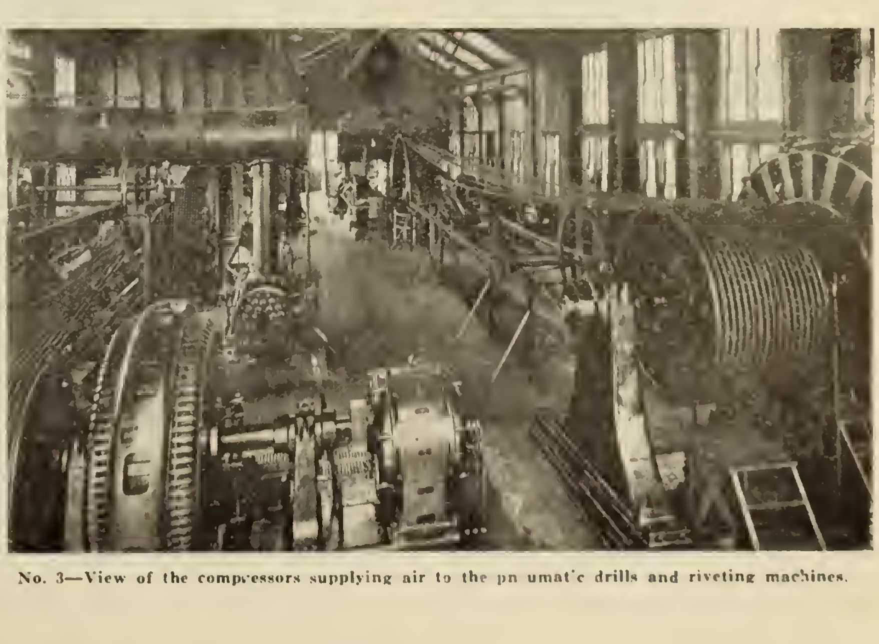
By this method the company have not to depend upon the transient worker who may be making his way from one city to another, as they have a ready source of good material to draw from and by making their work interesting, and providing real opportunities for progress, the sense of local patriotism is aroused, and the utmost loyalty is developed, resulting in advantages to the smelter that cannot be gauged in mere dollars and cents.

S. C. Blaylock, general manager, is a graduate of McGill University, Montreal, and is a chemist and metallurgist of distinction. Coupled with these scholarly accomplishments, he possesses that still rarer virtue of being able to inspire great zeal in all of his subordinates, ever keeping before them the achievement of some great accomplishment, and at the same time maintaining that co-operation amongst his 1200 employees that makes work pleasing and agreeable to them all, whilst he himself has gained the respect of all his workmen in a manner that is only to be expected.

Air Compressor

A new type of compressor unit which is comparatively small and compact for its capacity has recently been placed on the market. The cylinder and oil reservoir are integral with the base casting, which makes the appliance exceptionally rigid. The two cylinders extend horizontal through the length of the casting. The valves are located in the heads of the cylinders and are of ample size to prevent overheating. The valves are of steel, bearing against cast-iron seats, and have a 30 deg. angle. The pistons are of the double type, one located at either end of a connectiong section. The piston is operated by means of a hollow eccentric shaft that fits into a bronze bearing of large diameter. This arrangement eliminates the use of piston pins, crank bearings and connecting rods. Piston rings are provided at both ends to prevent the loss of compression. All bearings are made of bronze. The main shaft bearing is fitted to the side of the cylinder casting and the other end is supported by a small bearing within the cylinder. Forced-feed lubrication is used for all bearings, the small plunger pump drawing the oil from the reservoir in the base. The oil is delivered through the hollow main shaft and thence through small openings to the different bearings. The lubricating system is entirely automatic. These electric compressor units are made in various sizes, ranging in capacity from 1¼ cu. ft. to 3¾ cu. ft. of air per min., the last named rated at 250 lbs. pressure. The automatically controlled tank units are made in two sizes, one working at a pressure of 150 lbs. per sq. in. and the other at 175 lbs. per sq. in. These machines are made by the George Sacksinmaier Co., Philadelphia, Pa.

Listening in with Celoron.—This is the title of a new pamphlet being distributed by the Diamond State Fibre Co., of Canada, Toronto, in conjunction with their new standard radio panels, cut to size and individually wrapped in glassine. This pamphlet includes a complete list of broadcasting stations in Canada and the United States, together with symbols found in diagrams of hookups. One of the pamphlets is supplied with each panel. New window and counter display signs are also being supplied to dealers including an attractive sign emphasizing standardized Condensite Celoron panels, with clips to hold a sample glassine-wrapped panel.



No. 3—View of the compressors supplying air to the pneumatic drills and riveting machines.

Prospects for the Development of Shale Oil

In the Event of the Supply Being Exhausted the Method That Could be Adopted to Develop the Oil Bearing Shales on a Commercial Basis

In certain applications, oil has distinct advantages over coal as fuel. In the transportation field, for example, oil-burning engines of the Diesel type have proved exceedingly useful, and the familiar internal-combustion engine, burning the lighter distillates obtained from crude oil, is known to everybody. Many of the boilers used in marine service are designed for oil burning, because the use of oil saves space and labor, and it may also reduce the time that must be spent in port. Unfortunately, apparatus that is specially designed for using oil as fuel can seldom be operated advantageously with other fuels without extensive and expensive alterations. Once embarked on a fuel-oil basis, the owner of the apparatus must look to his oil supply for maintenance, and when many owners adopt the oil-burning policy, the supply problem becomes decidedly serious.

The oil-well situation in the United States must interest and concern all of us. The United States Bureau of Mines is authority for a statement to the effect that 40 per cent. of our well-oil has already been used, and that with the increasing demand our known underground reserves will be exhausted in something like ten years. But even though this diagnosis of the situation be correct, the United States need not fear an oil famine by 1932, because we shall still possess vast deposits of oil-burning shale, which can be made to yield many times more oil than has been taken from our wells up to the present time. It is plain, therefore, that the oil-shale industry is bound to be exceedingly important in the near future, and it behooves us to study the problems that it involves, so that we shall be ready to deal with them intelligently. The principal known deposits of oil-bearing shale occur in Colorado, Utah, Nevada, and Wyoming, although there are deposits in other states also, and some of these may be more extensive than we now realize. A limited amount of it is so located that a considerable investment of money would be necessary for its development. The needed money will doubtless be available, however, as soon as the commercial practicability of winning the oil from our shale has been demonstrated. The shale-oil industry is already thriving in certain other parts of the world, and notably in Scotland; but our own problems are somewhat different from those encountered elsewhere, and they call for correspondingly individual study.

Experience and test have shown that there is a wide variation in the oil content of the shale, the range in commercially workable deposits being from 25 to 100 gallons of oil per ton. In addition there are useful by-products, the most important usually being ammonium sulphate. Certain other materials available as fertilizers are obtained, and there is a considerable yield of permanent (or non-condensible) gases, which are combustible, and which can be used, locally, as fuel. Variation in the processes that are employed for winning the oil will materially alter the proportions of the products that are obtained, and it is therefore necessary not only to have a definite knowledge of the composition of the shale that is to be treated, but also to study the exact details of the process that is used, in order to insure a maximum yield of marketable output.

The oil is driven off from the shale by means of heat, and the first process in the industry consists in mining the shale and preparing it for the retorts in which the heating is to be done. Some deposits can be worked with advantage by steam-shovel or open-quarry methods, but in most cases it will be necessary to conduct operations similar to those involved in coal mining. Longwall and room-and-pillar mining methods can both be used in working shale deposits, just as in working coal deposits; and in shale mining we may expect to encounter many of the hazards associated with the coal industry, including falls of roof, fires, and explosions of gas and perhaps of dust.

On account of the softness or plasticity of the shale, considerable difficulty has been experienced in breaking it up into sizes suitable to be fed into the retorts. It does not fracture readily, and the ordinary crusher will not handle it satisfactorily; but it has been found that panmills with rotating hammers can be made to do the work quite well.

We cannot here discuss the design of the operating retorts, nor explain why the Scotch methods are not suited in all respects to the treatment of American shales; but we may note that it is essential to design the entire apparatus so that the raw shale can be fed into it continuously, and so that the spent or exhausted shale can be withdrawn continuously. It is also necessary to provide an effective means for keeping the shale in motion in the retorts, so that it cannot fuse together and so that all parts of it will be subjected to the same temperature-treatment. The reduced (or extracted) oil-vapor should be led away and condensed as quickly as possible, because continued exposure to a high temperature tends to fix the gases permanently, and thereby reduces the marketable output.

Most shales begin to give off oil-vapor at 150 degrees Fahr., and the temperature to which the shale is exposed may be gradually increased up to 700 degrees Fahr., at which point practically all the oil has been removed. Most of it will vaporize at a temperature under 300 degrees or 310 degrees Fahr., and that which is given off below this point must be removed and condensed, to avoid permanent gasification as already noted; but it may be important to raise the temperature of the partially exhausted shale still further, in order to obtain all the combustible elements that it can give off. By the time our American shales have been heated to 700 degrees Fahr., they give off, on an average, about 3,000 cubic feet of permanent gas per ton of shale retorted. Operating at higher temperatures will increase the amount of fixed gas and reduce the amount of oil; and an easy and accurate method of controlling the temperature of the retorts is therefore essential to the successful recovery of shale oil, on a commercially profitable scale. There is seldom any market for the permanent gas that is produced, and such gas must therefore be used at the plant or be allowed to go to waste. The fixed gas is likely to average more than 400 British thermal units per cubic foot of gas, or 1,200,000 such units per ton of shale. Less than half of this amount of heat is needed for retorting one ton of shale, and unless the remainder can be used advantageously about the plant, it may be more economical to stop distillation before the 700 degrees temperature is reached. The exact limiting temperature for maximum profit will depend in considerable measure upon the needs of the plant for gas as fuel, in comparison with the quantity of oil obtained from the shale.

As the hot vapors are led away from the retorts, they pass through water-heaters, condensers, and separators—apparatus similar to that used in handling the vapors produced in by-product coke-making. The vapors emerge from the separators as crude oil, fixed gas containing naphtha and ammonia, and steam impregnated with ammonia. The ammoniacal steam is condensed, and the permanent gas is scrubbed in a tower by means of a waterspray—the ammonia water that is obtained in this way being added to that obtained by direct condensation, and the ammonia being recovered from the whole in the form of

(Continued on page 28)

Boiler Room Appliances and Auxiliaries

Development of the Boiler Room From Its Earliest Stages, Showing Approved Appliances Relative to Safety and Economy —Easy Present-Day Methods Compared With Those Used Earlier

By W. B. ROBERTS

IT IS a very interesting study to follow the development and progress of the power plant from the days of the Newcomen engine in 1712, to the establishment of the modern up-to-date plant. Although progress for the first half century was very slow we had in the Watt engine a development in the application of steam that is the principle and basis of the present day engine, although in most cases these are so vastly different in design, that they can hardly be recognised as a development of the same machine. As the Newcomen's atmospheric engine was practically the first engine of any consequence operated by steam, it will be rather interesting to look into the merits of this engine as a means of comparing it with that of Watt's engine.

The principle of this engine was that steam upon being condensed contracted, thereby causing a partial vacuum. If therefore we have a vacuum on one side of a piston and the atmospheric pressure on the opposite side, the piston becomes unbalanced and we get a condition that is likely to produce work providing there is sufficient difference between the pressures on both sides of the piston to overcome the friction of the machine. It will be seen upon looking at Fig. 1 the general arrangement of this engine and how the motion is actually produced. Steam is generated in the boiler B at a very low pressure and is admitted through the valve S. V. into the cylinder C. A jet of cold water is sprayed upon the steam, the water having gravitated from the tank C. W. T. through the down pipe and regulated by the injection cock I. C. This condenses the steam, causing a partial vacuum in the cylinder. The piston therefore, being exposed on the one side to the atmosphere, is forced downward due to the difference in pressure on each side of the piston. At the end of the stroke, the weight of the rods at the opposite end of the beam, raises the piston to the top of the cylinder again ready for a repetition of the operation. We will therefore see that in this old and discarded form of steam engine, the pressure and expansive properties of the steam were not utilized or taken advantage of in operating the engine, as the steam was only used to condense and produce a vacuum. The waste of heat through the initial condensation, due to the steam entering the cold unprotected cylinder, must have been very great.

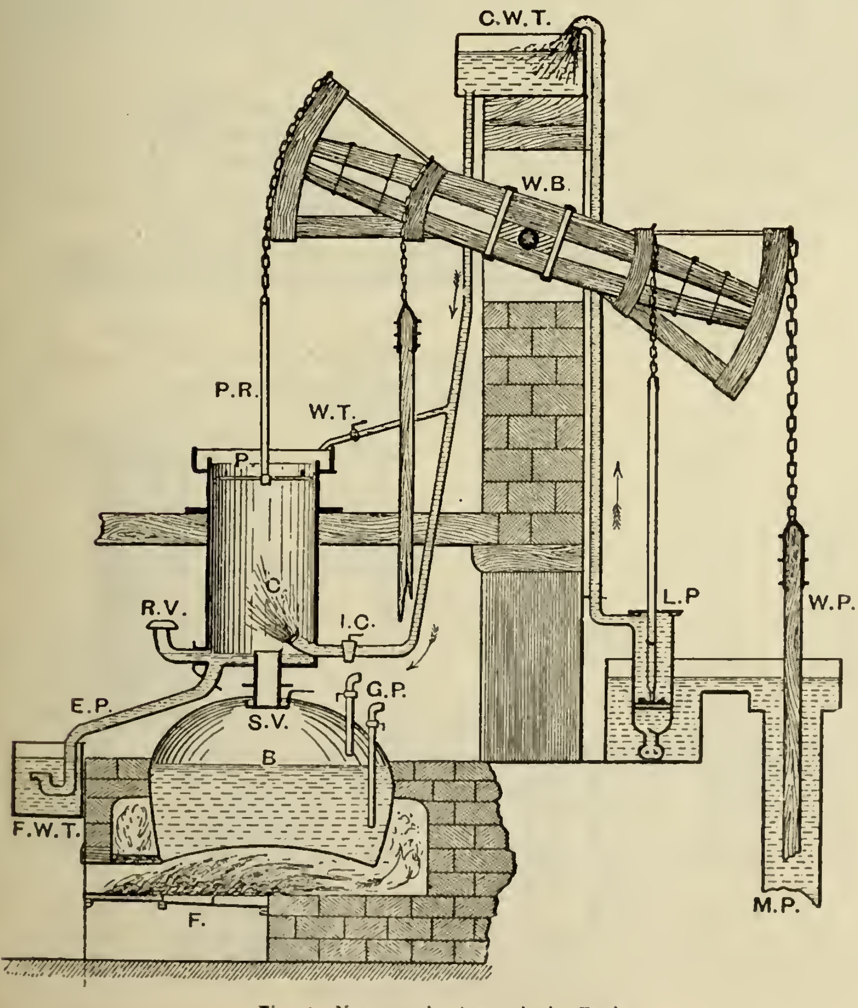


Fig. 1—Newcomen's Atmospheric Engine.

Although it will be realized that the demand for fittings and auxiliaries in a plant of this description was comparatively small, it would be interesting to know just what fittings were used. The illustration which was taken from a very old cut of a boiler of this type, shows two gauge pipes G. P. and a relief valve or snifting valve R. V. which valve would no doubt also act as the safety valve to the boiler. If however, this latter valve was set too rigid or jammed at any time, the pressure in the cylinder C could never exceed the pressure due to the head of water from the tank C. W. T. as long as the cock I. C. was open. These seem to comprise the total fittings of this engine.

In the Watt's single acting engine made in 1769 and illustrated in Fig. 2, we have an engine working on a different principle. In this case, although the piston-rod is connected to a chain on a quadrant similar to that of the Newcomen engine, the engine it will be noted, is detached from the boiler and the cylinder is closed at the top end. This enables the steam pressure to be directed against the top of the piston P. whilst the vacuum on the lower side of the piston, due to the steam being condensed in the condensor J. C., reduces the back pressure, thereby making the steam on the top of the piston more effective. In an engine of this description, it will be seen the necessity for additional appliances the principal of which, as far as the engine is concerncd, are the separate condensor, also the air and feed pump. This engine would be much more economical than the Newcomen enigne at the same time we can see it becoming more complicated in design. This renders it necessary to have a more complete record of our temperature and pressures at the different phases through which the steam passes.

The next great development in the steam engine was fifteen years later

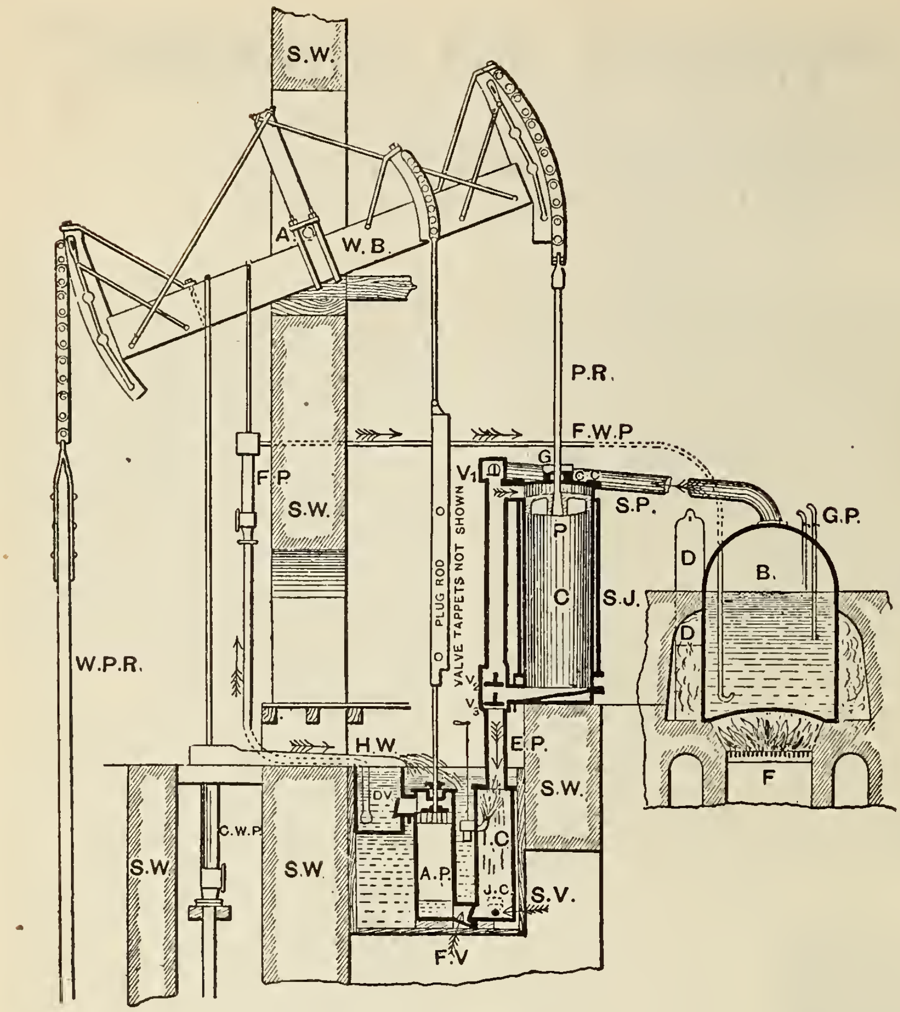


Fig. 2—Watt's Single Acting Engine.

when, in 1784 Watt invented his double acting single cylinder beam-engine, it will be seen the great improvements that were made upon his earlier machine, with the introduction of the piston rod, fly-wheel, better cylinder arrangement, and the governor and throttles valve. The steam and exhaust valves for the top and bottom of the cylinder are operated by the four tapped rods T. R., which are attached to the air pump rod and connected to the beam. It will be seen that the principle of this engine is much in common with the present day engine, except that the design has to be very materially modified, on account of using such high pressure steam compared with that used 150 years ago and also the extremely high speed of engines that are used these days compared with 20 revs. pr. m. which was a very common speed for engines of this description at that time.

Evolution of Steam Boilers

It is needless to say that during the development of the steam engine, corresponding progress was also made, in the development on the steam boiler. During the process of evolution, there is no such thing as rest. This would be amply demonstrated to anybody who cared to visit the Patent Records office, where they would find thousands of boiler designs patented, 95 per cent. of which would fall down very quickly upon being put through a vigorous examination. A favourite form of boiler that was much used during the early part of the eighteenth century was the externally fired egg-ended boiler. This type of boiler, however, became very unpopular owing to the number of explosions that occurred due to the ripping of the seams that formed the ends. The Cornish & Lancashire boilers were two class of boilers that were introduced to meet a certain need and are still a very popular form of boiler in Great Britain at the present time on account of the great abuse these boilers will stand. They are usually to be found in such places where we find the Horizontal Return Tubular boiler in this country.

There are also quite a large number of boiler types that are used for special purposes such as Scotch or marine type boilers: Locomotive Galloway Cochrane & Vertical boilers all having their own particular merit, but in each case the object seems to be to increase the heating surface without materially affecting the size or cost of the boiler.

The water-tube boiler has received a great amount of attention of late years, on account of it being a much safer type of boiler for use with high pressures, and furthermore, being a quick steamer, it is in a position to handle a sudden demand for steam almost instantaneously. This is a requirement demanded from boilers both in electric generating plants, fire stations, and also one that is indis-

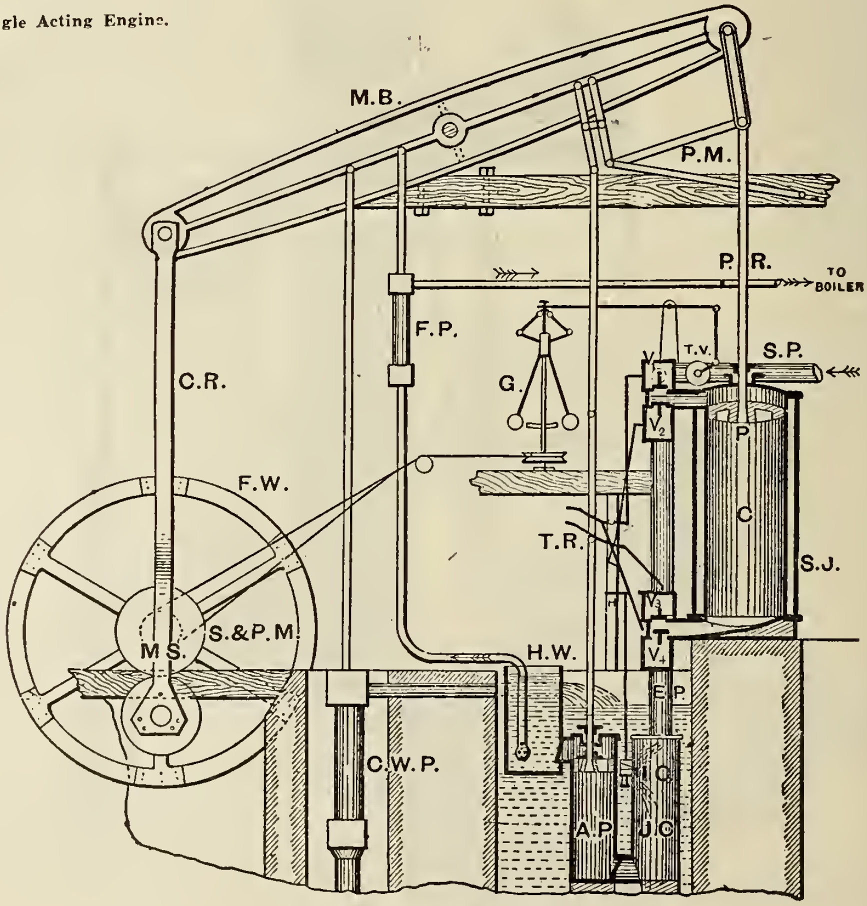


Fig. 3—Watt's Double Acting Engine.

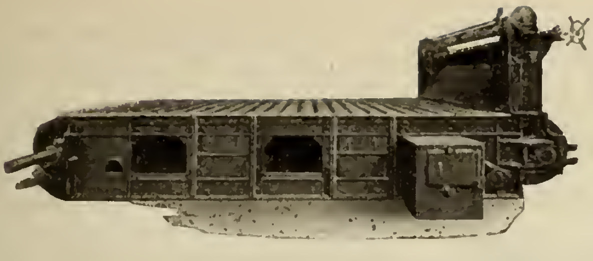


Fig. 4—Coxe Chain Grate Stoker.

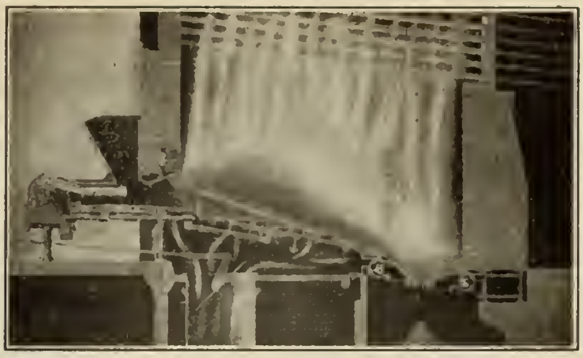


Fig. 7—Open Induction Feed-water Heater.

pensible in naval vessels. If you look at any standard design in this type of boiler, you are looking at a boiler that has stood the test in the process of evolution, and not some chance design that has been hit upon by some fortunate engineer. The number of water-tube boilers that are so similar in appearance, are numerous, but when you come to look into the merits of each, you find there is a structional weakness or economical drawback somewhere in its constitution. The water-tube boilers that we are familiar with at the present time, are the result of the "survival of the fittest" and although it may not be perfect, it is the ultimate result of many years of experience and tests as far as the design is concerned. The engineer demands that his boilers should be safe, efficient, economical as far as fuel and space is concerned, and to be economical they will of necessity be high pressure. Even with the high pressure steam that we are using these days, compared with that of fifty years ago, there is nothing like the number of boiler explosions now, as compared with those days. The safety appliances that we have in the form of fusible plugs, safety valves, high and low water alarms, automatic cocks to the glass water gauges, test cocks and the score of other arrangements and fittings, all help to reduce the possibility of a boiler accident as far as the mechanical equipment of the boiler is concerned. Our engineers are also trained to understand the theory and design of boilers, which in combination with the rigid system of examination that is forced upon the boiler owner by the various Provincial Governments, and also the further examinations that are given at a very nominal figure by the boiler insurance companies, the possibility of a boiler explosion is reduced to a minimum.

First Stages to Promoting Economy

When we come to look into the early methods of generating steam and compare the equipment with that used at the present time, we cannot but realize that their methods were most extravagant and offered great opportunities for improvement. The necessity for this very naturally inspired the engineer of that day to devote much of his attention to promote better and more economical operating conditions. The lost heat in the flue gases was a very favourite spot chosen by engineers with a view to recover some of the heat units by introducing an economiser for heating the feed-water. However there is only a certain amount of heat that can be recovered from that quarter and anything above this amount is going to very materially affect the draught of the stack, and therefore have a detrimental effect upon the operation of the furnace.

Stoker Design

It was realized at a very early date that great improvements were possible in the furnace design with a view to promoting greater economy in the combustion of the fuel. In 1819 Brunton designed a travelling grate, which is said to be the first mechanical stoker brought out in England. Numerous improvements were made on this type of stoker from time to time, and that form illustrated in Fig. 4 is one of the first of this type to be used with forced draught. In 1838 the first underfeed single retort stoker was patented by Jukes, which is an arrangement wherein the coal is thrown into the hopper and allowed to drop down in front of a ram. The coal is then forced under the centre of the grate below the burning fuel by means

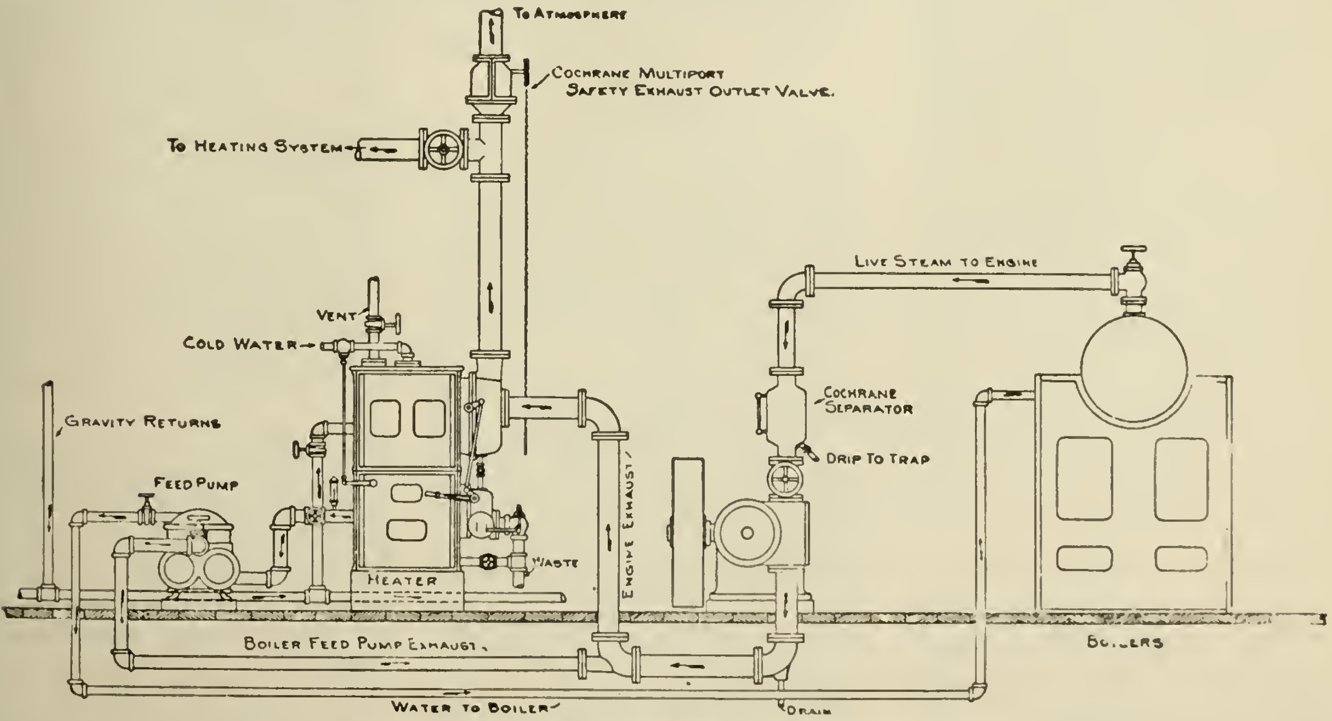


Fig. 6—Heating System Utilizing Exhaust Steam From Engine.

of a hand screw. About seven years later, the first fuel overfeed inclined grate stoker was patented by Hall. In this arrangement the grates were inclined, having reciprocating grate bars upon which the fuel was pushed. In 1876 the first underfeed multiple retort stoker was brought out by Smith. This was probably the first underfeed stoker to be used commercially, but it was only on the market a short time when it went into disuse. The illustration in Fig. 5 is a Frederick stoker and probably one of the latest stokers of this type to be brought out.

We have only given the dates when stokers of a certain class were first brought out, as a guide to indicate the development and advancement made upon these lines. It is needless to say, that numerous other stokers have been placed on the market since the introduction of those mentioned, and we think that there should be little or no difficulty experienced by anyone wishing to select a suitable stoker from the large assortment there are on the market, to meet with any requirement his plant demands.

Utilizing Exhaust Steam

There are various ways of utilizing the heat from the exhaust steam of an engine, one of the most common of which is a feed water heater. Great economics can also be effected when the surplus of the exhaust steam, above the amount that is required for heating the boiler-feed water, is applied to heating buildings, drying materials, cooking or any other process for which low pressure steam is suitable. In Fig. 6 we give an illustration of this arrangement where the exhaust steam from the engine is thoroughly cleansed and purified through an open induction Cochrane feed water heater. The steam is here separated from any oil, so that the returns of condensate can be brought back to the heater and used over again as feed for the boiler. The heater then serves as a receiver or return tank for the condensate, at the same time admitting the necessary amount of raw water to make up the total boiler-feed supply. If there is not sufficient exhaust steam both to heat the feed water and to meet the demands of the heating system, the exhaust steam can be supplemented automatically by live steam through a reducing valve set at a pressure somewhat lower than that for which the back pressure valve is set, so that the reducing valve will operate only when the supply of exhaust steam is deficient. Fig. 7 illustrates the form of heater used in this system.

The Present Day Boiler Room

When we come to survey the up-to-date boiler room and compare the lot of the engineer in charge, with that of 50 years ago, we think it will be admitted the engineer of the present day has the much more enviable position.

In many of the better laid out plants the process is almost automatic, and the heavy manual work that at one time was so closely associated with a boiler room, is reduced to a minimum. When we look at the stokers, automatic feed regulators, soot-blowers, ash conveyors and the numerous other up-to-date appliances in a boiler room, we quite realize we are aiming at increased efficiency and greater economy by introducing these appliances, but it must be admitted by the engineer, that these methods greatly decrease the drudgery work of the boiler room and tend to make the process about the boilers a much more interesting one by the absence of the heavy and unpleasant duties that once had to be performed.

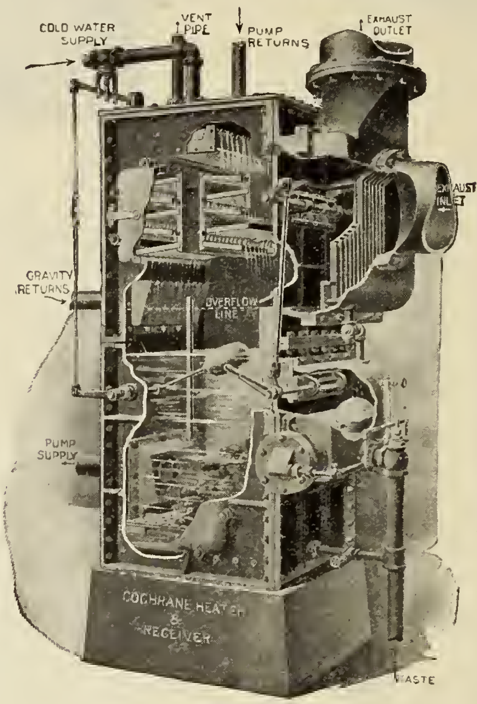


Fig. 7—Open Inudction Feed-water heater.

EXPLODED AND KILLED AT 300 POUNDS

By W. F. S.

The following interesting news item appeared in a recent issue of a North Dakota newspaper:

"In a threshing machine explosion that tore the steam engine to fragments scattering heavy parts sixty rods from where the machine stood, Gunder and Lars Larson, brothers, age 35 and 39 years, were instantly killed and five other workmen injured.

"The accident ocurred yesterday afternoon at the Vaagen farm five miles from Carpio. A defective safety valve which failed to operate when a pressure of 300 pounds of steam was generated is blamed for the tragedy. The victims were blown to pieces, fragments of their bodies being picked up a hundred yards from where the engine stood."

Sounds somewhat as though they were testing the safety valve with a boiler full of live steam at 300 pounds pressure, doesn't it?

If this news item is true it simply proves the writer's contention that most boiler explosions are preventable.

DEVELOPMENT OF THALE OIL

(Continued from page 24)

ammonium sulphate. The gas and naphtha, after being thus freed from ammonia, are then scrubbed in another tower by means of oil spray, which removes the naphtha and other condensible products—the emerging gas being used as fuel, while the oil is subjected to refining. The crude oil that is driven off from the shale is shipped to a refinery, where it receives the same treatment that is given to the crude oil that is obtained from the wells.

Among the more important products (in addition to oil) obtained from the retorting of shale, are ammonium sulphate and fertilizer, as we have already stated. The ammonium-sulphate content of American shales is not so high as in Scotch shales, but it averages about 10 pounds of sulphate per ton of shale, unless special retorts are made for realizing a higher ammonium-sulphate recovery, at the expense of the oil yield. The spent shale is in good demand as fertilizer if it is produced in the vicinity of agricultural land, but it cannot profitably be shipped to any great distance. Analysis indicates that the shale contains nitrates up to 6 per cent., together with small amounts of potash and phosphoric acid. This showing, alone, would hardly entitle it to be classed among the desirable fertilizers, but it apparently acts mechanically as well as chemically—possibly facilitating the aeration of the soil, and perhaps absorbing moisture from the air, to be drawn on by the plant-roots. It is possible to recover many other by-products, similar to those obtained during the process of well-oil refining; but a great deal of study and experiment are necessary before such products can be produced in quantities sufficient to make the work commercially profitable.

The hazards that we shall encounter in connection with this new industry may be forecast with a fair degree of accuracy from the knowledge and experience that we have already had in connection with steam-shovel operations, quarrying, coal mining, the destructive distillation of coal, and oil refining. Having such a foundation, it should be possible to enter into the development of the new industry with confidence that it will be quite practicable to assure safer working conditions than those that usually prevail in connection with pioneer work of other kinds.—Steam.

China, for the most part, is lacking in refrigerating facilities, and, because of this, vast quantities of salt are required for preserving food. The per capita consumption of salt in China averages twelve pounds annually, exclusive of salt used for manufacturing purposes. Crude salt is obtained from sea water along the entire coast line, from brine wells in the extreme western Province of Szechwan, and from the salt lakes in Mongolia. Some rock salt is also taken from the salt mines of Yunnan in the southwest.

Practical Application of Refrigeration

A Brief Outline of the Salient Features and Physical Laws That Underlie the Design of Refrigerating Systems

By FRED OPHULS*

THE number of industries in which refrigeration is a part of the manufacturing process is growing from year to year. It is gratifying that improvements in the application of refrigeration are keeping step with the growth of the refrigeration industry.

Since it is impossible in a short talk to cover the whole subject in great detail it may interest you to have me give you a brief outline of the most salient features and physical laws that underlie the design of refrigeration systems and the application of refrigeration in the arts to-day.

The usefulness of volatile liquids for producing refrigeration was discovered many years ago, still we are learning more every day about their correct use for this purpose. It is this knowledge that should be broadcasted more generally so that everyone who operates refrigeration systems and those who supervise such operation can do so intelligently.

If I make the bold statement that even to-day in nine out of ten plants, where refrigeration is used, the refrigerant is not handled so as to obtain the best possible results both as regards output and economy of operation, you would be inclined to accuse me of gross exaggeration. Since I inspect and analyze plants in most every part of our country, and I have found this to be the case, I have the right to make this broad statement. It is, therefore, not amiss to touch briefly on the fundamental principles that underlie the use of volatile liquids for producing refrigeration.

Use of Refrigerants

All these liquids have the same general physical properties like water. They boil away or condense at a finer temperature for every pressure to which they are subjected. When they boil away they absorb heat and when they condense they reject heat. While water at atmospheric pressure boils at 212 degrees F. liquid anhydrous ammonia boils at this pressure at about 28 degrees F. This is the property that makes anhydrous ammonia useful for refrigeration purposes.

It is, therefore the liquid ammonia that it injected into the low pressure side of the system that produces, in boiling away into ammonia vapor, the actual refrigerating work.

This brings us to one of the most important errors made in the handling of refrigeration systems.

Insufficient Ammonia in the System

What will happen when the supply of liquid ammonia in the system is insufficient—three things can happen:

First, when the expansion valves are open so far that the liquid supply in the receiver drops to the liquid outlet, high pressure ammonia vapor passes with the liquid ammonia to the low pressure side. The refrigerating effect of every pound of vapor that passes through the expansion valves with the liquid has less than one-eight hundredth the refrigerating effect that a pound of liquid has and is, therefore, of little help in producing the refrigeration required.

Second, the pound of vapor after it is reduced to the suction pressure on passing through the expansion valve will have the same volume, that is, it will occupy the same space in the low pressure system as the one pound of liquid ammonia, when it has been vaporized by the heat it has absorbed and has produced more than 800 times the refrigerating effect than the one pound of vapor that come into the low pressure side with it.

Third, the refrigerating machine, of whatever type it may be, compression or absorption, has a definite pumping capacity. If it has to handle ammonia vapor produced by the boiling away of liquid in the low pressure system it is helping to produce the largest amount of refrigeration that it is capable of. If, on the other hand, the machine has to handle in addition to each pound of vapor produced by the liquid, one pound of vapor that passes with it through the expansion valve, it must either be operated at twice the speed to do its work or else at the same speed can do only about one-half of the work.

Using Too Much Power

Furthermore, it takes just as much power to compress a pound of vapor from the suction pressure to the condenser pressure, whether or not this pound of vapor has come through the expansion valve or has been formed by evaporating a pound of liquid in the low pressure side. Therefore, in the case above stated twice the power will be used to develop a ton of refrigeration that should be.

The remedy is to have a gauge glass on the liquid receiver and keep the liquid level in the receiver at least six or more inches above the liquid outlet.

On the other hand, the operator may be aware of the foregoing and maintain the liquid level in the receiver and yet the output or the efficiency of the system fall far short of the result that should be obtained.

This condition of the plant can be illustrated in a few words. Supposing a plant is called on to develop one hundred tons of refrigeration and the refrigerating machinery is properly proportioned to do this work. Roughly speaking, about one-half of a pound of liquid ammonia must pass through the expansion valve per minute per ton of refrigeration. For one hundred tons, about fifty pounds of liquid per minute is required.

Insufficient Ammonia in the System

If there is not sufficient anhydrous ammonia in the system, and still the operator tries to maintain a proper liquid level in the receiver he must pinch down the expansion valve so that less than the fifty pounds of liquid passes through it per minute. The result is that the one hundred tons of refrigeration cannot be obtained. Mostly before charging more ammonia the operator speeds up the machines, pulls down the suction pressure and tries to make up the difference in that way. He can sometimes on a large system secure the necessary refrigeration in that way, for it is a fact that the lower the suction pressure for any given temperature in the refrigerating system the smaller will be the amount of liquid that can be held in the low pressure side. The speeding up of the refrigerating machines with a consequent drop in suction pressure will, therefore, cause a quicker evaporation of the liquid on the low pressure side and the liquid receiver will start to fill and the expansion valve can then be opened to let fifty pounds of liquid enter the low pressure side every minute.

Operating at a lower back or suction pressure than is necessary to produce the result means excessive power use.

It is easy to illustrate why a certain refrigerating system may hold more or less liquid ammonia when doing the same amount of useful work.

Take, for instance, a standard can ice making system. Suppose that it contains a sufficient number of ice cans so that the desired output can be harvested with an average brine temperature of 16 degrees F. As long as this brine temperature can be maintained so long can the usual ice harvest be continued. For proper economical results the plant should be equipped with a brine cooling system so that this brine temperature can be maintained with liquid ammonia boiling in the system at from 9 to 10 degrees F. In this case the temperature difference between the brine and liquid ammonia boiling in the cooling system is only from 6 to 7 degrees F., a small but correct temperature difference. Naturally the liquid ammonia boils slowly and a large amount of liquid ammonia must be held in the brine cooling system so that results are obtained. As an extreme case, let us suppose that the ammonia charge in the system is not sufficient to keep all the liquid in the brine cooling system that is required to produce the temperature difference of from 6 to 7 degrees F. and still have enough liquid in the receiver to seal the liquid outlet. The ice making capacity can be maintained provided the refrigerating machines are large enough, by dropping the suction pressure. Say we can drop the suction pressure so that the liquid boils at 0 degrees F. There is now a temperature difference of 14 degrees F. between the brine and the ammonia. Boiling will go on twice as actively as it did before. Under this condition a lesser amount of liquid ammonia will be required in the brine cooling system and, therefore, more is available to properly fill the receiver.

It is needless to point out to you that more power is needed to do the refrigerating work at a low than a high suction pressure.

An ample supply of ammonia in a refrigeration system and maintaining the proper liquid level in the receiver is, therefore, of prime importance in all refrigeration systems, whether they are used for distilled or raw water ice-making, for cold storage work, for water cooling or for any of the many purposes for which refrigeration is used to-day.

Danger from Slugs of Liquid

A refrigerating system may be so designed that it is dangerous to try and fill the low pressure side with as much liquid ammonia as it should hold to obtain best results. For instance, in ice making plants the harvesting of ice in all parts of the freezing tanks, and replacing the cans filled with water, has a varying effect on the action of the liquid ammonia evaporating in the brine cooling system. When harvesting ice at the end of the tank where the expansion valves are located, heat is added more quickly to the brine than in other parts of the tank, causing more rapid evaporation of liquid at this point. The rapid production of vapor at this point may push the liquid forward in the rest of the system more rapidly than when the ice is harvested at the other end of the tank with the result that slugs of liquid will be pushed out of the cooling system and if proper means are not available to separate this liquid from the vapor before the latter gets to the refrigerating machines, liquid hammer in the machines may appear, resulting sometimes in rupture and serious accident.

In well equipped refrigerating systems means are always provided to avoid this danger. I might point out here that the usual accumulator system now in common use will eliminate the danger.

Having outlined briefly how the refrigerating fluid must be handled to obtain both output and efficiency, it might be of interest to analyze in the same manner other parts of the refrigeration systems and tell briefly the way one can determine the extent to which one can go to equip a refrigeration plant, for whatever purpose it is used, to obtain maximum economy, and, what is more important, the largest returns on the investment.

Keeping Plants Up-to-Date

It is remarkable how many ice making and refrigerating plants there are from the operation of which the owners desire a good return on their investment and still if the machinery equipment of these plants was added to, here and there, and some of the obsolete machinery replaced by more modern apparatus the results would be most gratifying. To safeguard the investments in these plants it is absolutely necessary to keep the machinery equipment up-to-date. How often does it happen that the owners of these plants are threatened with the entire loss of their investment by the ruinous competition from a new and more modern plant. There are two safe ways to avoid this dilemma. The one is to keep the plant up-to-date and the other is to set up an ample reserve for depreciation and obsolescence with which the cost of these improvements can be met. It is not enough that such a reserve is set up as an item of bookkeeping but the actual cash must be set aside and invested in safe securities so that it is available when needed.

Choice of Proper Machinery

When building a new plant the choice of the proper machinery equipment is very important but difficult for the business man.

Taking for example ice making plants, in which most of you are interested, shall the plant be equipped with ten, twelve or more cans per ton? Up to a certain maximum number, the more cans per ton used the less will be the power to operate the plant per ton.

When the available water supply is so poor that a distilled water plant must be installed the choice of the equipment must be such that just enough distilled water is available to fill the can. When evaporators are used to make up some of the distilled water the problem is the same as that for a raw water plant.

When the water supply is of such a quality that raw water ice can be made either direct or after proper treatment, it is necessary to get bids on the various types of apparatus available with freezing systems, based on say twelve to eighteen cans per ton, and to figure up closely the cost of the completed plant in each instance. After that the probable cost of ice for these various systems must be determined. The cost of ice in each case must include every item of expense, labor, fuel or purchased power, waste and oil, sundry expenses. repair and upkeep, labor and materials, ammonia and salt or calcium chloride, taxes, insurance, depreciation, administration expenses, handling labor, etc.

This information, taken together with the reliability of the apparatus proposed in each case gives the answer to the problem. That plant which nets the largest income on the total investment is the one that must be chosen unless financial considerations make another choice desirable.

A brief summary of the most modern machinery for refrigeration systems may be of assistance to you. Starting with the compressor—the purpose of this machine is to remove the ammonia vapor from the low pressure side and discharge it into the high pressure or condensing side. That machine which obtains this result with the least expenditure of power and which performs this function in the most reliable and safe manner is the one to be chosen.

In some parts of this country the slow speed machine turning over at from 60 to 90 r.p.m. is preferred. In other parts medium high speed machines are almost always installed; these machines running at from 120 to 200 r.p.m. What is actually the difference between these machines, assuming that both types are properly designed? Will a slow speed machine last longer than a medium speed machine? The correct answer to these questions is that there is no difference between them, considering the service they will render and the length of life. The pressures on the moving parts are the same. It is true that the moving parts of the medium speed machines are lighter than those of a slow speed machine. This is a distinct point in favor of the former. Repair parts cost less to buy and install. They occupy less space. The piston speed is the same. Take for instance a 36-inch stroke slow speed machine running 75 r.p.m.—the average piston speed is about 450 feet per minute. The equivalent medium speed machine has a stroke of 15 inches and operates at about 165 r.p.m., or an average piston speed of 413 feet per minute.

The failure of some of the high speed machines has been due to faulty design, which has since been remedied. The most important feature of a compressor, next to the safe design of all its parts, is the effective valve area of its suction and discharge valves. If the valves are of such size and the required number is used that the vapor speed through them does not exceed from 3,000 to 5,000 feet per minute, the medium speed machines so equipped are far superior to most of the slow speed machines now on the market.

Ammonia Condenser

The ammonia condenser is going to be entirely different apparatus from the atmospheric or double pipe condensers now most commonly used. A flooded condenser is an abortion. Its design is contrary to all the physical laws governing the condensation of vapor.

Would a steam engineer ever think of using our open air or double pipe condensing steam? No. Why should we? The fact is that modern refrigerating plants are now being equipped with shell and tube condensers that are assuming more and more the form of modern steam condensers. This new type takes up less space, is easier to clean, requires less surface and gives better results, that is, lower condenser pressures, than the old types. Heat transfer co-efficients

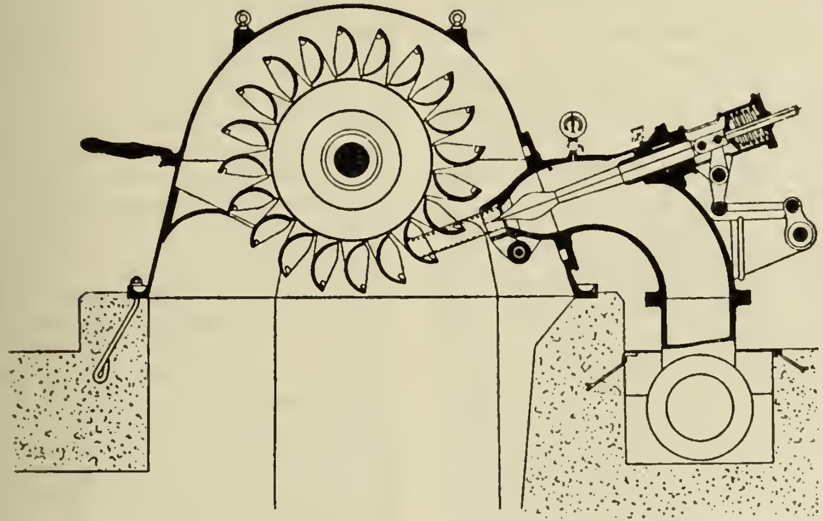
(Continued on page 31)

Pelton Water Turbines

Turbine Fitted for 24-Hour Service for Driving Air Fan at Colliery

THE utilization of the water power made available by mining operations is more often discussed than practised, but the high cost of fuel, especially in many of the metalliferous mining districts, has given the subject a more practical turn. For auxiliary power supply in mines the water turbine utilizing the head of water developed by shaft sinking and the driving of winzes or inclines is of great value, and deserves more consideration than it has yet received. An interesting example of the harnessing of mine water is provided by the Pelton turbine supplied recently by Messrs. Salterns, Ltd., for the driving of a Keith induced draught fan at the Argoed Colliery in South Wales.

The fan shaft is in the centre of the turbine house, and on one side is the electric motor, and on the opposite side the Pelton wheel, and normally the fan is driven by the Pelton wheel, which is designed for 24 hours' service, and in emergency the electric motor could be used.



Pelton Water Turbine.

The Pelton turbine is normally of 5 b. h. p. running at 500 revs. The head of water in this instance was only 110 ft., but as it was essential to have a turbine which was absolutely fool proof, it was decided to use this type of wheel in preference to a Francis turbine. The inlet connection on the Pelton wheel was 6 in. diameter.

These standard Pelton wheels are of very robust construction, and are totally enclosed in accurately machined cast iron houses, furnished with bronze lined ring oiling bearings. They are also furnished with ball bearings if required. The buckets are accurately machined and fitted on a tight press fitted on a solid disc runner, which is turned all over, and balanced; turned and ground steel bolts of 60 ton tensile strain are tightly pressed into reamered holes. The turbines are fitted with a bronze needle and a bronze nozzle for hand regulation, and a hand hole with a cover plate is fitted for access to the nozzle if required.

Standard sizes of this pattern are made suitable for any head of water up to 500 ft., but special Pelton wheels, which have the top part of the case made removable, have been designed for heads of water up to 2,000 ft. or more, and single units of 1,600 h. p. have been supplied.

The Pelton turbine is constructed in forms suitable for either hand regulation or fitted with a deflector and patent universal oil pressure governor, which includes the oil pump, servo-motor, and double compensating gear. The pendulum shaft is fitted with ball and thrust bearings, and the drive shaft with bronze and steel silent skew gear running in oil. The regulating needle is mounted on a very stiff steel shaft, and is well supported and protrudes into the water-way with a minimum of obstruction. The needle shaft is furnished with substantial bronze liners, and fitted with a water-tight gland.

By means of the levers and links shown in Fig. 1 the movement of the needle or deflector is automatically controlled from the governor, and it will be noticed that a coil spring in compression is fitted, which thrusts the needle in towards the nozzle, thus reducing the amount of energy required from the governor to a minimum.

The action of the patent governor is as follows:—A deflector is fitted which cuts in to the jet from above, the aperture in the deflecting plate being given a circular shape so that it almost embraces the jet.

One Servo-motor piston is connected to the deflector, so that immediately there is any increase of speed the deflector cuts into the jet and throws a portion of the water away from the wheel. The needle is then allowed to travel slowly forward so as to economise the water and prevent any possible shock on the pipe line. An interesting feature is that it is only necessary for the deflector to move half way into the jet to deflect the whole of the stream.

After the needle has moved forward and the jet is reduced in diameter to suit the new conditions it will be found that the deflector is resting just clear of the reduced jet ready to go into instant operation again in the event of the load being further reduced.

It will be noticed in Fig. 1 that at the back of the housing a "silencer" or baffle plate is fitted to prevent waste water being carried up into the top of the housing and again falling on the wheel. In the larger Pelton turbines a rotary oil pump is included, fitted with a filter and a cooling pipe placed in the exhaust water so that a continuous supply of cooled oil is admitted into the top of the bearings. The inlet pipe can be bolted on at any angle as convenient. The turbines are usually furnished with a pressure gauge and Tachometer. Messrs. Salterns, Ltd., also manufacture Francis turbines and complete hydro-electric equipment.

PRACTICAL APPLICATION OF REFRIGERATION

(Continued from page 30)

of 150 B. t. u. are now the rule rather than the exception.

Another innovation is the compound compressor. Some think that this compressor is only desirable for low temperature work. This is not so. They should be used for ice making as well. Whenever the ratio of compression, that is the absolute condenser pressure divided by the absolute suction pressure, is four or more, compound compressors should be used.

Please remember that the above are not views based on a whim of the moment. Every statement I make is borne out by actual and accurate tests made on the machines and apparatus discussed.

---

*Paper read before Southwestern Ice Manufacturing Association at Fort Worth.

Twenty-four thousand tons of freight had to be transported fifty miles into a veritable wilderness in connection with the construction of the Gouin dam on the St. Maurice river. According to Major Brace, M. E. I. C., the greater portion of this had to be transported up-stream for thirty miles and then transferred to standard gauge railways built for the purpose. Comfortable quarters had also to be built for the workmen, and to avoid danger from fire, oil-burning locomotives had to be used.

Impulse Turbine Versus Reaction Turbine

Comparative Merits and Efficiencies of Various Types of Turbines Under High Heads, Giving an Analyses of Results and Pointing Out Mechanical Drawbacks Under Heavy Pressures

ALTHOUGH the impulse wheel is typically a high head unit using comparatively little water as compared with the reaction wheel which is a low head unit often using vast quantities of water, there are many factors which enter into a consideration of the choice between the two types of hydraulic prime mover, particularly for fairly high heads. In the following discussion the term "impulse wheel" is considered as restricted to the "Pelton" wheel, while as reaction turbines are now for the most part of the Francis type, especially when operating under high heads, the choice of impluse or reaction turbine virtually resolves itself into a choice between a Pelton and a high head Francis. The primary criterion for choosing between the two types is the specific speed formula.

$$N_s = \frac{\text{r.p.m.} \times \sqrt{\text{H P}}}{H^{\frac{3}{4}}}$$

Where H is expressed in feet, values of N_s below 9 call for an impulse wheel, values above 11 for a reaction turbine, while between 9 and 11 fall within a debatable zone where other considerations usually determine the choice.

Theoretically, considering the specific speed formula alone, there is no limit to the head suitable for reaction turbines. Practically the revolutions per minute are limited by generator speeds, while horse-power is limited by quantity of water available. The higher heads can only be developed on mountain streams, which are usually of small volume. Even when a large volume of water is available at a high head, there are various mechanical difficulties in the design of a reaction turbine to fit the conditions. For instance, a casing large enough for the required volume of water must be of considerable thickness to withstand the heavy working pressure. This not only adds to the cost but a point is soon reached where it is difficult, if not impossible, to obtain sound steel castings of the requisite thickness and diameter. At the present time the highest head reaction turbines are those at the No. 3 plant of the Kern River development, Southern California. These were built by the Pelton Wheel Company and are of 25,000 h.p., and operate under an average head of 810 ft., and are of a particularly interesting design due to the peculiar operating conditions which call for different speeds for different electrical conditions at alternate seasons of the year, necessitating arrangements being made for changing the runners at short notice without disturbing the remainder of the apparatus. As a matter of fact, reaction turbines have been considered and even designed for heads of as much as 1,100 ft., but so far nothing of this kind has been built.

As regards impulse turbines the highest head with which it has as yet been attempted is 5,320 ft., and there are four 3,000-h.p. units of the Pelton type operating under this head at Fully, Switzerland. This plant, like the Kern River plant, called for special arrangements in the shape of protective devices in case of pipe bursts or governor failures. Opportunities for development of such high heads are of course rare, at the present time few plants are working on heads higher than 2,000 ft., in fact it is often the better proposition to break up these high heads into two or more stages, as for instance, the Big Creek development in California with a total head of 6,000 ft., which will, when complete, be divided into five sections.

In the case of an impulse wheel, the head determines the spouting velocity from the formula $v = \sqrt{2gh}$. Given the water quantity and spouting velocity, the jet diameter is determined. This more or less fixes the wheel diameter, because, although special types of construction permit the use of a low ratio of runner diameter to jet diameter, an increase of the latter usually means an increase of the former. Therefore, if all the conditions of a project are kept constant except the horse-power output, the weight of an impulse wheel installation will increase more rapidly with increase in power turbine. Consequently, when any given set of hydraulic conditions except the power output is kept constant, a point is reached, with increase of power output, where the cost of an impulse wheel installation exceeds the cost of a reaction wheel installation, although this would not seem to be readily apparent when the extreme simplicity of the impulse wheel is considered. Just where this point is in any given case cannot be determined in advance of a study of the conditions.

When, however, this point lies within the debatable zone, as determined by the specific speed formula, the question of cost may be so important as to be the determining factor. The specific speed for any given project may be varied considerably by varying the revolutions per minute or the capacity of the individual unit. The former course is occasionally adopted where a trial solution of the specific speed formula indicates a different type of unit than the one favored by the other conditions, but it must be remembered that variation in revolutions per minute is limited by the range in generator speeds allowed by the electrical manufacturers.

For most large projects the maximum efficiency of a well-designed impulse wheel will lie between 84 per cent. and 88 per cent., while a similar reaction turbine would show better results by about 4 per cent. On the other hand, the impulse wheel will have a flatter efficiency curve. Consequently, when a plant must operate for a considerable part of the time on fractional loads, the average efficiency for an impulse wheel installation is likely to be higher than that of the corresponding reaction turbine, even if the maximum efficiency of the latter is higher. At the same time it must be borne in mind that the efficiency of the reaction turbine depends upon the maintenance of minimum clearances between the runner and other parts of the turbine. Corrosion and erosion may so reduce these clearances as to eventually call for renewal of runner and other costly parts. On the other hand these bad effects of the water are not so marked with the impulse wheel, and in any case renewal of the worn parts is a simpler and cheaper matter. In fact, for this reason alone, a new development in Arizona operating on a comparatively low head of 110 ft. with a maximum quantity of water of 720 cub. ft. per second, incorporates impulse turbines of 1,000 h.p. each, although the conditions of head and quantity would appear to be the reverse of favorable. It so happens that the water is very corrosive, and being also used for irrigation is heavily charged with silt at certain periods of the year, while the requirements of the irrigation scheme render the water quantity very variable. Hence the choice of the impulse wheels which in this instance have vertical shafts and six nozzles, the number of which actually in service is varied according to the quantity of water available so that the efficiency curve is practically flat whatever the quantity of water.

It should be mentioned, of course, that water used for irrigation should not be robbed of its silt, in consequence settling basins are often inconvenient under such conditions, but the water supplied to the Kern River plant previously referred to is settled before passing through the turbines, and although most of the deposit is fine enough to pass a 200-mesh sieve, it would, if allowed to remain in the water, do considerable damage in view of the head and the fact that the turbines are of the reaction type.

In such cases the silt should be removed as far as possible in settling basins, but even then there is the risk of erosion if the water is initially charged

(Continued on page 35)

Air Pressure in Furnaces of Forced Draft Boilers

The Opinion of Engineers and Operators Relative to Methods of Obtaining Constant Low Draft—Same Principle Applicable to All Types of Fuel—Early Mechanical Regulators Cause of Bad Experiences

By E. M. ELIOT

AT THE well-managed power plant of a certain packing firm, the flue gases from one boiler showed CO_2 content of 10% with the draft controlled by a hand-regulated damper. After the installation of an automatic regulator for maintaining a low draft over the fire the CO_2 was increased by two to three per cent.

The boiler on which the experiment was made was a 700 H. P. Stirling Boiler, operating 12 hours per day, 300 days in a year. A good grade of Middle West coal was used, at $3.80 per ton, and a check of the boiler efficiency previously made indicated that a boiler horse-power could be produced with about four pounds of coal. The boiler was run approximately at rating.

Figure 1 shows certain curves which were available for the coal being used. (If the coal used had been an average Eastern grade, chart No. 2 would have been used instead of chart No. 1). The flue gas temperature, where the 10% CO_2 was obtained in the packing plant, was 550° F. and with automatic regulation of the draft was 480° F., this having been obtained by actual measurement. The combustible in the ash was 25%.

Entering the chart, Figure 1, at 10% CO_2 and projecting upward to the excess air curve, it was found that at 550° flue gas temperature, there was 80% excess air, and a boiler efficiency of 75.8%; also entering the chart at 12% CO_2, and projecting upward to the excess air curve, it was found that at 480° flue gas temperature, there was 52% excess air, and a boiler efficiency of 79.6%. Reducing these two efficiency figures for the combustible in the ash, they become respectively 69.8% and 73.6%.

$\frac{73.6\%-69.8\%}{69.8\%} = 5.45\%$ increase in boiler efficiency or saving in fuel.

The amount of coal used at 100% rating was

$\frac{700\text{x}12\text{x}300\text{x}4}{2000} = 5{,}040$ tons per year which, at $3.80 per ton, was worth $19,152.

Applying the fuel saving of 5.45% to the value of the coal—

$19,152x5.45% = $1043.80 saving per year.

As this was more than three times what it had cost to secure a low constant draft over the fire, the engineers were well pleased. The above figures are computed on a yearly basis.

Various objections to the use and value of low constant draft over the fire are urged from time to time, and are of interest not only in themselves, but as indicating the need for clearer thinking on this matter, if best results are to be obtained in the boiler room. At the risk of repeating some points already mentioned, these are listed together below.

1. Operators confuse boiler efficiency with furnace efficiency. They point to a satisfactory overall boiler efficiency, obtained by a boiler test, and say that they do not believe it can be improved, notwithstanding the fact that the percentage of CO_2 in the flue gases may be 8% or 9%.

Overall boiler efficiency depends on a number of factors, such as cleanliness of tubes, ratio of tube surface to grate area, amount of gases passing through the boiler, etc., as well as on the amount of excess air and temperature of gases. The draft over the fire affects the last two quantities, and if excess air can be reduced, and temperature of gases increased, (i.e. flue gas temperature reduced) without increasing losses elsewhere greater economy of fuel will result whether or not other losses in the boiler are eliminated. As a matter of fact, no other loss is increased by a measurable amount because of carrying a low draft over the fire.

The percentage CO_2 is the proper criterion upon which to base judgment concerning excess air and draft. If this is increased by any change, it is certain that a saving in fuel has been effected, (always excepting the extreme case where CO begins to be formed, whether the result can be detected by a boiler test or not.) It is possible that some other loss will increase enough to entirely wipe out the increased efficiency, due to better combustion conditions, but this is an argument for reducing such loss to its original amount. It does not in any way reduce the advantage of getting a high percentage CO_2 in the flue gases nor reduce the financial saving effected thereby.

2. Operators advance the argument that a high velocity of gases through the boiler is desirable especially to give a scrubbing action, which tends to clean soot from the tubes. They claim that low draft over the fire reduces the velocity of the gases.

It has been pointed out that draft does not appreciably influence the velocity of the gases in the boiler, except by changing the amount of excess air. When excess air is reduced, velocity is decreased, but this is a desirable condition under ordinary circumstances.

3. The statement is sometimes made that high draft is wanted at overloads, but whether manual or mechanical means are used for handling the damper, or induced draft fan, it is a very simple matter to change the adjustment to a higher constant draft when overloads are expected, and to put it back when the overloads have gone by. Such over-loads ordinarily last over an hour and can easily be anticipated. The draft

(Continued on page 37)

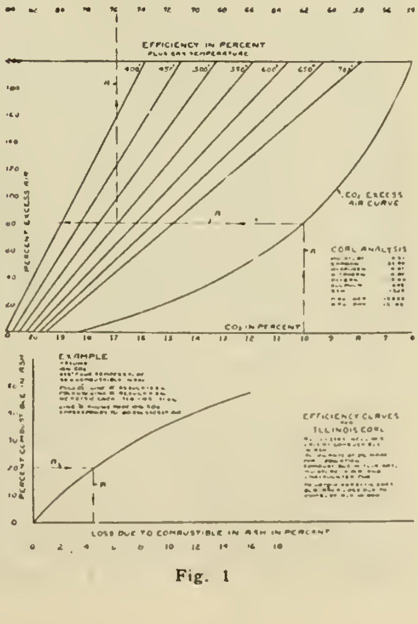


Fig. 1

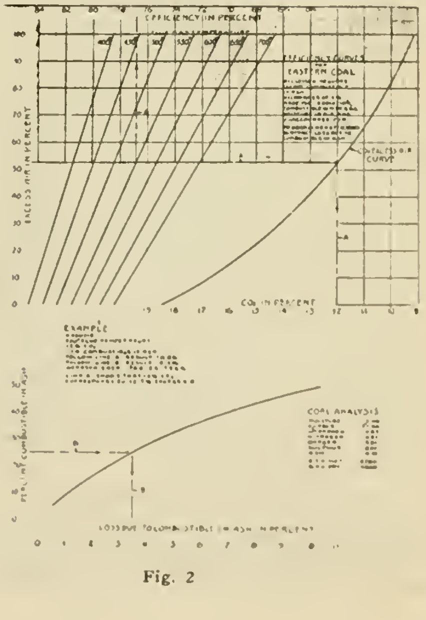


Fig. 2

More Economical Method for the Burning of Gas

Correct Amount of Oxygen Essential—Liquid Fuels Require Less Excess Air Than Solid Fuels—Maintaining Control of Air-Combustion Ratio—Difficulties of Some Systems

WHEN gas was cheap and abundant, little thought was given to its economical consumption, but at present, with gas-making fuels becoming relatively scarce and expensive, more attention is being given to methods for utilizing all the available heat units in the gas. This article outlines briefly the various methods now in use, with their advantages and disadvantages.

The Air Supply

To burn a fuel efficiently only the correct amount of oxygen required should be supplied—no more, no less. When the correct amount of air is used and combustion is complete, the waste gases leaving the heating chamber consist only of carbon dioxide, water vapor, and the nitrogen present in the air supplied to burn the fuel. If sufficient air is supplied, some of the combustibles in the form of carbon monoxide or other incompletely consumed carbon compounds pass out of the furnace, thus wasting part of the fuel. If an excess of air is present, a large part of the heat liberated is wasted in heating this excess air to the temperature of the furnace.

Utilization of Heat

All fuels cannot be burned in a given heating system with the same efficiency. These differences are due to the physical properties of the fuels themselves. To obtain efficient heat utilization, combustion must not only be complete, but also rapid to produce an intense "reaction temperature," resulting in the greatest possible heat gradient and the best heat transfer, for heat will flow only from points of high temperature to points of lower temperature. The greater the temperature difference, the more heat utilized.

To obtain maximum temperature in the combustion zone, not only should the correct amount of air be supplied, but the air must come in intimate contact with the minute particles of the combustible; and the resulting products of combustion rapidly replaced by a fresh supply of air. If this is not the case, combustion will be slow, and the "reaction temperature" and temperature within the furnace low. This is well illustrated by the covering up and smothering of a fire, where the products of combustion are retained, with a fresh supply of oxygen excluded, eventually causing the fire to go out.

Application of Liquid Fuels

In the application of liquid fuels for industrial heat generation, the oils or tars are sprayed into the combustion chamber, thus breaking it up into a large number of minute globules, and exposing large surfaces. When the molecules on the surface of the globules come in contact with the molecules of oxygen present in the air supplied, at the proper temperature, combustion takes place and heat is liberated. This generation of heat causes a further breaking up of the small globules, to form gas molecules, exposing new surfaces capable of being oxidized as soon as the atmosphere at the surface is replaced by a fresh supply of air. This step in the direct burning of oil requires time, and to speed up the reaction and insure complete combustion before the gases generated and products of combustion leave the heating zone, excess air is needed.

However, liquid fuels require less excess air than do solid fuels, due to the fact that larger surfaces are exposed and combustion is therefore more rapid. Normally not over 25 per cent. to 50 per cent. excess is required, but in average practice it is from 50 per cent. to 100 per cent. This is due to the lack of development of suitable combustion apparatus that will automatically maintain a constant air-combustible ratio at varying consumptions. As less excess air is required for the combustion of liquid fuels, the "reaction temperature" and the temperature within the combustion chamber is hotter. or more intense.

Amount of Heat Obtainable

The amount of heat utilizable from any fuel depends upon the temperature at which the waste gases leave the effective heating zone, as well as the amount of excess air used. The higher the waste gases, including the excess air, are heated, the more heat they absorb from the furnace. If the gases leave the heating chamber at a relatively low temperature they carry out but little heat, even though excess air be present. But in not every heating system is it possible to discharge the products of combustion at a low temperature, and large heat losses necessarily occur. Heat losses that occur through lack of control of excess air for solid and liquid fuel combustion run into millions of dollars each year.

Using Gas for Fuel

Gas is the ideal fuel. Its physical properties are such that excess air is not required for its efficient utilization in modern appliances, or gas burning systems. The molecules comprising gas are neither large nor compact; when mixed with air, rapid, complete combustion takes place, due to the intimacy of the mixture and the large exposed surface of the molecules of the combustible. Maximum temperature is thus obtained, permitting the greatest heat transfer with minimum heat loss. In brief, it is the most efficient type of fuel known to-day.

Gas is the only fuel that can be applied to give a reducing, oxidizing or a neutral atmosphere in the furnace, that can be changed readily at will. Wherever there is lack of control of the air-combustible ratio, heat losses occur with gas as with other fuels. However, due to the physical characteristics of gas, no excess air is necessary for rapid and complete combustion. Herein lies its greatest advantage over other fuels, for due to this property alone, consumers obtain more effective work from an equivalent number of gross B. t. u.'s with gas than from any other type of fuel. It is, therefore, not logical to compare the cost of fuels on the basis of a "gross B. t. u." relationship. Relative fuel values depend upon the percentage of "gross B. t. u. as fired" that are "available" to do the work under the conditions the fuels must be burned. As gas can be fired with no excess air, no heat losses occur in the waste gases, as with solid and liquid fuels; consequently, a greater per cent. of the "gross B. t. u. as fired" are rendered "available" to do effective work.

Control of Air-Combustible Ratio

Only recent developments of modern gas combustion systems have made perfect control of the air-combustible ratio possible. They have brought about flexibility and efficient combustion, for without them there can be no control over combustion conditions and large heat losses in the waste gases occur.

For every volume of a given gas consumed there is a definite volume of air required for complete combustion. This definite ratio of gas to air must be maintained at all rates of consumption if the most efficient combustion is to result. The maintenance of this air-gas ratio is therefore fundamental to any efficient gas combustion system.

Absolute Control With Gas

With gas as a fuel it is possible to have absolute and automatic control of furnace conditions and temperature at all times, and with its rapidity and intense temperature of combustion, it saves time in bringing the furnaces up to temperature. The use of gas also eliminates spoilage and waste of material by improper control of combustion conditions and furnace temperatures. There are also no labor charges for handling the fuel, or for the removal of ashes. Gas is, therefore, the ideal fuel, but its position in fuel classifications is made possible only by a correctly designed gas combustion system.

Gas Combustion Systems

A large number of industrial gas combustion systems are on the market. Many are more or less effective and suitable for the burning of gas, some suitable only for special installations, and others do not obtain the correct results at all.

Practically all industrial gas systems consist of a compressor or blower to deliver the required volume of gas or air to the furnace; a pressure regulator to maintain a constant pressure and uniform flow of gas to the furnace under varying loads; and an air-gas ratio control device for maintaining the desired combustion conditions. This latter, the air-gas ratio control equipment, may be an integral part of the compressor system or may be some modification of the well-known Bunsen burner, in which the air is injected by the gas flowing through the burner, or a combination of both.

The Five Types of Systems

Five distinct types of gas combustion systems are in general use, which utilize some or all of the foregoing three principles. They are:

(a) The two pipe system, in which gas and all the air required for complete combustion are delivered to the furnace in separate pipes.

(b) The high pressure Bunsen system, in which the gas alone is delivered under high pressure to a modified Bunsen burner located near the furnace, the air required for complete combustion being induced at the burner.

(c) The central unit total premixture system, in which the gas and all the air are mixed at the compressor or blower and delivered to the furnace.

(d) The individual unit total premixture system, in which the gas and all the air are mixed by individual blowers located at the furnace and delivered to the burners through a short pipe.

(e) The partial premixture system, in which the gas and a portion of the air are mixed and delivered to a modified Bunsen burner located at the furnace, where the remaining air required for complete combustion is induced.

Difficulties of Some of the Systems

The objection to the two pipe system is that it is expensive to install. This system is sometimes called "the two valve system." Its advantage is that no Bunsen burners are needed, which in themselves have limitations, but it places the control of the atmosphere within the furnace in the operator's hands at all times, a control which can be made automatic if desired.

The high pressure Bunsen system is low in first cost, and has found a wide application. The main objection is that it is limited by the sole use of the Bunsen burner for the injection of air, which cannot be correct for changes in the density of the gas. If the gas density changes, as happens with all manufactured gas, there is no control of the ratio of air to gas, and waste of fuel results.

The central unit total premixture system has a disadvantage in that the compressor must be large and expensive, as it must handle all the gas and air required for complete combustion; and in that it delivers an explosive mixture to the furnace, which in itself is dangerous. Due to the fact that all air and gas must be handled in a single pipe, the pipe lines are large and costly. Pop valves must be installed to take care of explosions in the pipe line.

The individual unit total premixture system also has the disadvantage of handling an explosive mixture, but as the blower is usually installed close to the furnace, large volumes of air and gas are not in the pipes and the danger is much less. The pressures used on such systems are low and the power requirements correspondingly small. However, most of such systems lack the fundamental automatic air-gas ratio control at varying loads of gas consumption.

Partial Premixture System Most Efficient

The partial premixture system overcomes practically all disadvantages inherent with other systems. The installation is relatively small, as only a portion of the air is mixed with the gas and handled by the compressor—the remainder required for complete combustion is induced at a modified Bunsen burner located at the furnace. As a portion of the air is mixed with the gas at the compressor, only the small remaining portion required for complete combustion must be induced at the burner. Since only a portion of the air must be induced, less energy in the gas (partial premixture) stream is required at the burner, and the pressure required and power consumption are correspondingly low. As a result of premixing a portion of the air with the gas at the compressor, any variation in the density of the gas is neutralized automatically by the density of the air, which is constant. There are smaller fluctuations in the energy of the gas stream at the burner and the air induced remains more nearly constant than would air induced by the energy of a high pressure gas stream alone. Wide variations in the air-gas ratio are eliminated, and combustion conditions and the temperature within the furnace remain constant. Large heat losses in the waste gases are therefore minimized. The partial premixture system or Selas system, maintains this constant air-gas ratio irrespective of the amount of gas consumed and the variation in consumption.

This system also enables the operator to obtain a neutral, a reducing, or an oxidizing atmosphere within the furnace, as desired, and to maintain the same automatically.

Use of Gas Increasing

Since gas can be applied more efficiently than any other fuel, we find its field of use growing larger year by year. In the not distant future we can expect to see all our fuels gasified and applied in this form, and the use of solid and liquid fuels condemned as wasteful. By this change in the methods of fuel application, not only are production costs lessened, but our natural resources are conserved. Scientists now tell us that the end of some of our most valuable fuel resources is in sight. It is important then to work together for the conservation and the economical utilization of our fuel resources.—From the Melting Pot.

IMPULSE TURBINE VERSUS REACTION TURBINE FOR HIGH WINDS

(Continued from page 32)

with silt and the only means by which the designer can make provision for coping with it is to so arrange the turbine that easy access may be had to the interior without dismantling generator, shaft or bearings. The overhung construction is entirely suitable in this respect and in combination with renewable clearance rings permits of the operator observing and keeping track of the degree of wear of these rings without taking down the turbine. There are three such turbines, each of 11,300 h.p., operating under a head of 580 ft., at the Maitenes plant on the Rio Colorado, in Chile.—"Engineering."

PULVERIZED FUEL EXPERT ADDRESSES ENGINEERS

Colonel Harlow D. Savage, head of the Pulverized Fuel Department Combustion Engineering Corporation, addressed the Engineering Institute of Canada in Winnipeg, March 15th, on the subject on pulverized fuel, and its application.

Western Canada has shown great interest in this subject and engineers from all over Manitoba and Saskatchewan attended the lecture.

For the past seven or eight years Col. H. D. Savage has been devoting his time to the development of pulverized fuel. At the present time he is probably the most prominent individual in this particular field of engineering endeavor. He has been speaking on this subject for several years past before many of the important engineering organizations in the United States and Canada. His intimate contact with all phases of pulverized fuel development, as well as his ability to put forward the essentials of this method of combustion in a clear and interesting manner, have made his services as a speaker in constant demand.

Col. Savage is a member of the American Society of Mechanical Engineers and of the American Institute of Mining and Metallurgical Engineers.

Big Strides Made in Industrial Electric Heating

Applications of Industrial Electric Ovens and Heating Equipment Extending—Electric Steam Boilers for Special Service Have Aroused Interest

By J. L. McK. YARDLEY
General Engineer to Westinghouse Electric and Manufacturing Company.

CONTINUED progress is being made in the development and application of apparatus for utilizing electric heat in industrial processes. Most striking, perhaps, are the strides which have been made in electric ovens, heat-treating furnaces and electric steam boilers. Arc-type melting and refining furnaces have become well established, and inductive heating has the inherent advantage of generating heat where it is desired, which makes its potentialities considerable. Rivet-heating apparatus has been developed to the point where it can meet moderate demands at low operating expense. Control apparatus for all of the fore-going apparatus has kept pace with these developments so that accurate and reliable operation is practically assured.

The development of the industrial electric oven rests upon a firm engineering and commercial foundation. Applications in the baking of electrical apparatus, foundry cores, japan, enamel and other processes requiring temperatures between 200 deg. and 700 deg. F. are continually extending. In the smaller sizes there is a tendency toward shelf-type ovens and toward vertical or tower construction for the particular purpose of saving floor space and employing some of the generally unutilized overhead spaces. Fortunately this sort of thing may be done in some low-temperature ovens if a relatively light conveying mechanism may be used, as the total weight is not so great but that the whole installation may be carried upon a comparatively light steel framework. Such possibilities are not inherent in industrial furnaces for higher temperature operations, owing especially to the much greater weight of refractories and heat insulation.

Electric Furnace at 2,000 Deg. F.

The industrial electric furnace for heat-treatment operations of many kinds gives increasing indication of coming into its own at no far distant date. In the past there has been considerable disappointment through mistakes and inadequacies in initial constructions and through misapplications, due in all cases observed to insufficient analysis and preliminary consideration of the underlying situation, the exact condition the furnace must meet and the changes in conditions which it would introduce. However, experience and knowledge have multiplied. In the approximately 20 per cent. chromium and 80 per cent. nickel alloy we have a heating element of very long life if it is not mistreated. We have furnace constructions in crucible, pit, chamber and car-bottom types which approach in ruggedness the fuel-fired furnaces without unduly losing in efficiency. However, the details of many process applications must yet be solved by experts. Recent successful installations indicate that, with the help of moderate-priced power, we are honestly entering a period of extensive electrical applications for hardening, tempering, patterning, annealing, cementation or case-hardening and other processes requiring temperatures ranging from 1,800 deg. F. down to, say, 1,200 deg. F. The field for applications of electrical power in heat within this range of temperature is unquestionably one of the largest still potential. The estimate in the N. E. L. A. 1921 Power Sales Bureau report of a potential total connected load in glass annealing of 60,000 kw. covered merely one part of this field.

Electric Furnace at 2,500 Deg. F.

Probably second to the above is the extensive field of forging operations, supplemented by high-speed steel heat-treatment processes, demanding temperatures within the range of 2,000 deg. to 2,400 deg. F. If the possibility of brass melting in the more than 3,600 brass foundries of the country be included, the potential field for electric power in heat at such temperatures is indeed great. Much commendable work, both in design and in application, has been done. More remains to be done in developing furnaces which will be readily and economically applicable to such processes. The engineering difficulties are great, owing particularly to the fact that the only practical resister elements available, carbon and graphite, are rapidly oxidizable at the temperatures required. The resisters must, therefore, be absolutely secluded from oxidizing atmospheres in order to have long life and low maintenance. Hence in these applications the competition of fuel-fired furnaces, and in the case of brass of the arc and induction types of electric furnace, has been more difficult to meet.

The electric steam boiler, which is a special form of electrode-type furnace, has aroused considerable interest during the past year or two. The principle was employed on a big scale over fifteen years ago at Niagara Falls in the three-phase water rheostats which were used for unloading the then largest 12,000-volt alternators while making acceptance tests. It has been incorporated in a number of very simple boiler constructions in which the amount of steam produced, and hence the amount of power consumed, may be controlled, automatically if desired, by regulating the water level. The electric steam boiler may become a very practical and helpful auxiliary to supplement or temporarily supplant the fuel-fired boiler in industries which require large quantities of steam and which are so located geographically as to have available waste or cheap hydro-electric power. The particular field for such boilers in large sizes would appear to be as an auxiliary to hydro-electric systems in territories where it has been found impracticable to approach 100 per cent. load factor with pulp grinding, electrochemical, electrometallurgical or other loads.

It appears more than probable that a host of successful applications will be found for electric steam boilers in small sizes; say 5 boiler-h.p. or less, in locations having moderately priced electric power, generated by steam or water power, in special processes, in isolated parts of industrial plants, in garages, in public buildings, in laundries and domestic use, in climates having only brief and irregular periods of low temperature. Such applications probably must usually be new or isolated or beyond the capacity of existing fuel-fired boiler plants. It is obvious, for instance, that when public service companies such as the Boston Edison Electric Illuminating Company will sell steam in quantities less than the output of a 5-h.p. boiler at $1.35 per 1,000 lbs., and at a smaller price for larger quantities, only very special and exceptional circumstances would permit the existence of an electric steam boiler within reach of its steam lines.

To-day there are probably more than a thousand arc-type melting and refining furnaces in the world, of which more than four hundred are in the United States and employed in the iron and steel industry. The special reasons for the expansion of electric steel making are the reduction of wholesale power rates, the extreme flexibility and adaptability of electric furnaces to a wide range of uses, and the quality of the products. With the electric arc furnace a reducing atmosphere can be maintained which enables the removal of sulphur and manganese sulphide, thus making it possible to readily eliminate oxides. The furnace may be used alone or in conjunction with the Bessemer or open-hearth type, or both. It may also be used in connection with the blast furnace or cupola for making semi-steel, gray iron and malleable-iron castings. Furthermore, it may be operated either acid or basic. The popularity of the arc furnace is increasing most rapidly in the small high-grade steel or iron foundry, owing to its advantages in small units for making frequent small heats. The desirability of relatively high voltage for melting and low voltage for refining is now generally recognized.

Arc Furnace Coming Back

As a means of melting brass the arc-type furnace is attracting increased recognition, the advantage of rapid operation outbalancing the early criticism that the arc would unduly volatilize the non ferrous materials. Possibly the best indication of the sound basis on which this application stands may be read in the recent announcement by one of the oldest and best known builders of fuel-fired melting furnaces for brass of a line of electric furnaces for brass melting employing the arc principles. The construction embodies the familiar pair of horizontal electrodes operated from a single-phase transformer; otherwise it retains the seasoned features of the oil-burning furnace, with some modification perhaps.

The possibilities of inductive heating should be kept in mind since it generates heat directly in the material to be heated. When suitable heat insulation is provided, the temperatures obtainable are limited only by the fusion temperatures of the best refractories.

The high-frequency induction furnace has come as a boon to the scientist engaged in the study of properties of matter at high temperature and under controllable chemical conditions. It is commercially promising for heating in vacuum, for melting silver, gold, platinum and precious alloys, and for melting of very high-grade alloys of steel and nonferrous metals. The units are small, so that a total of over 1,000 kw. installed, or double the amount two years ago, represents a widely diversified field and indicates a growth that appears healthy.

The low-frequency induction furnace is being applied—particularly for commercial uses—in the melting of non-ferrous metals and the production of brass. In fact, some foundries where continuous operation is the rule use this type of furnace only. New modifications of the low-frequency induction type are being brought out from time to time, indicating the interest that is taken in improving this application, although it seems to be on a successful basis already where established.

An example of the employment of commercial frequencies in a somewhat similar manner is found in the type of rivet heater in which the rivet forms a part of the transformer secondary circuit and is heated by the I^2R losses. The outstanding characteristic of this type is that the individual rivet may be heated exactly when wanted. However, constant attendance or close-control mechanism are necessary to prevent burning; otherwise, if the rivet is not required just when expected, then the energy of heating is wasted.

A type of rivet heater which gives promise of becoming popular consists of a chamber capable of holding fifty rivets or so, air-tight, except at the door, perhaps lined with non-oxidizing metal, and surrounded by heating elements and generous heat insulation. Such a heater kept filled with rivets and under pyrometric control is capable of meeting sudden demands for rivets in small quantities at any moment; still, it operates at a very low expense between demands owing to low radiation losses and the absence of attendance.

The regulation of the arc-type furnace, owing to the highly concentrated heat and intense temperature of the arc, must necessarily be controlled by current or kilowatt input. Several effective regulators have become fully developed which will hold the input with sufficient accuracy to a constant value according to the setting. The setting is changed during the cycle by the operator, as determined by the maximum permissible power demand and by the particular melting and refining periods desired for the kind and amount of charge. Induction furnaces require special controlling apparatus. For the resister type of furnaces, at least below 2,500 deg. F., methods of pyrometric control have been fully worked out by which the electrical input in the furnace is controlled according to the temperature of the work itself by means of one or more thermocouples placed in the furnace chamber adjacent to the work. The actual temperature variation below the maximum, within a furnace chamber, over a cycle, of course, depends upon the initial temperature and weight of charge, the amount of stored heat in the furnace walls and the rate at which energy is given up by the heating elements and absorbed by the charge after power is turned on. Radiant-type heating elements disposed as uniformly as possible about the work tend to give up heat at the greatest rate, owing to the resistance to heat flow from the source being a minimum. The maximum chamber temperature and the actual operating temperature after the work has reached the desired temperature are susceptible of the closest possible control by the pyrometric method, inasmuch as commercially available indicating and recording pyrometers are highly sensitive and, through secondary relays, will actuate contactors in the supply circuit upon changes in temperature even so little as one-half of 1 per cent. above and below the setting. The accuracy, flexibility and reliability of pyrometric control, more than anything else probably, constitute the appeal of the industrial electric furnace in heat-treatment processes.—Electrical World.

AIR PRESSURE IN FURNACES

(Continued from page 33)

should not be increased unless lower boiler temperatures are imperatively necessary.

4. Occasionally an engineer will state that a low draft over the fire is hardly worth trying, because he is not operating a modern stoker-fired plant, but a forced draft, hand fired boiler. The idea seems to prevail that only a plant with all the most modern improvements can obtain advantage from low constant draft.

The fact is that a hand-fired forced draft installation usually has a lower percentage CO_2 in the flue gases, and a much higher percentage excess air than a stoker fired installation, because constant opening of the fire doors admits excess air in quantities: Therefore, the hand-fired, forced draft installation would profit by draft control more than the stoker-fired installation. The only limitation is that the damper must be set so that it cannot shut completely when the boiler is being fired.

5. There is a tendency to call the conditions of a low constant draft over the fire "balanced draft." As a matter of fact this term is a trade name, used by a particular manufacturer. Much confusion may be caused by using the term where it is not intended to be used, and the manufacturer responsible for it expressly calls attention to this in his printed matter. Sometimes it is used when there is no "balance" whatever, and much use is distinctly ludicrous. The term should not be used in general discussion of draft conditions.

6. Sad experience with early types of mechanical regulators have made a good many engineers skeptical as to their value, but improvements in this class of apparatus have changed the situation and present types should be thoroughly investigated anew, when the question of low draft over the fire is under consideration.

It is important, in the interest of national economy of fuel, as well as in the interest of individual power plant operators, that a clear understanding of this matter of draft over the fire should be obtained by everyone who has charge of handling fires. Whether oil, coal or blast furnace gas is used for fuel, the same principles apply; so long as the fuel is injected under pressure or is supplied with air under pressure.

The mechanical cleaning of soot from boiler tubes, the application of forced draft to many installations and better methods of treating feed water have all tended to improve the economy of the boiler plant. Such economy will not be complete, however, until the rather substantial losses due to excess air and irregular temperatures are eliminated by some better means than merely endeavoring to make boiler settings tight.

No attempt has been made to discuss here the relative merits of different mechanical methods of obtaining a low draft over the fire. This is a matter for the engineer to study thoroughly before he makes up his mind concerning action to be taken. But the general principle that a low constant draft over the fire effects very real economies with boilers having forced draft and that satisfactory means are at hand for obtaining this economically is one which no engineer can afford to overlook.—"Steam Power."

Cause of Slag Incrustation Upon Boiler Tubes

Demonstrating Furnace and Draught Conditions That Have an Effect Upon Slag Formation—Analysis of Samples Taken at Different Times During Tests

By HARRY H. BATES

SLAG formation on boiler tubes and walls is essentially governed by the same rules as apply to clinker formation, inasmuch that the slag in the iron must be kept in the ferric state which is practically infusible. This can only be done by completely oxidizing the sulphur and iron before the tubes are reached.

All types of stokers have difficulty with slag formation and it is believed that slag particles are carried up with the draft in such minute form that they can be transported by the low-velocity gas as well as by the gas that rises rapidly.

An examination of the slag under the microscope revealed small spherical globules, substantiating the belief that the particularly troublesome particles were the small ones.

When these small particles come in contact with the free oxygen in the furnace gas for a sufficient time to oxidize them completely, they will be transformed into their completely oxidized state and become solid. If they solidify before touching the tubes or walls, they are carried through the boiler as solid ash. On the other hand, no free oxygen is obtained through the fuel bed. In this event the particles remain in a molten condition, on account of their fusing temperature, and are deposited on the tubes and walls where they may either be completely oxidized and solidified or be covered by successive coatings or layers of the same plastic material.

That the latter is true to a large extent is shown by layers of a very dark vitreous material covered by a reddish brown layer or protective coating. This reddish coating is largely ferric material and it prevents further oxidation of the dark ferrous material within by excluding the oxygen from it. A considerable portion of the material on the outer surface, especially on the tubes, is of a friable and non-fusible character, and it is of a completely oxidized nature.

Various efforts have been made for producing complete combustion in large furnaces, but it is pointed out even if some efficient means is developed for mixing the gas and excess air together, it is very questionable whether the slag difficulty will be entirely overcome. It is to be remembered that in addition to the problem of supplying and mixing the oxygen and combustible gases, time is required for the various chemical reactions to take place.

There is but little chance for thoroughly mixing all gases in the combustion chamber, as the rapid rate with which the gases ascend prevents a thorough mixing, so that stratification of the gases results.

In proof of the above, analyses of samples were taken from the first-pass baffle opening of a boiler immediately under the first row of tubes.

These readings showed a carbon dioxide content of from 10.0 per cent. along the walls to 17.5 per cent. in the center. From these figures it can be appreciated that the chances for the ferrous material to change into the ferric state are very few. It was evident that there was an insufficient penetrative effect from the ventilated walls to take care of the wide furnace, and it is also noted that there was considerable excess air along the walls.

Numerous samples of coal ash and slag were analyzed and it was found that the slag on the furnace walls ran much higher in ferrous iron, by per cent., than did the slag on the tubes. In consequence of this the slag on the walls was much freer from the coarse, friable, infusible material than was the material on the tubes.

Numerous theories were advanced during this investigation as to the causes of slag formation on the tubes. Chief among these was the condensation of tarry vapors on the tubes, to which the flying particles could adhere and solidify.

Whether condensation of tar can actually occur is, however, subject to doubt in view of the facts pointed out by the author.

In the large number of tests made it was indicated that the slag deposit on the tubes was nearly proportional to the total amount of gas, and was not greatly affected by the rating. The amount of slag was affected by the temperatures in the furnace, however, for the hotter fires kept the slag in a more viscous state, which greatly increased the tendency for cinders and particles of ash to adhere.

In trying to prevent slag accumulation three methods were considered. Among these the injection of steam into the air supply was tried, but no decrease was noticed in the formation of slag on the tubes. Another method now being tried is that of intimately mixing air with the gases. The original boilers were set about 13 ft. from the grates. It was thought that by increasing the distance between the grates and boiler tubes the gases would have more opportunity to mix thoroughly. Also, since the total time of travel of the furnace gas is dependent upon the velocity and distance of gas travel, more time would be allowed for complete oxidation of the small particles. Consequently a boiler was set up 6 ft. higher than those originally installed.

Assuming that the rapidity with which the gas rises from the fuel bed is uniform, it is calculated that its velocity was about 18 ft. per sec. This is the lowest possible velocity that can be expected. The direction of gas travel is from the grate direct to the baffle opening, which was proportioned as 46 per cent. of the grate surface. Necessarily the velocity was twice as high under the baffle as it was leaving the fuel bed.

On this basis the time it took for particles to reach the tubes with the original installation would be 0.72 sec. This is very little time for oxidization to take place, unless it is of an explosive character. Further, by raising the boiler to 19 ft. this same time would be 1.05 sec., which is still a very short period.

This arrangement has not shown any great improvement in slag prevention and has the disadvantage of exposing more brickwork to high temperatures and to draft, with resulting greater infiltration of air through the setting.

Furnace construction undoubtedly has much to do with the external incrustation of the tubes with slag. The ratio of the exposed tube surface to the grate area was 1 to 1. This is very low and the lower the ratio, under set conditions of fuel and fuel bed, the higher will be the furnace temperature. It is apparent that the higher the furnace temperature, the greater will be the tendency for the ash to fuse and stick.

It has become common practice now to have the ratio of exposed tube surface to grate surface as high as 1.87 to 1, and it is seldom less than 1.2 to 1. By increasing this ratio the amount of heat radiated up and absorbed is very materially increased, with a consequent reduction in furnace temperature. This last item, namely, furnace construction, is a step in the right direction.

It is extremely fortunate that only a comparatively few coals give slag trouble to a serious degree. A great many coals have fusing temperatures so high that they give no trouble with ordinary furnace temperatures. Another class of coals have low fusing temperatures, but do not seem to have the tendency to be lifted from the fuel bed. But when a coal gives serious slag trouble, with the present knowledge of

(Continued on page 44)

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

S. S. MOORE - - - Managing Editor
W. B. ROBERTS - - - - - - Editor
B. G. NEWTON - - - - - Manager
H. D. TRESIDDER - Advertising Manager

SUBSCRIPTION RATE
Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year, other countries, $3.00. Single copies, 25c. Advertising rates on request.
THE MACLEAN PUBLISHING COMPANY, LIMITED
143 UNIVERSITY AVENUE, TORONTO, CANADA
JOHN BAYNE MACLEAN, President
H. T. Hunter, Vice-President. H. V. Tyrrell, General Manager.

New Element Discovered

IT IS surprising to what degree of accuracy we can prophesy the discovery of a new element long before it is actually detected by our chemists. We know through the use of X-ray spectroscopy, that all chemical elements can be arranged in perfect rotation ranging from hydrogen with its atomic weight as one, right through the list of elements until we arrive at the last element on the list which represents the heaviest atom known and which bears the name of uranium. Thus our list of elements is complete in information, inasmuch that we know the position of each element, its atomic weight, and also a few of its chemical and physical characteristics, even before we have actually isolated this element in the chemical laboratory. This information is obtained through an analysis of the spectrum of various compounds, which has in its constitution a trace of the rarer element. The only means of tracing this is on the diagram of the spectroscope, even though the element has never before been seen or separated from its complex mass.

Until just recently, there were five such elements missing from our list, or perhaps it would be more correct to say instead of missing, that these elements had been identified, but not completely isolated or discovered. Now we are informed that the list has been made more complete by the discovery or isolation of a new element which has filled one of the gaps on the list, and which element has been given the name of hafnium. This element conforms in all particulars to one of the missing elements, and located in position seventy-two on the list, which number also signifies its atomic weight. This metal was discovered by Professor A. Scott, Director of Science at the British Museum, who, we are informed, detected this new element first in some peculiar black sands from New Zealand and from which he was successful in obtaining an oxide of the new element, which is the first that has been ever produced. It is a little too early in the day to speak about the possible uses for this new metal, but it is suggested that it may possibly be used in the manufacture of filaments for incandescent lamps and also for making crucibles.

Salinity Indicator

MOST marine engineers are familiar with the difficulties associated with the operation of an evaporator, and the constant attention required to insure that priming does not take place. There has been no means up to the present, whereby an engineer can tell at a glance the density of the water, without the usual hot and objectionable procedure of drawing off a portion of the water and testing it out with a salinometer. The same condition applies to a boiler where the circulating water in the condensor of the engine is salt, and a leakage would mean an increase in the density of the water in the boiler with its consequent ill results, if not caught in time. How often has an unsuspecting engineer taken it for granted that everything was in order when he suddenly realizes the density of his boiler is up. This is now a thing of the past, as a salinity indicator has recently been introduced that instantaneously and automatically indicates the density of the water by the use of a series of coloured lights. This is effected by means of a signal light controller and can be applied either in conjunction with an evaporator, or in a slightly modified and much more sensitive manner, directly with a condensor where the slightest leakage is immediately detected. This visible indication of the actual density condition, is conducive to much more satisfactory results since the chlorine contents are immediately indicated by a predetermined light colour, which should make operating conditions much more reliable than have hitherto been obtainable in the boiler or engine room, and at the same time make the position of the engineer a much more comfortable one.

Autogenous Welding

DURING the last decade, great strides have been made in the methods of making an autogenous weld. Further developments have been made just recently when a new process was demonstrated before the representatives of a large number of engineering and shipbuilding companies in Great Britain. In this process which is for both welding and cutting, hydrogen is used in combination with a 50 per cent. mixture of gasoline and benzol, and it is claimed that great economy is effected by the adoption of this combination, on account of the considerable reduction in oxygen costs. Tests were made upon cast iron, aluminum and steel and in the case of the latter, a ¾-inch boiler plate seventy-four inches long was cut through on a consumption of ¼-pint of gasoline-benzol mixture in less than eight minutes.

It is interesting to note among the advantages claimed, that this process can be operated without the generation of noxious fumes. It is stated that it can also be operated with such perfect safety, that an unskilled or unexperienced operator can use the apparatus without fear of an explosion. There are certainly points worthy of consideration in the selection of such an outfit, and one that we feel will be appreciated by the employer.

One advantage claimed by this system, is that the rough surface that is usually produced by the result of a torch cut, is perfectly soft and readily removed by a file. We are not, however, informed whether the physical properties of the metal are affected in any other way and whether segregation takes place.

Our Question Box

Commercial Rating of Boiler

Question.—Would you kindly inform me the rule that is used for obtaining the commercial rating of a boiler horsepower.

Answer.—This can be approximately determined by estimating the number of square feet of heating surface per boiler horsepower; or it may be calculated according to ratio of grate surface per horsepower. The heating surface of a boiler means that part of the boiler where heat is applied to one side and the water is on the opposite side. In a locomotive portable boiler, the heating surfaces comprise the internal surfaces of tubes, inside firebox sheets, as the crown sheet, wrapper plate, door sheet, firebox tube sheet, except the area taken up by the tubes, etc. The following table gives the estimated grate to heating surface per boiler horsepower: Heating Surf. per Horsepower in Sq. ft.

Type of boiler	
Locomotive	12 to 15
Watertube	11 to 12
Horizontal return tubular	12 to 14
Vertical	10 to 12
Flue	8 to 12

Heating Surf. to 1 Sq. ft. of Grate Area

Type of Boiler	
Locomotive	50 to 100
Watertube	35 to 40
Horizontal return tubular	25 to 35
Vertical	25 to 30
Flue	20 to 25

Having determined the heating surface of the boiler, divide the total effective heating surface by the unit of heating surface estimated to produce a boiler horsepower.

Take for instance, a portable locomotive boiler has an effective heating surface 900 sq. ft. As the horse power rating of this boiler is considered as of 12 sq. ft. of heating surface, the commercial horse power will be

900 divided by 12=75 H.P.

The actual boiler horsepower depends on the amount of water evaporated per hour. The unit of boiler horsepower is the evaporation of 30 pounds of water per hour from a feedwater temperature of 100 degrees Fahrenheit into steam at 70 pounds gage pressure. This is equivalent to the evaporation of 34.5 pounds of water at 212 degrees Fahrenheit into steam of the same temperature at atmospheric pressure. Boilers generate steam at different pressures and feedwater is fed into the boilers at different temperatures so these conditions must be taken into account in making boiler comparisons and in estimating the horsepower.

For this purpose a factor of evaporation is employed. This factor of evaporation is the ratio of the amount of heat required to make a pound of steam under actual working conditions to that required to produce a pound of steam from a feedwater temperature at 212 degrees into steam at atmospheric pressure. This is found by subtracting the heat units in one pound of feedwater at the given temperature from the heat units in one pound of steam at the working pressure. This difference is divided by 965.7, the number of British thermal units in one pound of water evaporated from and at 212 degrees F. Engineers' hand-books give the table covering the factors of evaporation, which are used in making boiler horsepower calculations. If for example a boiler evaporates 10,000 pounds of water per hour from a feedwater temperature of 70 degrees F. at a steam pressure of 100 pounds per square inch, gage, the factor of evaporation given in the table of factors of evaporation equals 1.188. This factor indicates that if the feedwater had been 212 degrees F. and evaporated into steam at the same temperature, or at atmospheric pressure the boiler could have evaporated 10,000 x 1.188=11,880 pounds of water, which is called the equivalent evaporation. Since one boiler horsepower is the evaporation of 34.5 pounds of water per hour at 212 degrees F. with steam at the same temperature, the horsepower of any boiler is determined by dividing the equivalent evaporation by 34.5, and in this example 11,880 ÷ 34.5=344.3 boiler horsepower.

Work Effected by Pump

Question:—We have a large water tank having a capacity of 100,000 gallons from which water is being constantly used, and wherein it is impossible to tell the exact amount. There is a pump in constant service pumping this tank up. Could you tell me how many gallons per minute and per day, this pump discharges into the tank, the pump having a plunger of 9¼ inches diameter, 14 inch stroke and having 38 strokes per minute.

J. P. T.

Answer:—If the pump is working at a constant speed, it will be an easy matter to find out the number of gallons displaced in one minute and also in 24 hours. We do not, however, know the efficiency of the pump, which can be fairly well judged by its condition, if a test has not been made. We will, therefore, presume the pump to be 100 per cent. efficient and J. P. T. must deduct a certain percentage from our figures to allow for leakage.

The plunger having a diameter of 9¼ inches, the area in sq. inches will be 9.25 × 9.25 × 9.25 × .7854 = 67.2 and the volume displaced each stroke will be 67.2 × 14, which is multiplying the area by the stroke in inches, which gives us 940.81 cubic inches per stroke. If this is multiplied by the revolutions or strokes which are 38 and divided by 1728 (cubic inches in one cubic foot) we get 20.6 cubic feet per minute, which multiplied by 6.24 (gallons in a cubic foot) we get 128.73 gallons per minute. For gallons per day multiply this by 1440 which gives us 185,381 gallons per day.

$$\frac{9.25^2 \times .7854 \times 14 \times 38 \times 6.24}{1728} = 185,381$$

gallons per day.

Compressed Air

Question.—What is the principle of compressed air as applied to refrigerations?

A. T. M.

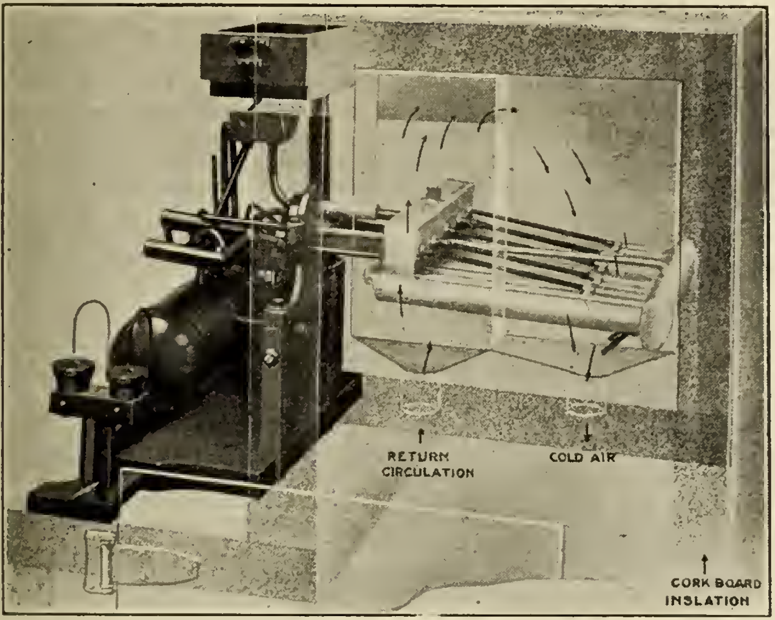
Answer.—In the first place it must be understood that in order to effectively expand a gas, it must absorb heat, and secondly, that the act of compressing a gas generates heat. If therefore a compressed gas is re-expanded it absorbs the heat lost during the process of compression, but if the compressed gas has already been cooled down, it is evident it will not contain sufficient heat to effect its own expansion, and it will therefore have to extract the necessary heat from its own surroundings and by so doing it will considerably reduce its temperature. If, for instance, 1 lb. of air at 14.7 lbs. absolute pressure and 60 deg. Fahr. is compressed to 110 absolute pressure, its temperature will be raised to 475 deg. Fahr. This compressed air is now cooled down to 6 deg. Fahr. or through 410 deg. Fahr. (475 deg. — 65 deg.), as the specific heat of air is .238, the number of thermal units that have been extracted from the air are 97.58 (410 × .238). When this cool compressed air is now re-expanded to 14.7 lbs. absolute, it will have to absorb 97.58 B. t. u.'s. Since the extraction of 170 thermal units from 1 lb. of water at 60 deg. Fahr. converts it into ice, it is evident that if the 1 lb. of compressed air at 65 deg. Fahr. is expanded surrounded by .574 lbs. of water (97.58 ÷ 170) at 60 deg. Fahr., it will also be converted into ice.

Progress in New Equipment

Iceless Refrigerator

An electric refrigerator has been recently developed, that has no working parts and still is operated by electricity and produces its own ice. The actual ice making apparatus itself is very small and is as simple as the two principles which it employs. The first is—that pure liquid ammonia whilst evaporating, chills the surrounding air, just as your finger feels cold when moistened and held in the wind, allowing the moisture to evaporate. The difference is that liquid ammonia chills in a very much more marked degree. The second principle is that evaporated ammonia is absorbed by water very easily and readily, and in large volumes.

Referring to the illustrations: on the left hand side in the tank, is about two quarts of ordinary ammonia such as is purchased for home use. Within the tank there is also a small electric heater. When the heater is started the gas is driven out of the water. This gas is not very warm, as ammonia is very easily driven off, and when it flows over into the pipes shown on the right of the illustration it is chilled by a trickle of cold water which is flowing over the pipes. When it is chilled the gas is deposited on the inside of the pipes, about the same as dew is deposited by the chill of the morning air. This deposit is pure liquid ammonia. When the pipes are nearly full of the pure liquid ammonia, the weight is sufficient to swing the pipes down, raising the tank and shutting off the electric heater. Almost immediately pure liquid ammonia begins to evaporate and to chill the pipes, which in turn, chill the surrounding air which flows down into the refrigerator. As the pure liquid ammonia evaporates it flows back as a gas into the tank of water, where it is quickly absorbed. As soon as the evaporation is completed the pipes, having become lighter and the tank heavier, the apparatus tilts back to the original position and the electric heater starts again. The operation is automatic. The mechanism can be arranged for either chilling the air or freezing the water into ice cubes for table use, which latter process is just a little more costly. The amount of electrical energy consumed varies from 2.7 to 3.8 kilowatt hours per day, continuous operation. These refrigerators are made by the Keith Electric Refrigerator Co., Toronto, Ont.



Operating mechanism of the iceless refrigerator.

Ames No. 55 Simplified Dial Gauge

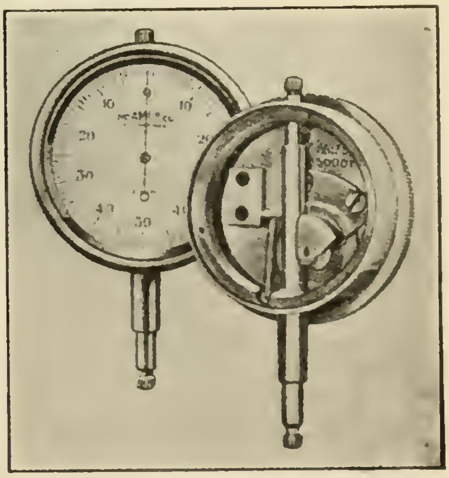
The simplified dial gauge or indicator shown in the accompanying illustration is a recent addition to the line of gauges produced by the B. C. Ames Co., Waltham, Mass. It embodies several marked improvements in construction and design over the previous type, such as simplicity, durability, accuracy and interchangeability.

The No. 55 dial gauge has only 39 [illegible] as compared with 55 parts [illegible] gauge made by the same firm. Simplicity has been gained by putting both the rack wheel and the take-up wheel with the spring all on one large staff, and thus using only one bridge to support these parts and the center pinion. The design of the bezel eliminates other parts such as lugs and lug screws, since the bezel is held onto the case by one piece of spring brass wire. The elimination of these parts has made the mechanism more durable and accurate since there are fewer parts to wear, break, get out of order or replace.

The gauge can be badly abused and yet retain its smooth spindle action and accuracy. The manufacturer claims that it can be dropped from a height of 5 ft. or even more to the floor, so that contact is applied to the plunger, without injury to the instrument; and that the case may be battered out of shape, and still the gauge will function perfectly. This is made possible chiefly because the wheel staff is very large and the spindle is so designed that the shoulder thereon comes in contact with the top of the case to receive the shock.

A tolerance of only 0.0005 in. plus or minus is allowed in the entire spindle travel, and any gauge showing a greater inaccuracy is rejected at the factory. All parts are made with jigs and to standards, so that parts substituted at any future time will fit perfectly. The screw and other parts have all been constructed larger than before, thus making assembling and disassembling easier and simpler.

The bridge is made of thick pressed brass and the guide block of solid brass. The case and back are similar to those on the No. 5 gauge. The spindle travels 0.3 in. The dial is usually graduated into 100 parts, reading 0.050 in. each way. By using a special rack wheel, the dial can be divided into 50 parts, the marks being twice as far apart. Special dials and spindles can be supplied.



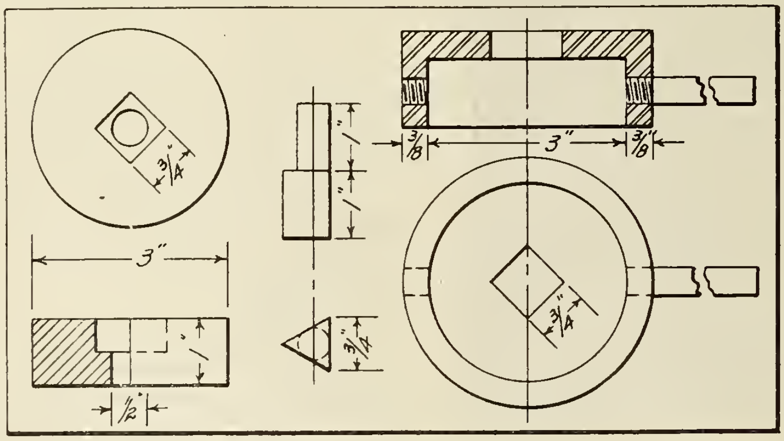
No. 55 Simplified Dial Gauge.

The Operator's Point of View

Drilling Square Hole

By F. Hindle

The accompanying sketch shows the method of holding 3 in. discs while recessing out the square hole as indicated at A. The block is one of a number of forge machine die heads that were required to the dimensions given. The square section was drilled out by using the jig and triangular drill bit. A piece of tool steel large enough to make the triangular portion was selected and turned on one end to fit the drill chuck. The triangle was then milled with one side equal to that of the side of square required. After the jig and drill were made and hardened the drill bit was ground until it turned freely in the square hole of jig. When in operation the jig is allowed to float on the drill table, the handle serving as a stop. The ½ in. hole was first drilled through the center of the 3 in. block.



Gear for Drilling Square Holes.

Double the Life of Electric Bulbs

A great number of electric bulbs, which are considered as being burnt out and useless, can be quite easily repaired, by knitting together the broken ends of the filament, and the bulb will last as long again. If, however, the bulb is fogged, (white or yellowish-white) or if there are pieces of hair-like filament loose in the bulb, it is useless, since the ends cannot be brought together.

Electric Bulbs

It is best to work in daylight and behind a pane of clear glass, such as may be in a cupboard door, or by raising a window, so that the pane of glass will protect the face, eyes, of the worker,—if bulb should happen to burst,—which is quite unlikely. Simply screw bulb in socket (an extension makes it more convenient) and turn on the current. Now move bulb about so as to bring the two broken ends of the filament together. As it connects, the bulb will light. Leave bulb burning for a minute. Turn off current and turn on again and it will found that the filament has been knitted or welded together.—M. E. Franklin.

Little Losses Often Costly

By W. F. Schaphorst

It is a pretty safe bet, in most establishments where power is used, that the simple little losses when added together amount to more than the single big loss that, because of its bigness, can be plainly seen. Besides, the cost of eliminating the small losses may amount to considerably less than the cost of eliminating the big loss. The writer is more familiar with power transmission by belt and ropes than with most other mill equipment hence his mind usually thinks in terms of belts, ropes, shafting, pulleys, etc. Nevertheless, the little losses in other departments are of equal importance. There is too much lost motion wherever you go. Too much friction not only between shaft and bearings but between human beings.

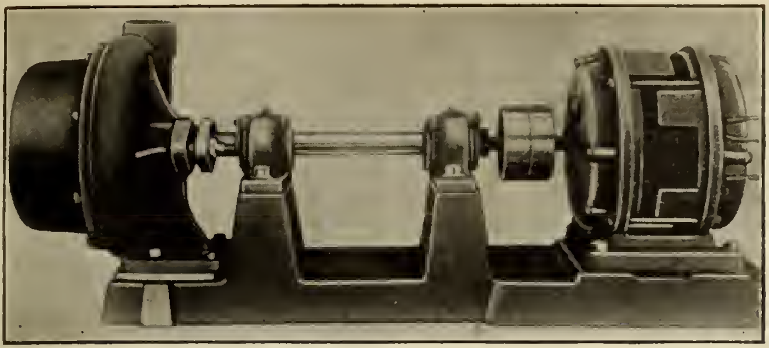
For example the head miller finds that a machine isn't running fast enough. It is 5 per cent. too slow. He cannot speed it up faster because it was made for one speed and only one. The foreman may not know it, but in addition to the 5 per cent. production loss there is a 5 per cent. power loss. The driving engine or motor is doing just as much work as though it were pulling a full load. The actual load of the driven machine plus the power loss due to belt slip is equal to the full normal load without slip. However, the head miller knows or feels that production could be increased by spending a few cents to treat the belts and make them pull without slipping. Or, he would spend a little more and use some larger pulleys. He knows that large pulleys are not so liable to slip.

He, therefore, goes to the manager and suggests the improvement. The manager, however, is a balky person. He tells the head miller that he doesn't know what he's talking about—that everything is O. K. aside from the slight 5 per cent. production loss. He says to the head miller, "If we wanted to increase the speed by that 5 per cent. we would buy a larger driving pulley for $30 but it wouldn't pay. It's too much trouble." There the matter rests. In the above case a new $30 pulley wasn't needed at all. About 5 cents' worth of belt treatment would have put the belt in proper condition to do full work without slipping. The manager, you see, proposed to spend $30 and at the same time continue to pay for the constant power loss of 5 per cent. which might amount to another $30 per year, plus the cost of wear and tear on the slipping belt. Little losses, surely, are worth investigating and stopping, if it is possible to do so at slight expense.

Electric Steam Boilers

Equipment for generating steam with electric power has aroused interest in various parts of the country, especially where fuel is scarce and surplus water power is available at a low rate. High tension electric steam generators have been installed to the extent of 150,000 kw. in the past year and are operating at 99 per cent. efficiency, according to the manufacturer. One big advantage of such boilers is their lower first cost compared with fuel-fired boilers and their flexibility and ease of control. Another electric steam generator has been developed which is also extremely simple, reliable, compact and high in efficiency. Its chief difference from those previously developed is a separation of the steam generating space from the hot well and the provision of adjustable circulation between the two which enables regulation for steam demand and energy input and facilities forcing.

Albert W. Honywill, Jr., has severed his connections with the Terry Steam Turbine Company, at Hartford, Conn., to take up new duties as assistant to the president of the Diamond Specialty, Ltd., of Windsor.



Motor-driven centrifugal pump.

Motor-Driven Centrifugal Pump

A ball-bearing, motor-driven, self-priming centrifugal unit for pumping liquids such as coolant compounds, oils, brines and enamels, has recently been placed on the market. This pump is similar in design to others of the same make except that this latest model is equipped throughout with ball-bearings, and has a capacity of 75 gal. per min. Intake and discharge openings are located at the top so that sufficient fluid is retained in the pump chamber for priming; no valves or other mechanical appliance is necessary. Flow starts as soon as the unit is placed in operation. The pump can be regulated to discharge any given quantity, from a few drops per minute to the full capacity. These pumps are made by the Fulflo Specialties Co., Blanchester, Ohio.

The Amateur Inventor

John S. Watts

The desire to get rich quick is the underlying cause of at least ninety per cent. of the abortive inventions which flood our patent offices. Out of all the mass of patents granted, it has been stated that only three per cent. are successful, a statement which my experience leads me to believe to be approximately true. The main reason for this seems to be that although the bulk of these so-called inventions are of mechanical contrivances, the inventors themselves are generally men who are only indirectly connected with mechanical work, such as salesmen, bookkeepers, etc. In the nature of things, and in this mechanical age, the largest field open for new ideas of a patentable character is naturally in the mechanical arts.

The variety of machinery, such as typewriters, sewing machines, autos, radio phones, etc., which the ingenuity of engineers has made available in such form that they can be operated by any intelligent person, has had a tendency to impart to the non-technical operator a feeling of familiarity with machinery, based wholly on his ability to operate such machines, and a very slight acquaintance with their mechanism acquired by the curiosity engendered by its use. To the mechanic it is amusing to note how the owner of an auto who has successfully taken some part adrift and got it together again, will, on the strength of this simple feat, give himself the airs of a full-fledged mechanic, and plainly indicate his feeling of confidence in his ability to criticize and improve on the work of an automobile designer.

As an illustration of this, I would cite the case of an automobile salesman who conceived the idea of having the blades on the radiator fan made adjustable in order that in cold weather the blades might be set neutral so as not to draw cold air into the radiator, or even reversed to blow air from inside the hood through the radiator. The inventor patented the idea and had a model made, which he submitted to a manufacturing concern with a proposal that they should manufacture the fan on a royalty basis, and employ him as salesman. This firm consulted me for advice on the subject, and for an estimate of the cost of redesigning the fan to make it a feasible proposition, the model being a very crude thing and obviously impractical.

Like most of the non-technical man's patents all that could be said in its favor was that it embodied the idea of something that might be useful if it could be accomplished, but that the inventor had not really invented anything, as the idea as it stood was not practicable, firstly because it would cost too much to manufacture, and when made would soon rattle itself to pieces; secondly, no chauffeur would be bothered with adjusting a fan that required his stopping the car and getting out to lift the bonnet to get at it every time the fan needed adjusting; thirdly, that while having the fan blades set at neutral would assist in getting the engine warmed up quickly when starting, to set the fan blades reversed with the idea that this would warm up the engine by taking heat from it to warm the radiator is as absurd as trying to raise ourselves by tugging at our own boot-straps.

I handed in an estimate for making a workable design, arranged for manipulation of the fan from the dash-board, and there the matter still rests, as the inventor had spent all his money getting the patent and having a model made. The poor devil was quite enthusiastic about his scheme, as these fellows usually are, and bringing him to face the facts was an unpleasant business. Indeed, about the work I dread most is that of advising upon patents, as they are generally worthless, or at best are only a crude idea needing considerable expense to make workable, and to kill the inventor's wild enthusiasm is a painful business for which one is rarely paid, even in thanks. Indeed, in many cases I have known my advice has been received with scepticism as being due to professional jealousy, or even imputed to a desire to steal a valuable? invention, by discouraging the original inventor. It seems as though in the overwhelming enthusiasm of giving birth to their invention, they could blind themselves to its weaknesses, just as a mother can see nothing but beauty in her new-born child, although to outsiders the said child looks rather more like a boiled lobster than a future president.

My latest experience with patents is rather amusing. The invention was an automatic gate for railroad level crossings, "invented" by a miner and financed by a doctor. The general idea was to have a lever which would be struck by a wheel of the locomotive, and the movement of this lever being transmitted in some undetermined manner would open and close the gates. There was no drawing of the invention, merely a rough wooden model, which worked, of course, beautifully. But a moment's consideration would show that a train striking this lever at any speed would simply break it off, or the train would go off the track. Even if the lever could be made to stand the blow or force required to start it from rest to a speed of perhaps sixty miles an hour instantly, which would require an infinite force, the gate arms, being some twenty feet long, would move with a velocity of about one thousand miles per hour, which would be absurd. Then again, even if all this were possible, consider the added excitement of joy riding across a level crossing, never knowing when the gate arms would come crashing down on one without warning at a speed exceeding that of sound.

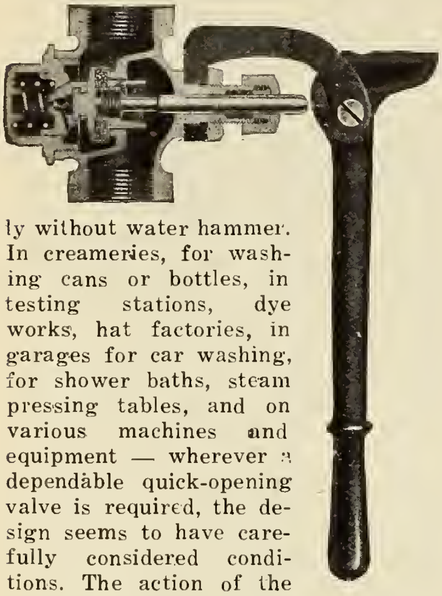
NEW PUBLICATION

Steam Turbine Principles and Practice, cloth bound 5½ in. x 8 in., 350 pages, 282 illustrations published by McGraw-Hill Book Co., Inc., 370 Seventh Avenue, New York. First Edition. This book treats with the subject most fully from the time of the first turbine, 150 B. C., through its successive stages until the present day. It is divided up into 14 divisions; at the end of each, there are questions to be answered dealing with problems from the various chapters. The book is essentially written for the operator, or the man who wishes to know sufficient about turbines to make a purchase and all calculations can be easily followed with those who have a working knowledge of arithmetic.

Waterman-Waterbury Mfg. Co., Regina, Sask., will construct a warehouse and office building. Work will be started immediately. Approximate cost $40,000. Further units will be added as required.

WATER HAMMERLESS VALVES

Adapted to a wide variety of special purposes, it is claimed for the recently-perfected Jenkins Rapid Action valves that they were designed to meet demand for a valve that would act instantaneously without water hammer. In creameries, for washing cans or bottles, in testing stations, dye works, hat factories, in garages for car washing, for shower baths, steam pressing tables, and on various machines and equipment — wherever a dependable quick-opening valve is required, the design seems to have carefully considered conditions. The action of the valve does not depend upon set screws, locking devices or other appliances. When given a pull, equivalent to a quarter turn, the hand lever bears on the end of the spindle, forcing the disc from the seat and opening the valve. Aligning as it does with the spindle, the lever positively holds the valve open. A slight pull on the lever will throw it out of alignment with the spindle, and the disc is then immediately forced on the seat. The closing of the disc on the seat is regulated to avoid water hammer through a combination of spring, piston, cylinder and water pressure. Herewith is a sectional illustration showing how spring and pressure in the line hold the disc on the seat. The valve is made of high grade bronze mixture, fitted with Jenkins renewable composition disc, the spindle is made of steel, the yoke steel forged, and the lever of malleable iron. The end of spindle and cam on lever are especially hardened to prevent wear. The valve has a slip-on type of disc holder, making it possible to change the disc very rapidly.



CAUSE OF SLAG ENCRUSTATION

(Continued from page 38)

the art of burning coal, means must be provided for its mechanical removal. This, however, is not as serious a matter as it appears, for soot blowing in boiler plants is now recognized as a necessity, and apparatus for soot removal is now installed as regular boiler equipment.

Elmira, Ont.—Mr. A. M. Bowman, local hydro superintendent, states that the increasing power load has necessitated the purchase of new transformers.

IRVING SUBWAY FLOORING

In these days when industrial economics seek to combine safety, service and sanitation, Irving Iron Works, Long Island City, N. Y., are making distinctive claims for their Irving Subway flooring. Advantages are summarized as follows:

A complete sectional open flooring—as safe and comfortable and noiseless to walk or work or wheel upon as the best solid floor.

A surface absolutely and permanently non-slipping, even with oil, grease, soap or water upon it.

Fire-proof, non-warping, shock-proof, non-chipping, non-dusting.

80 per cent. open space for light and air to pass—a cool floor to work on or under.

Clean, sanitary, non-dirt-collecting, yet with openings too small for tools or large objects to pass through.

Openings for pipes, columns, etc., easily cut out without seemingly impairing the strength of the panel.

Wheels, trucks, barrows, and rib-hooped barrels easily rolled over it in any direction.

Easily and quickly installed in any type of construction without drilling or tapping, screws or bolts.

A general-purpose flooring adapted to probably 75 per cent. of the places where flooring is used in industrial and engineering construction.

Irving Iron Works also manufacture the Sofstep, an all-steel, self-contained unit with its own carrier, drilled ready for mounting in stairs or ladders. It is said to be non-slipping, time-proof and wear-proof.

TRANSFORMER BROCHURE

Brush Electrical Engineering Co., Falcon Works, Loughborough, Eng., issued a transformer brochure, descriptive of Brush static transformers. This company have standardized definitely on the core type of transformer for single-phase and three-phase alike, claiming certain advantages in definite temperature regulation, ease of repair, and less danger to distortion of circular-wound coils in the event of heavy currents flowing in the windings. The Brush company also manufacture transformers for special service.

Testing Feed Water for Corrosiveness

Place a small quantity of the water to be tested into a glass tumbler, and add a few drops of methyl orange. Then the water will turn pink, if the water contains acid.—Steam, Feb., 1923.

Uehling Instrument Company, Paterson, N. J., manufacturers of CO_2 recording instruments, have appointed the Combustion Engineering Corporation, Ltd., head office, Toronto, and branches in Montreal, Winnipeg and Vancouver, as their Canadian engineers and sales agents.

That the purchasing department of the Central Division of Canadian National Railways may be located in Toronto, is the current report. Purchasing agents will welcome this as indicating that they are not to lose that contract with the National system which they have secured during location of general offices in Toronto. The Central Division is described as extending from Chicago on the west to Riviere du Loup on the east and will have to do with the most thickly-populated section of the country. Nationally, more extensive purchases are made for this section than for any other. Although the tender system throws prospective purchases open to the entire market, selling agents feel that direct contact is an important consideration.

Hamilton.—National Steel Car Corporation, Hamilton, have orders on hand at the present time for new work with the Canadian Pacific Railway and the Canadian National Railways, and for repair work with the Canadian National and Temiskaming and Northern Ontario Rly. Commission; also for some export repair work for the Erie Railroad of the United States. The Corporation reports that the outlook is brighter than it has been for the past few years.

It is reported that the Canadian Car & Foundries Co., Ltd., will vacate their present premises on the ninth floor of the Transportation Building, Montreal, May 1, to take up extensive offices in the building they have acquired near the north-east corner of Craig Street and Victoria Square. This building is four storeys high, of spacious dimensions, with stone front. The frontage is at present being remodeled.

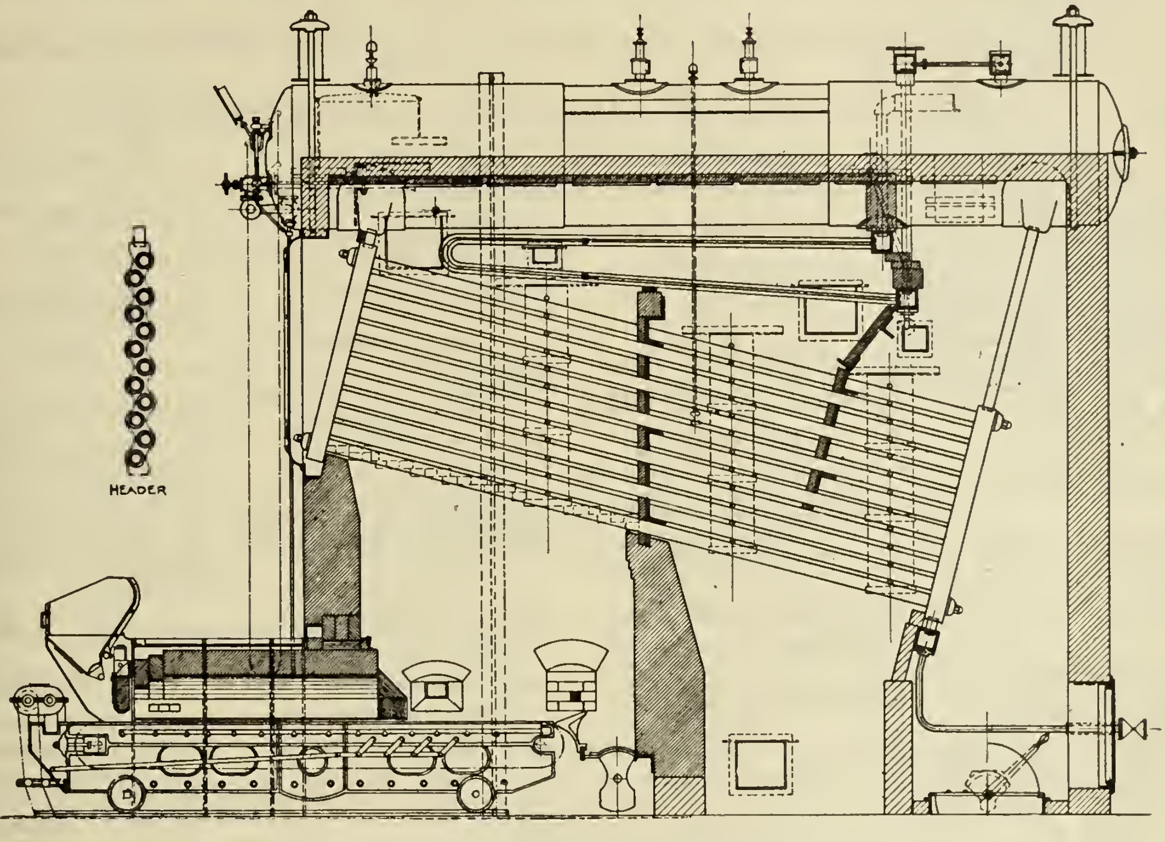
Canadian Fairbanks-Morse Co., Ltd., have made arrangements with the Henry Pels & Co., of New York, for the sale and distribution of their metal working machinery in the Province of Ontario.

Canadian companies incorporated during the past week include the following: The Combustion Engineering Corporation, Ltd., Toronto, Ont.; The National Meter Co. of Canada, Ltd., Toronto.

A. F. White, who has been connected with the Marsh Engineering Co., Belleville, Ont., as general superintendent for the past ten years, has been appointed Toronto sales manager for the John Inglis Co. Mr. White commenced his new duties March 1.

Plans for the further extension of the Canada Gas & Electric Corporation, now supplying Brandon, Man., with electricity, have recently been made by J. R. Harvey, manager. Approximately $400,000 will be spent. Included in the expenditure list is the installation of three new 500 h. p. boilers burning lignite, in the little Saskatchewan plant on the Saskatchewan river. Completion of the power plant will enable the development of 4,000,000 k. w. The highest amount ever generated there is about 500,000 k. w.

BOILER EFFICIENCY



Standard Longitudinal Drum Sectional Header Boiler

The laws of each province provide that every boiler operated within its boundaries must be built to certain recognized standards. All details such as seams, riveting, fittings, etc., must meet the approval of their inspectors before they will pass any boiler as safe to operate.

The Civil Law also states the lowest grade of engineer you can employ and how often he is required to prepare each boiler for inspection.

The lawmakers are concerned with the safety of the public, they do not make it compulsory for you to buy economical plant. You are expected, on your own judgment as a business man, to buy boilers which will give you the highest degree of safety and the greatest return for your money in pounds of water evaporated.

Now just as there are Civil Laws to make sure no unnecessary risks are taken by the public, so there are certain acknowledged engineering laws for the design and construction of economical boilers and furnaces. The success of all such equipment depends upon the success with which these laws, which safeguard your money, are applied—practically.

Boilers made by B. & W. are readily accepted by the authorities, even in the provinces with the stiffest requirements, because they are designed with a higher factor of safety than asked for, and no steam apparatus is made of better material or with more care. Every part is readily accessible inside and out, and with a responsible man in charge to see they are kept clean, there is little possibility of serious trouble.

As regards the efficiency of B. & W. steam plant, we can only ask you here to consider two factors—(1) THE EFFICIENT FURNACE because the fuel is fed evenly and intermixed with a proper amount of air while burning. Perfect combustion is produced and the fuel all gasified in the large combustion chamber before the heating surfaces are reached. (2) THE EFFICIENT HEATING SURFACE because of the proper circulation of the water and hot gases with reference to each other, and because they thoroughly interpenetrate each other, due to the arrangement of the baffles and the manner in which the tubes are staggered.

Babcock & Wilcox, Limited

Head Office for Canada: St. Henry, Montreal

Branch Office: Bank of Hamilton Bldg., TORONTO

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we willtell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

AMMONIA PLANT EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
Under-feed Stoker Co. of Canada, Ltd. Toronto.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co.,: Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd., Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Sheil Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. McLaren Limited, Montreal, Que.

BELT HOOKS
Bristol Co., The, Waterbury, Conn.
D. K. McLaren, Limited, Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd.

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, FABRIC
D. K. McLaren Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. McLaren, Limited, Montreal, Que.

BELTING, SOLID WOVEN
D. K. McLaren, Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

CORD CLOTHING
D. K. McLaren Limited, Montreal Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd., Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto. Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Suply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goidie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goidie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co. Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren, Limited, Montreal, Que

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W

GEO. CALLARD
BUILDER & CONTRACTOR
Furnace and Boiler Work a Specialty
Highest References from All the Leading Engineers of the City
Phone: Uptown 1590
210 Quesnel Street Montreal

FOR SALE
Fuel Oil Storage Tank
10,000 GALS. CAPACITY
This is a new tank. We have not yet taken delivery of it, and offer it at a very attractive price.
MR. VOGAN, The MacLean Publishing Co.,Ltd, 143 University Ave., TORONTO.

FOR SALE

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15″ deep, 2 ft. 6″ wide, 3 ft. 11½″ high, fitted with built-in compartment. Price $250.00. 18″ deep, 2 ft. 8″ wide, 4 ft. 5″ high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order Apply Box 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

SAWMILL MACHINERY—MODERN DESIGN—most satisfactory to operate. Apply Box 105, Power House.

SAWMILLS—PORTABLE — DOUBLE EDGES; also all kinds sawmill machinery. Apply Box 106, Power House.

WELDING

ELECTRIC AND ACETYLENE WELDING—of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

BELTING BARGAIN

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES · $1 A MONTH
8754 ILLUSTRATIONS · $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator --Lubrication --PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________
Occupation ____________
Employed by ____________
Residence ____________
Reference ____________

YORK Ice Making & Refrigerating **MACHINERY**
For Every Practical Purpose
Consultation on any Refrigerating Problem invited.
CANADIAN ICE MACHINE CO., LIMITED
Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

OIL BURNING SYSTEMS
INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.
LAURIE ENGINE CO.
(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.

SUPERHEATERS
ELESCO
DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES.
FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

WESTERN REPRESENTATIVES:
THE TAYLOR ENGINEERING CO., LTD.,
VANCOUVER, B.C.

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

MADE IN CANADA
WORKS AT SHERBROOKE, QUE.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johna-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Wsring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engina Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Godfray Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Maad-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Balt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montraal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Northern Crana Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Maad-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.

COILS
Frick Co., Wayneshoro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CARBONIC ACID GAS
Laurie & Lamh, Montreal.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battla Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamh, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Wayneshoro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Bahcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engina Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montraal.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterhury, Conn.

COUPLINGS
Csn. Fairhsnks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldia & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pannock, Reg'd, Montreal.
Northern Crana Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montraal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Canadian Link-Balt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crana Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairhanks-Morsa Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherhrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb. Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Ruhber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto. Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DOORS, CAST IRON, AIR TIGHT
Conveyors Corp. of America, Chicago, Ill.

DRAFT GAUGES
Schaefer & Budenhurg Mfg. Co., and American Steam Gauge & Valva Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairhanks-Morse Co., Ltd., Montraal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairhanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injetor Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can, Fairhanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd. Montreal

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto.
Cansdian Ingersoll-Rand Co. Ltd., Sherhrooke, P. Q.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engina Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamh, Montreal.
Sturtevant Co., B. F., Toronto and Boston

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR DRIVES
Sterling Engine Co., Buffalo, N. Y.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairhanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines. Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Lauria & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto,
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N. Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER HEATERS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamh, Montreal.
Northern Equipment Co., Erie, Pa.

FILTERS
Graver Corp., East Chicsgo, Ind.
Laurie & Lamh, Montreal.

FILTERS, WATER
Frick Co., Waynesboro, Franklin Co., Pa.
Graver Corp., East Chicago, Ind.
Schaeffer & Budenhurg Mfg. Co., and American Steam Gauga & Valva Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaifa & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y
Bevaridge Supply Co., Montreal.
Elk Fira Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fira Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Baveridga Supply Co., Montreal,
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS. AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crana, Limited, Montreal.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crana, Limited, Montreal.
Karr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crana Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N. Y.
Kerr Engine Co., Walkarville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane'e Limited, Montraal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOORING, SUBWAY
Irving Iron Works Co., Long Island City, N.Y.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Bahcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Wm. B. Scsife & Sons, Pittshurg, Pa.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FUEL ECONOMY DEVICES
The Boiler Repair and Grate Bar Co., Toronto, Ont.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome. N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

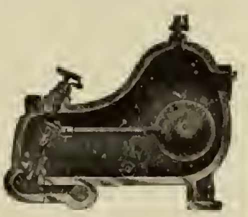
FURNACES, SMOKELESS
Bahcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Roma, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Johns-Pratt Co., Tha, Hartford, Conn.

HINTS TO BUYERS

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial?
Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.
Send for Catalogue
THE GARTH COMPANY
Craig Street-MONTREAL, CAN.
WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



1. Draft Increased
2. Cinders Eliminated
These are two of the plant economies of Sturtevant Cindervane Fans. Sturtevant engineers will gladly outline others to you.
Send to-day for folder 609.
Sturtevant
PUTS AIR TO WORK
B. F. Sturtevant Co. of Canada Ltd.
Montreal, Galt, Toronto

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue*
Patterns *Machine Work*

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK
Nature's Water Softener
Copyright 1920—The Refinite Co.
For Boiler Feed Water
Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.
A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.
Write for Information and Catalogue.
Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

Foxboro quality indicating and recording thermometers, pressure gauges, liquid level gauges, vacuum and draft gauges and CO2 recorders are designed and built especially for power plants and industrial processes. Write to Dept. C.F.
THE FOXBORO CO., INC.,
Foxboro, Mass., U.S.A.
FOXBORO
TRADE MARK
THE COMPASS OF INDUSTRY 4915

GARLOCK
Main Canadian Offices and Factory
Hamilton - - Ontario
Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.
PACKINGS
THE GARLOCK PACKING COMPANY

FUEL OIL BURNING
for
HEATING and POWER PLANTS
Correspondence Invited
ENGINEERING & CONTRACTING
The T.J. CUNERTY *Company*
Room 240 17, Queen St, East Toronto

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HAND-HOLE
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Beldam Asbestos (Canada) Co., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.

GASKETS, LEAD, COPPER AND SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

HANGES, GAUGES, AMMONIA, OIL, GAS, AIR
Schaffer & Bundenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Bristol Co., The, Waterbury, Conn.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto. Ont.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal
Canadian Steam Boiler & Equipment Co., Toronto.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E. London, Ont.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto, Ont.

GRATE BARS, FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.
The Boiler Repair and Grate Bar Co., Toronto, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicago, Ind.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Graver Corp., East Chicago, Ind.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INDICATING THERMOMETER, SARCO
Sarco Co., Inc., New York.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Bristol Company, The, Waterbury, Conn.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Celite Products Limited, Montreal, P.Q.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.
Celite Products Limited, Montreal, P.Q.

INSULATING POWDER

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LACE LEATHERS
Can. Johns-Manville Co., Ltd., Toronto.
D. K. MacLaren Ld., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mo.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MARINE CASTINGS
Mueller Mfg., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co, Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

METERS, F.M.
Canadian General Electric Co., Toronto.
The Bailey Meter Co., Cleveland, Ohio.
Can. Johns-Manville Co., Toronto.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superbeater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.

OILING SYSTEMS
Lunkenheimer Co., Cincinnati, Ohio.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos Canada Co., Toronto.
Beveridge Suppy Co., Montreal.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, H. P. ROD
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont.

PENSTOCKS
W. M. B. Scarfe & Sons, Pittsburgh, Pa

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
The Superheater Co., Limited, Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE STEEL
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

A Reasonable Saving of 5 to 10%

Should You Expect More?

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee St. PHONE G. 3660 Toronto, Ont.

Power House

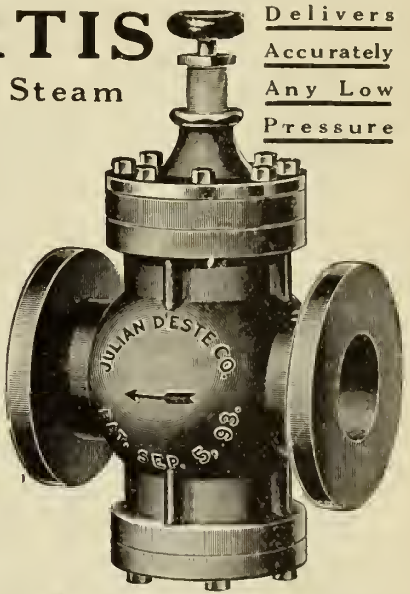
Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

$2.00 PER YEAR — Every Power Plant employee should read Power House



CURTIS

Improved Steam Pressure Regulator

Delivers Accurately Any Low Pressure

A compact, self-contained Regulator suitable for any boiler pressure. It delivers accurately and uniformly any lower pressure from one to within a few pounds of the initial pressure.

It has no levers, weights or projections; no glands or packing; no drip or leak of steam or water. Use it for efficient service on steam-heating apparatus, slashers, jacket kettles, air or water pumps, pulp mills, etc.

The Improved Steam Pressure Regulator is a lock valve, very simple and sensitive. Send for descriptive pamphlet.

JULIAN D'ESTE COMPANY

Main Office: 26 Canal St., Boston, 14, Mass.

Why Individual Boiler Feed Water Treatment?

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)
Distributors: William C. Wilson & Co., 21 Camden Street, Toronto
Phone Adel. 1054 or write for full particulars.

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Pratt & Cady, Hartford, Conn.
Smart-Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, GAS
Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co., (Inc., Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

OIL PUMPS FOR FUEL OIL BURNING SYSTEMS.
Albany Pump Co., Toronto, Ont.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co. Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCullcoh Co., Galt.
Laurie & Lamb. Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMP TANK, RECEIVER
American Steam Pump Co., Batle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Bristol Co., The, Waterbury, Conn.
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Tayor Instrument Co., Toronto, Ont.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamieson Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Inde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SAFETY STEPS (Irving Life Step)
Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester Mass.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamb, Montreal,

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.

Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd., Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

SPECIAL MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch, Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM ENGINES
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM JETS
Green Engineering Co., East Chicago, Ind.

STEAM SPECIALTIES
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa,
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
The Reliance Gauge Column Co., Cleveland, Ohio.
Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM CALORIMETERS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Division, Brooklyn, N. Y.
Sarco Co., Inc., New York.

STEAM TRAPS
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Julian D'Este Co., Boston 14, Mass.
Sarco Co., New York, N. Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal

STOKERS
Canadian Planet Engineering Co., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd., Montreal.
Green Engineering Co., East Chicago, Ind.
Underfeed Stoker Co., of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
Sturtevant, Co., B. F., Toronto and Boston.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

DOMINION BELTING CO. LIMITED

HAMILTON - CANADA

Quebec Branch, 51 Duluth Bldg., Montreal

Sole Manufacturers:

"Maple Leaf" Brand Stitched Cotton

Duck Belting, Belt and Dressing

The demand for our products has steadily increased because the standard of quality has been strictly maintained. We make only one grade, the best that can be produced. Write for prices and further information.

ALLEN BLOCKS *for* **BOILER SETTINGS**

MADE IN CANADA

EVERY Engineer is aware of the decrease in boiler efficiency due to faulty and inferior brickwork around Boiler Headers and Dusting Doors, the inconvenience caused by shutting down of his boilers to make repairs, and the expense and loss of production that accompany each shut-down.

The Allen Header Blocks as illustrated are designed to serve a double purpose to prevent air leaks, one cause of low boiler efficiency, and to protect the header from the hot gases.

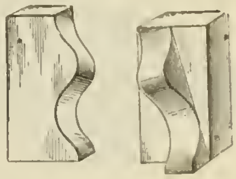
These blocks are conformed to the outline of the Boiler Headers, allowing for their downward expansion, and dispense with the unsatisfactory and expensive method of cutting and fitting each individual brick and setting it in its proper place, from which the boiler vibrations repeatedly shake them loose and result in the shut-down of the boilers, to make the necessary repairs.

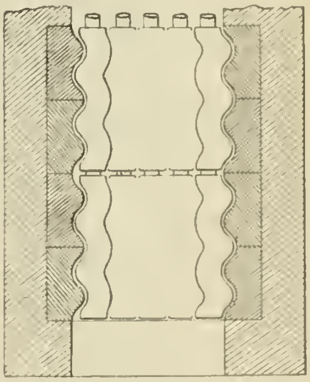
The Allen Dusting Door Blocks (also illustrated) provide an improved brick, which completely insulate the boiler Dusting Doors, wherein the duster openings are provided in integral blocks. These blocks do away with a large number of hand-cut brick, that are ordinarily employed in placing dusting doors. They therefore eliminate the danger of faulty workmanship and consequently shutting down of the boilers to replace the small brick portions that repeatedly fall away.

Both the Allen Header Blocks and the Allen Dusting Door Blocks are guaranteed to last the life of the boiler.

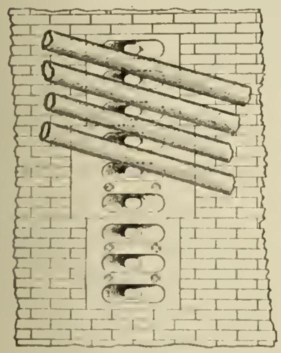
Our thirty (30) years of experience as Boiler Setters is always at your service, both as to new installations and repair work.

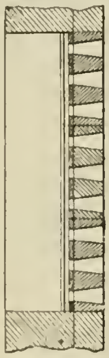
Let us solve all problems dealing with the Settings of your Boilers.





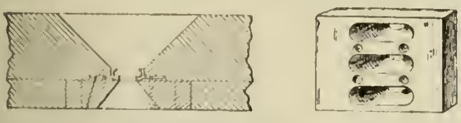
ALLEN HEADER BLOCKS (Patented)





Boiler Settings

For all types of boilers. Settings for Steam and Oil Stills. Stoker Brickwork.



ALLEN DUSTING DOOR BLOCKS (Patented)

GEORGE ALLEN & SON

MASONS AND BUILDERS
1511 Third Ave., New York, N.Y.

GENERAL ENGINEERING COMPANY, REG'D.

207 St. James St., Montreal, P.Q.
Canadian Representatives

FLAME BRAND

HIGH TEMPERATURE CEMENTS

RED FLAME
PLASTIC CEMENT
WHITE FLAME
INSULATING CEMENT
BLUE FLAME
FIRE BRICK CEMENT

"MONO" TRADE MARK
REG US PAT OFF
BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE

KING REFRACTORIES CO. INC.

SOLE CANADIAN REPRESENTATIVES:

GRANT E. COLE CO.

Represented in
VANCOUVER, WINNIPEG,
MONTREAL, HALIFAX

21-23 River St.
TORONTO, CANADA

Thomson-Gordon Limited

Engine Packings

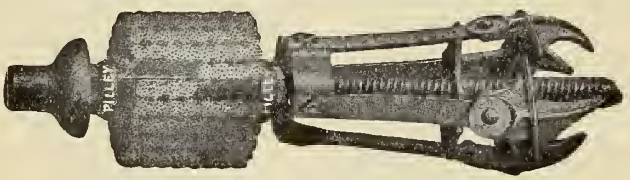
Hamilton, Ontario

AMERICAN STEAM ASH CONVEYORS

Cut ash handling costs 50-75%. AMERICAN STEAM ASH CONVEYORS give minimum ash removal charges. Send for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Calgary, Edmonton, Vancouver
WM. A. GOOLD, Winnipeg

CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

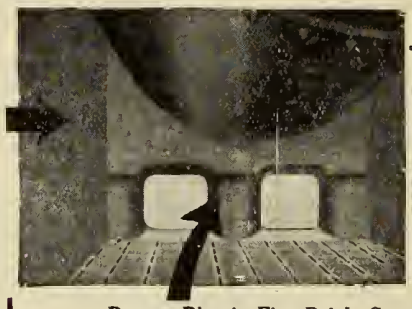


The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over.
A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.



Be Rid of Boiler Furnace Lining Troubles

Arches and Furnace Linings in one piece. No brick, no joints. Any handy man installs it without special forms or tools.

Betson Plastic Fire Brick kept on hand for emergency repairs and for use in building sloping baffles always proves profitable. Write for instructive booklet.

Betson Plastic Fire Brick Co., Inc. P. O. Box 386-6, ROME, N. Y.

CANADIAN DISTRIBUTORS: International Chemical Co.,
26-6 Adelaide St. E., Toronto, Ontario, Canada

SUPERHEATER, STATIONARY
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, LOCOMOTIVE
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STEAM SHOVEL
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N. Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Canadian Johns-Manville Co., Ltd., Toronto
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE
Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co. Brantford.

TANKS, OIL, KEROSENE, GASOLINE
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

TANKS, WATER
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

TACHOMETERS
Bristol Company, The, Waterbury, Conn.

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

THERMOSTATS
Sarco, Inc., New York, N.Y.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N Y

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Sarco Co., Inc., New York, N.Y.
Wason & McDonald Co., Philadelphia
Taylor Instrument Co., Toronto, Ont.

TACHOSCOPES
The Reliance Gauge Column Co., Cleveland. Ohio.
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS
Canadian Sirocco Co., Ltd., Windsor, Ont.
American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Schaeffer & Budenburg Mfg. Co., and Am-
Sarco Co., Inc., New York, N.Y.

TRAPS, DUMPING
Grant E. Cole Co., Toronto, Ont.

TACHOMETERS
Bristol Company, The, Waterbury Conn.,

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES POWER
Sturtevant Co., B. F. Toronto and Boston.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal.
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES OF ALL KINDS
Reading Steel Casting Company, Inc.
Pratt & Cady Division,
Bridgeport, Conn.
Reading Steel Casting Company, Inc.
Reading Valve and Fittings Division,
Bridgeport, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Shell Bar Boico Supply, Ld., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.

WALKWAYS, (Irving Subway)
Irving Iron Works Co., Long Island City, N. Y.

When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*

Annual Convention

of the

CANADIAN ASSOCIATION
of
STATIONARY ENGINEERS

OF THE DOMINION OF CANADA, INC.,

will be held in conjunction with

Annual Exhibition of Power Plant Equipment

June 25, 26, 27, 28

in the

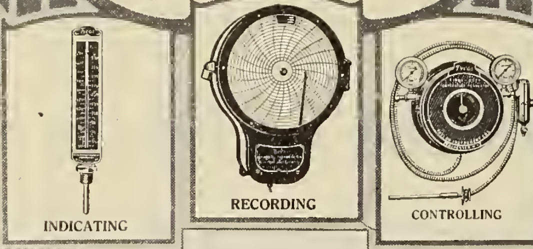
Central Technical School

Toronto, Ontario

Remember it ! *Boost it !* *Come to it !*

For further particulars write

George J. Soucy, Chairman, 48 Moore Avenue
TORONTO



Tycos temperature instruments

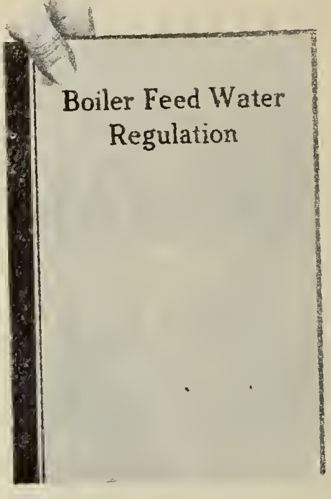
FACILITIES FOR handling the most difficult temperature conditions in the power plant are supplied by *Tycos* Temperature Instruments. The knowledge of just what *Tycos* can do for you when you want anything done and done right will prove invaluable.

This information is given in our catalog part number one. Let us send you this valuable power plant temperature reference book.

Taylor Instrument Companies
110-112 Church St., Tycos Bldg., Toronto
There's a Tycos or Taylor Temperature Instrument for Every Purpose

Are you a STUDENT of power plant economies?

Our experience has been that many of the most succesesful power plant engineers and executives, as you get to know them, turn out to be men who never got over being "students." This leads us to offer, to men in the field, a free copy of this new text book on boiler feed water regulation. Originally prepared for technical students, this little book contains information that every power plant engineer and manager can make use of.



It pictures the first efforts to provide mechanical boiler feed water regulation; tells what objects the first builders of regulators had before them. It explains, step by step, how the different types of boiler feed water regulators developed, giving illustration and description of each.

The man who reads this book—whether he be a student in technical school or the "STUDENT" who is responsible for the economical operation of a power plant—will have a more complete grasp of the subject than he can get otherwise. He will look at any boiler feed regulator with understanding, seeing what is behind it.

Write us for a copy of this new text-book.

NORTHERN EQUIPMENT CO., 112 West 11th St., Erie, Pa.
BRANCH PLANTS: Hamilton, Ontario, Can.; Croydon, England; Paris, France; Cologne, Germany.

COPES
SYSTEM OF BOILER FEED CONTROL

INDEX TO ADVERTISERS

A
Audel, Theo. 47
Allen Feed Water Purifier Co.. 51

B
Babcock & Wilcox, Ltd. 45
Betson Plastic Fire Brick Co., Inc. 54
Bailey Meter Co. 18
Bristol Co. 13
Buyers' Directory 46, 48, 50, 52, 54
Builders Iron Foundry 16

C
Callard, Geo. 47
Canadian Fairbanks-Morse Co., Ltd. 6
Canadian Raybestos Co......... 8
Canadian Steam Boiler and Equipment Co. 51
Celite Products, Ltd. 17
Cole Co., Grant E. 53
Conveyors Corp. of America.... 54
Cory & Sons, Inc., Chas.......... 13
Combustion Engineering Co..... 3
Cunerty Co., T. J. 49

D
Dart Union Co. 14
D'Este Co., Julian 51
De Laval Steam Turbine Co.... 9
Detroit Stoker Co. 7
Dominion Belting Co. 53
Dunham Co., C. A. 4
Durabla Mfg. Co. 6

E
Engineer and Mach. Works of Canada 4

F
Fisher Governor Co. 5
Foxboro Co., Inc. 49
Flexible Steel Lacing Co........ 14
Flexible Metallic Packing Co. .. 18

G
Garlock Packing Co. 49
Garth Co., The 49
General Engeering Works ... 53
Goldie & McCulloch 20
Gutta Percha & Rubber Co. .. 2

I
Irving Iron Works 15
Imperial Oil Co. .... Inside Front Cover

J
Jamieson Cold Storage Door Co. 11
Jenkins Bros. .... Front Cover
Jointless Fire Brick Co. 17

K
Keasbey & Mattison Co. 18

L
Laurie Engine Co. 47
Lunkenheimer Co. 12

M
Magnolia Metal Co. 8
Maclean Underfeed Stoker Co. . 9
McGowan Co., The John H. ... 17
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncrieff, Ltd. 56
Mueller Mfg. Co.......... Inside Back Cover

N
Northern Equipment Co. 56

P
Page-Hersey Tubes, Ltd. 10
Pilley Packing & Flue Brush Mfg. Co. 54

R
Refinite Co. of Canada 49

S
Sarco Co., Inc. 5
Sanford Riley Stoker Co. 17
Shell Bar Boico Supply Co..... 8
Sterling Engine Co. 16
Sturtevant Co. 49
Superheater Co., Ltd., The 47

T
Taylor Instrument Co., The..... 56
Thomson-Gordon, Ltd. 54

U
Underfeed Stoker Co. of Canada 19

V
Victoria Foundry Co. 49

W
Wall, W. J. 56
Waterous Engine Works Co. .. 1
Watson & McDaniel Co. 49
Watson, M. Barry, M. E......... 47
Williams & Co., J. H.......... 11

Y
York Mfg. Co. 47
Young Pump Co. of Canada... 10

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

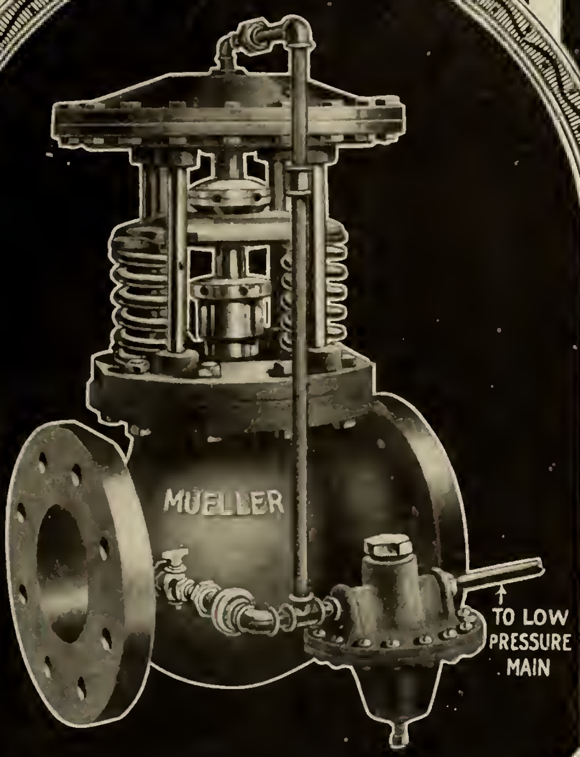
MONCRIEFFS "UNIFIC"

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representati : W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

Make Canada Prosperous by Buying Canadian Products



MUELLER Reducing and Regulating Valves

This valve—No. A-5030—will make any desired reduction and will maintain a constant delivery pressure regardless of fluctuations in initial pressure. For water, air, steam or oil, it has no equal.

When valves are installed under our supervision, we fully warrant their performance. There is a *MUELLER* stock valve to meet practically every need. Tell us your problems—and we will help solve them.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Ill., U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of Red Tip Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

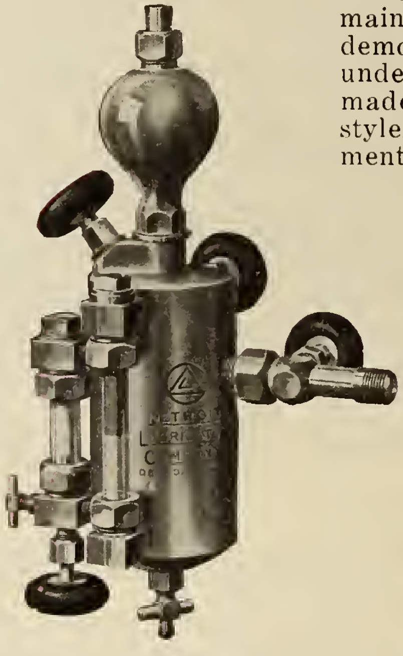
MORRISON

There's no "hit-or-miss" method

about the way the Morrison line of Sight Feed Cylinder Lubricators do their work. The paramount idea in the process of their development has been to meet that long felt need of **efficient and constant lubrication.** That they do this—at a remarkably low maintenance cost—has been demonstrated in actual service under all conditions. They are made in a sufficient variety of styles to meet different requirements. Send for bulletin.

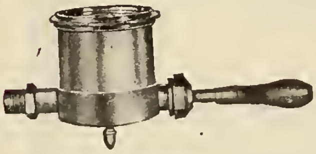
"SIMPLEX"

Automatic Sight Feed Cylinder Lubricator—Single Connection



"DETROIT"

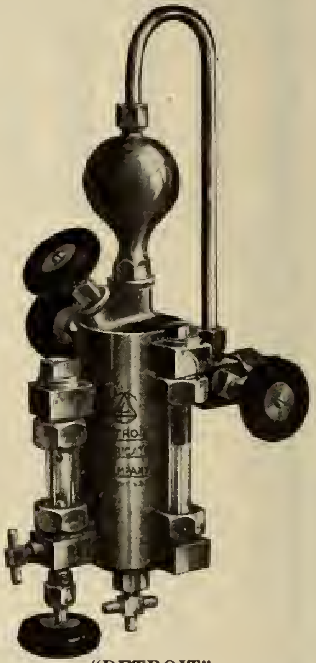
Automatic Sight Feed Cylinder Lubricator—Double Connection



HAND CYLINDER OIL PUMP

A thoroughly dependable auxiliary to the cylinder lubricator on steam engines, air compressors, etc. Constructed also for use on ammonia cylinders. Capacities, 1/4 pt. to 1 qt.

"Every Installation is a Demonstration of Merit"



"DETROIT"

Automatic Sight Feed Cylinder Lubricator—Single Connection

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. West **Toronto**

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission and Application of Steam, Gas, Electric Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street, E. C. NEW YORK, BOSTON, CHICAGO.

Vol. XVI—No 7. Publication Office, Toronto—April 5, 1923 Published Semi-Monthly. Canada, $2; U.S. $2.50 a year

Here's the answer to Increased Fuel Costs!

"Burn All"

NONPAREIL SHAKING AND DUMPING GRATES

You'll admit that unless you are getting complete combustion from every pound of fuel you burn, you are not getting full value for the money you spend for fuel. Moreover, you can't hope to get maximum heat value unless your grates are specially designed for this purpose.

NONPAREIL GRATE BARS are demonstrating every day in some of the largest Canadian manufacturing plants that they actually save 10% in fuel expenses. Their 65% air space and 95% underdraft are features that ensure perfect combustion and maximum heat value without waste—even from cheap fuel.

Our 30-day trial (under any kind of boiler) will convince you, too, that NONPAREIL Grates are the logical solution of your increasing fuel costs. No obligation whatever—write us.

AGENTS: Gates Engineering Co., Montreal, Que. Mr. C. Berry, Ottawa, Ont. Mr. A. McTaggart, Leamington, Ont. W. Green, Church St., Smiths Falls, Ont.

MANUFACTURED SOLELY BY

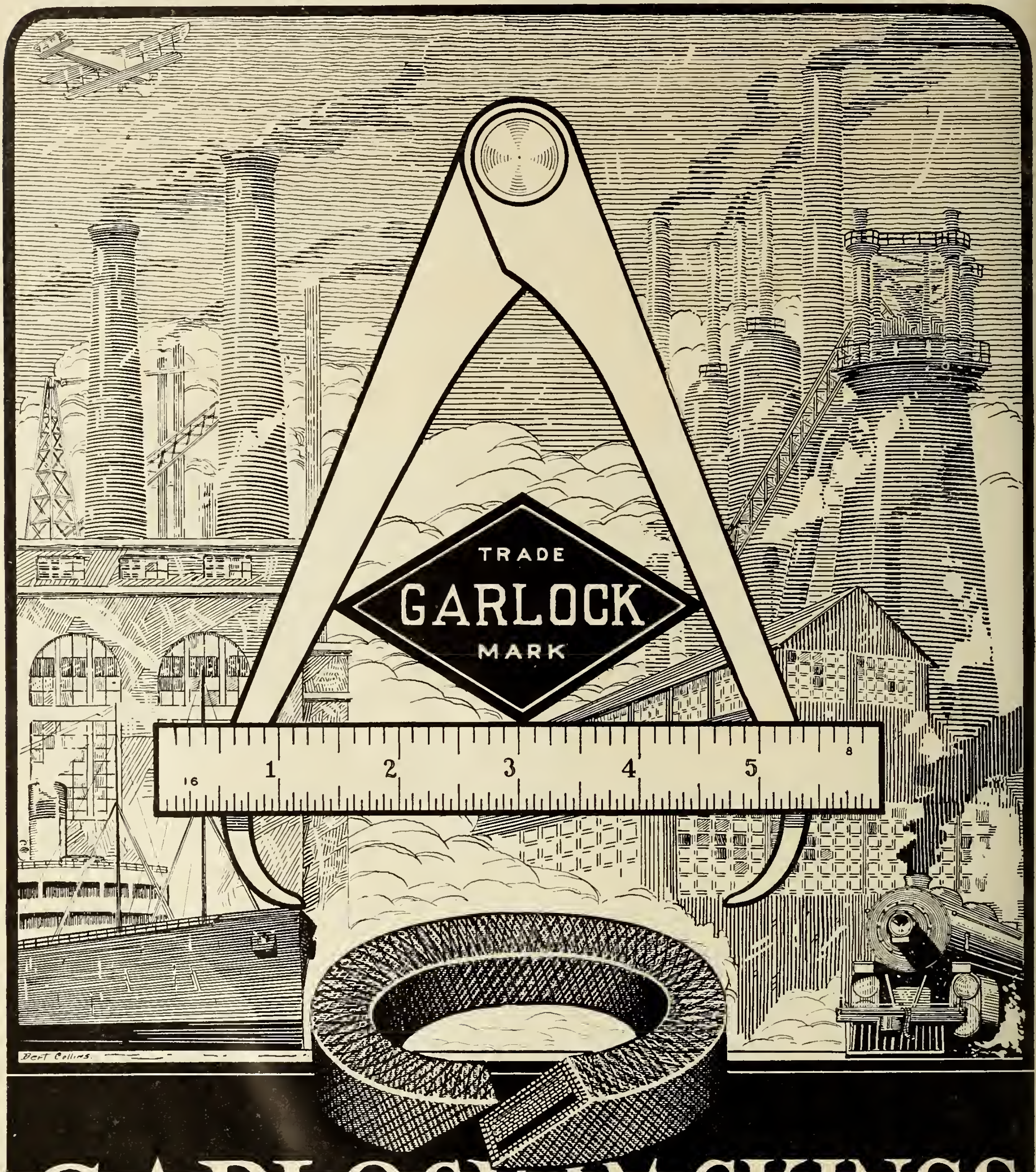
THE W. R. SEXTON BOILER SETTING CO.

Established 1900 114 Grenadier Road, Toronto Phone Junc. 2765W

Renewals and Repairs for all kinds of Shaking and Dumping Grates for all sizes of Boilers.

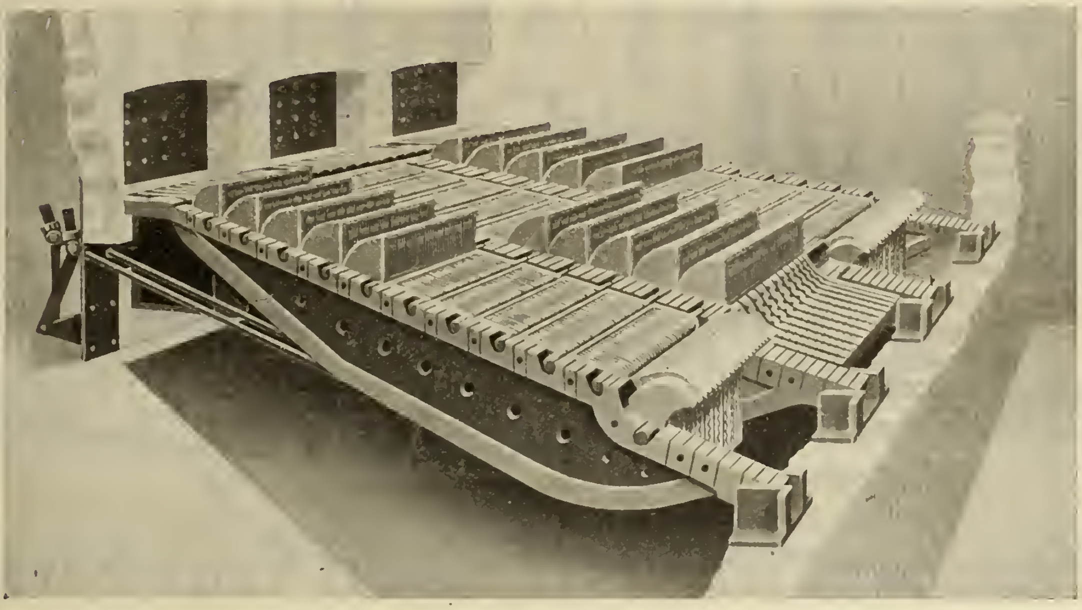
Our PINHOLE GRATE burns ANYTHING. Special Bars for Brickyards.

Industry's Sun never sets on the Garlock Trade mark



GARLOCK PACKINGS

The Garlock Packing Company
HAMILTON, ONTARIO
BRANCHES :
Montreal, Que. Winnipeg, Man. Toronto, Ont.
Calgary, Alta. Vancouver, B. C. St. John, N. B.



THE FILES STOKER

Pays for Itself in One Year

Below is a copy of one of the many letters we have received, telling of the efficiency and economy of the Files Hand-Operated Stoker

Re **FILES HAND STOKERS.**

Gentlemen:—

Frequently we receive letters from manufacturers, asking for information and our experience with the "Files Hand Stokers"—the most economical and efficient system of burning coal with the utmost conservation of labor.

As these inquiries are becoming more and more frequent, our better plan will be to furnish you with a letter to pass on, outlining our experience and satisfaction.

In September, 1920, we placed an order with you for two 150 H.P. Tubular Boilers, specifying our desire to have them equipped with "Files Hand Stokers." This we did on the recommendation of our United States Engineering Department, who had installed "Files Hand Stokers" in some seventeen plants, finding in them a decided saving and advantage over flat or shaking grates.

Speaking for ourselves, we have found them most satisfactory and economical, particularly so in regard to the elimination of smoke, rapid disposal of ash and clinker, thorough cleaning of fires without disturbing the active fire, and in maintaining an even bed of fuel.

We are able to keep a clean fire at all times; we have no cleaning period, for with the "Files Hand Stoker" the grate can be cleaned at peak load. It is only a matter of working one rod on each section, which can be done in less than two minutes.

The better the coal the better the result, but almost any kind of coal that will burn free can be used. With good coal, however, it is an easy matter to procure 150% boiler rating, which in reality is 12½ lbs. evaporation per pound of coal. Generally speaking, evaporation is around 7 or 8 lbs., and often as low as 5 or 6 lbs.

Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel.

And what we have done and are doing with them others can do.

We know they effect a saving; we know they are a convenience; they have proved satisfactory in every particular, and we have no hesitation in recommending them.

Yours very truly,

Messrs. THE WATEROUS ENGINE WORKS CO., LTD.,
Brantford, Canada.

Why not Profit by others Experience?

Waterous

BRANTFORD, ONTARIO, CANADA

D.K. McLAREN'S

Genuine British Oak Tanned

LEATHER BELTING

The Stretch is Taken Out First

The one outstanding feature of D. K. McLaren's Leather Belting is its stretchless quality which, in turn, means the elimination of most of the engineer's troubles.

This stretchless quality is the result of the

Genuine British Oak Tanning Process

used in the manufacture of D. K. MacLaren's Belting. This process, usually considered too expensive for belting manufacture, takes every bit of stretch out of the hide, at the same time adding to its natural toughness and pliability. Incidently, only the **back portions** of specially selected hides are used in D. K. McLaren's Leather Belting.

The Oak Leaf stamped upon every length as your guarantee of "trouble-free" service —look for it.

D·K McLAREN
LIMITED

Head Office and Factory :
351 St. James St., Montreal, P.Q.

BRANCHES:

ST. JOHN, N.B. 90 Germain Street	TORONTO 194 King Street, W.

STOCK DEPOTS:

VANCOUVER, B.C.
Gormans, Ltd.,
1158 Homer St.

CALGARY Gormans, Ltd.	EDMONTON Gormans, Ltd.

The "Long Service" Belting

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

FLEXIBLE!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

Flue gases can be reduced 50 degrees by careful firing and clean boiler surfaces

Such is the substantial saving that can be effected by recording and measuring your flue gas temperature with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.
Recording Pyrometers

Of course, the temperature of outgoing gases can be decreased by economizers, or by a change in the baffling — but such changes are costly and the economy depends upon the cost of coal.

The information supplied by Bristol's Pyrometers, as to the temperature of uptake gases leaving the boilers, is of prime importance as an aid to super-efficient plant operation.

Hundreds of Bristol's Pyrometers are recording flue gas temperatures in prominent power plants. Let us tell you more about what they could do in your plant. Our new Catalog O-1401 is waiting for your address.

The Bristol Company, Waterbury, Conn.

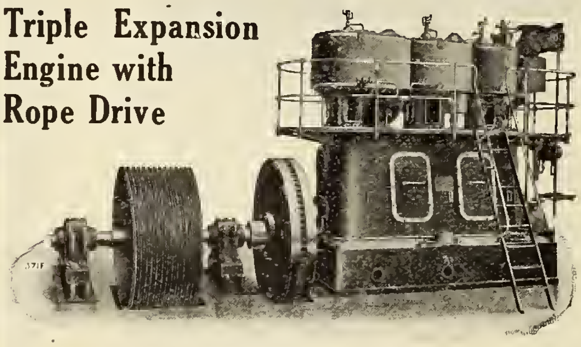
Canadian Distributors:

Eastern Territory: Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory: Gorman's, Ltd., Edmonton.

Fig. 1007

A suit has been filed in the United States Federal Court against a Pyrometer manufacturer who is infringing patents owned by the Bristol Co. covering Automatic Cold End Compensation for Thermo-Electric Pyrometers.

Triple Expansion Engine with Rope Drive



Belliss & Morcom Ltd.
Birmingham, England

Builders of:

- STEAM ENGINES
- AIR COMPRESSORS
- STEAM TURBINES
- CONDENSERS
- CRUDE OIL ENGINES

Packing for Centrifugal Pump Spindles will not cut

Maxim Silencers

for Air Compressor Suction, Gas Engine Exhausts, etc.

Welldeck Steam Traps

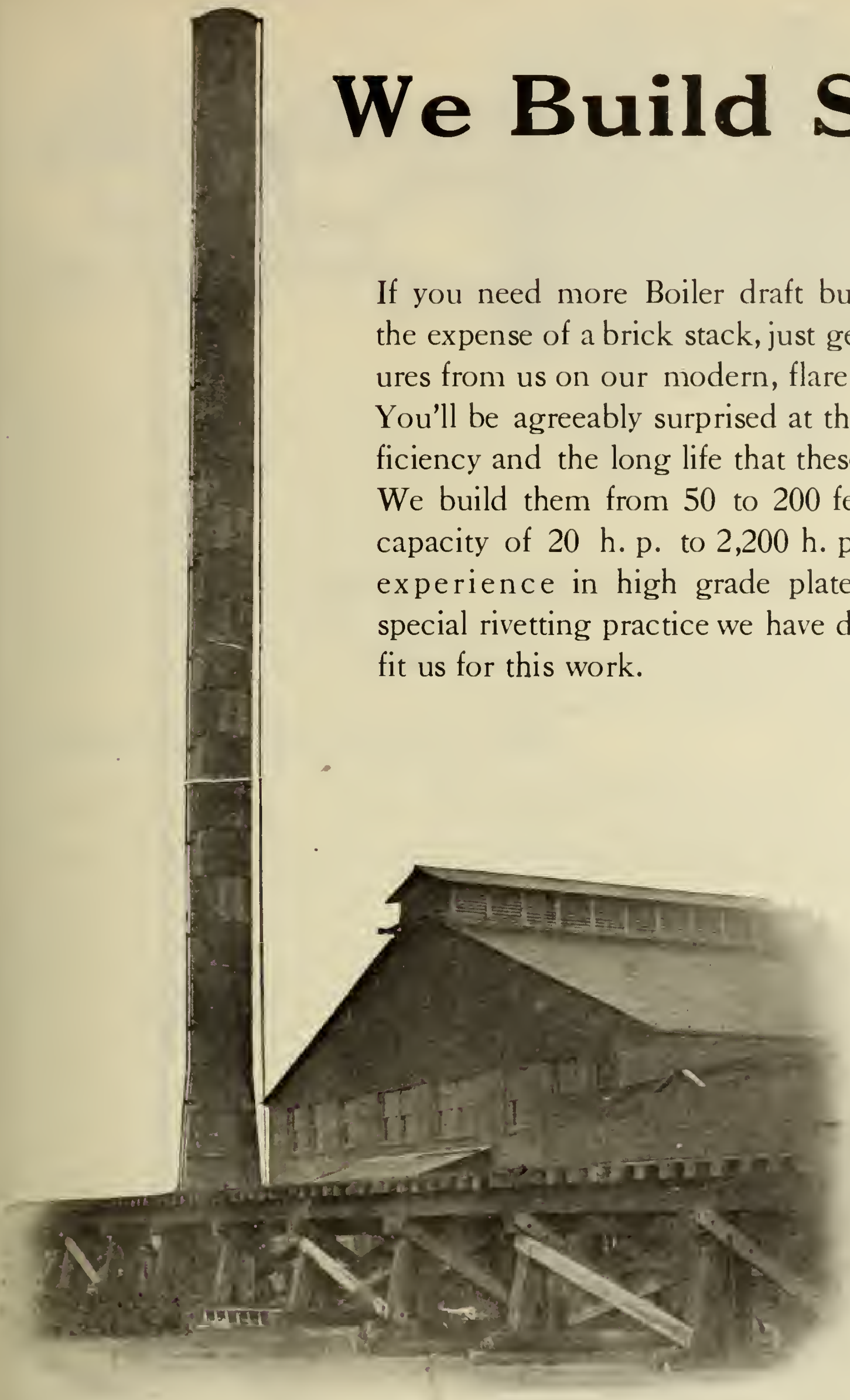
do not get out of order

AGENTS:

LAURIE & LAMB, Board of Trade Bldg., **MONTREAL**

We Build Stacks

If you need more Boiler draft but hesitate to go to the expense of a brick stack, just get the facts and figures from us on our modern, flare base Steel Stacks. You'll be agreeably surprised at the low cost, the efficiency and the long life that these stacks offer you. We build them from 50 to 200 feet high for Boiler capacity of 20 h. p. to 2,200 h. p. Our 35 years of experience in high grade plate-making and the special rivetting practice we have developed specially fit us for this work.

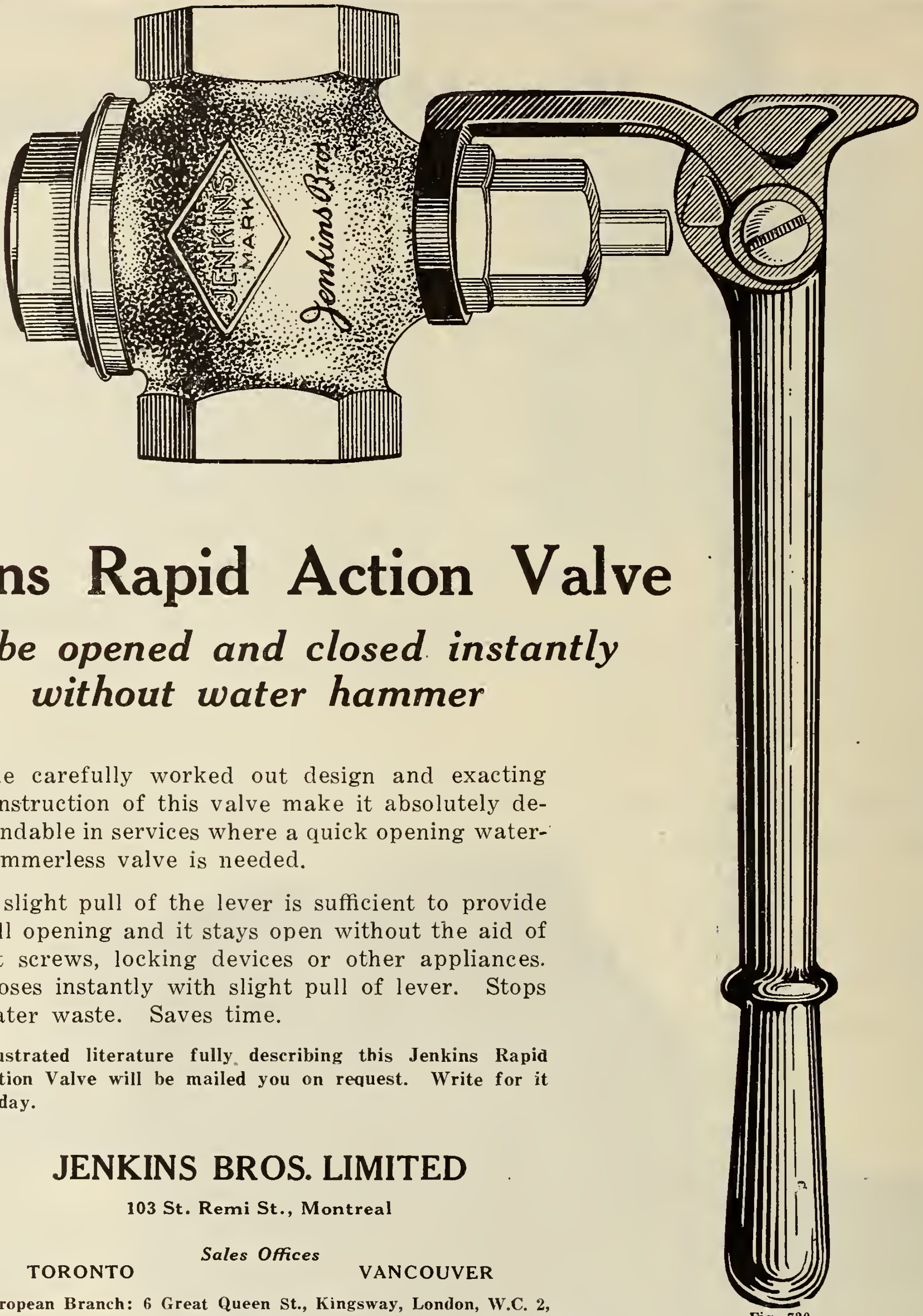


A self supporting steel stack, 140 feet high, 6 feet, 6 inches diameter, erected by us for Pilkington Bros., Limited, Plate Glass Works, Thorold, Ont.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal



Jenkins Rapid Action Valve

Can be opened and closed instantly without water hammer

The carefully worked out design and exacting construction of this valve make it absolutely dependable in services where a quick opening water-hammerless valve is needed.

A slight pull of the lever is sufficient to provide full opening and it stays open without the aid of set screws, locking devices or other appliances. Closes instantly with slight pull of lever. Stops water waste. Saves time.

Illustrated literature fully describing this Jenkins Rapid Action Valve will be mailed you on request. Write for it to-day.

JENKINS BROS. LIMITED

103 St. Remi St., Montreal

Sales Offices
TORONTO VANCOUVER

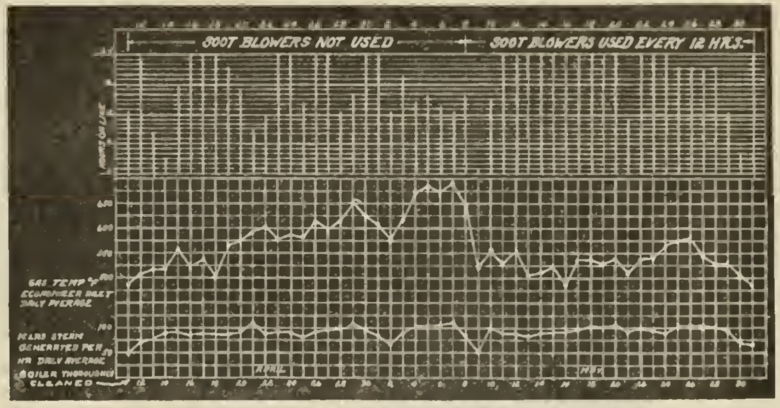
European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, England

Fig. 720
JENKINS
Rapid Action Valve

Since 1864

Diamond Soot Blowers

Reduce Flue Gas Temperatures



The chart above covers results of a test made recently by a large central station on a modern 1,000 H.P. horizontal water tube boiler operated at 250 lb. pressure, 200° superheat, and at 200% rating, using bituminous coal handled by underfeed stokers. On April 12th the boiler was put on the line with the tubes, having first been thoroughly cleaned. From this date until May 8th, a period of 26 days, the soot blowers were not used. At the end of this 26-day period, flue gas temperatures had risen from 480° to 690°. The first day the soot blowers were operated the average temperature fell 40°. The next day it fell to 530°. It remained at approximately this average throughout the remaining period of the test, from May 8th to May 30th, during which soot blowers were used every twelve hours.

Obviously any equipment which effects such marked reductions in flue gas temperatures is a first-class investment.

The fuel saved by reducing the flue gas temperatures may be estimated at 1% for each 20 to 30 degrees drop in flue gas temperature, depending upon the amount of excess air in the chimney gases.

On the basis of fuel saving, Diamond soot blowers are one of the best paying investments in the power plant. They pay for themselves many times over during their period of service.

There is a Diamond soot blower for every type of boiler and every boiler needs one. Send data regarding your boiler equipment and write for full information. Ask for Bulletin 287.

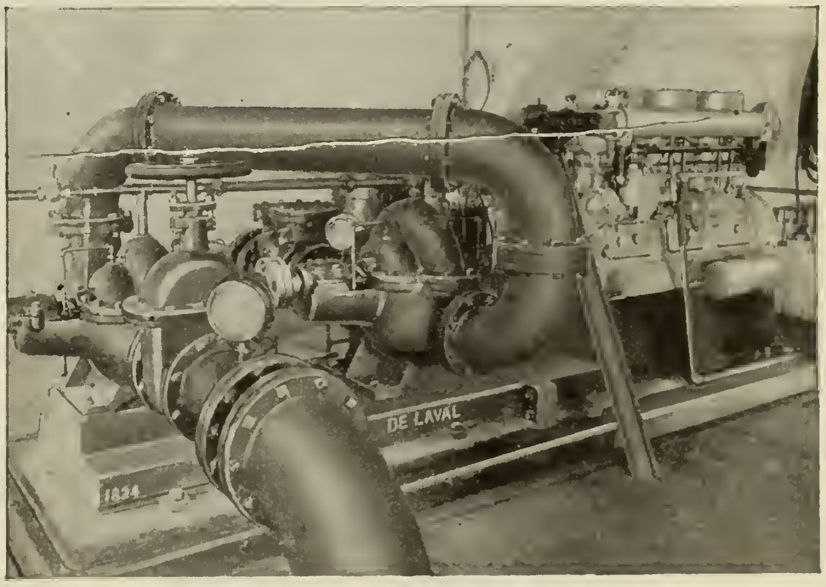
Diamond Specialty Ltd. - Windsor, Ont.

De Laval Gasoline Engine Driven Pumps for Fire Protection at Barrie, Ont.

Barrie uses two electric motor driven De Laval pumps, while a third, an 8 in. two-stage pump, is driven by a Sterling gasoline engine. The latter, which has a capacity of 1800 gal. per min. against 275 ft. head when running at 1400 r.p.m., can easily be started on a moment's notice, and provides fire protection in the event of failure of the electric current supply. De Laval centrifugal pumps are ideally adapted for gasoline engine drive because of their high efficiency, low starting torque and power limiting characteristic.

The horizontally split casing, with suction and discharge connections in the lower or main part of the casing, renders all internal parts at once accessible upon lifting the casing cover. There are no diffusion rings to become damaged or rusted. All parts are made to limit gages on an interchangeable basis, and parts subject to wear, such as shaft protecting sleeves and bearings, are easily replaced. The efficiency is guaranteed and is demonstrated by test at the factory.

If interested in pumping, whether by steam, electricity, water power or internal combustion engine, read our book W-100, "Ten Years' Progress in Water Works Pumps."

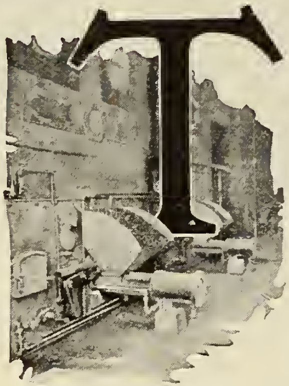


DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

Now an entirely under-fed side cleaning stoker



THE arrows below are the symbol of a great development in mechanical stoking. They trace the path of fuel travel of a stoker that embodies a new basic design—the *lateral retort* principle.

Briefly summarized the advantages of the *lateral retort* design are:

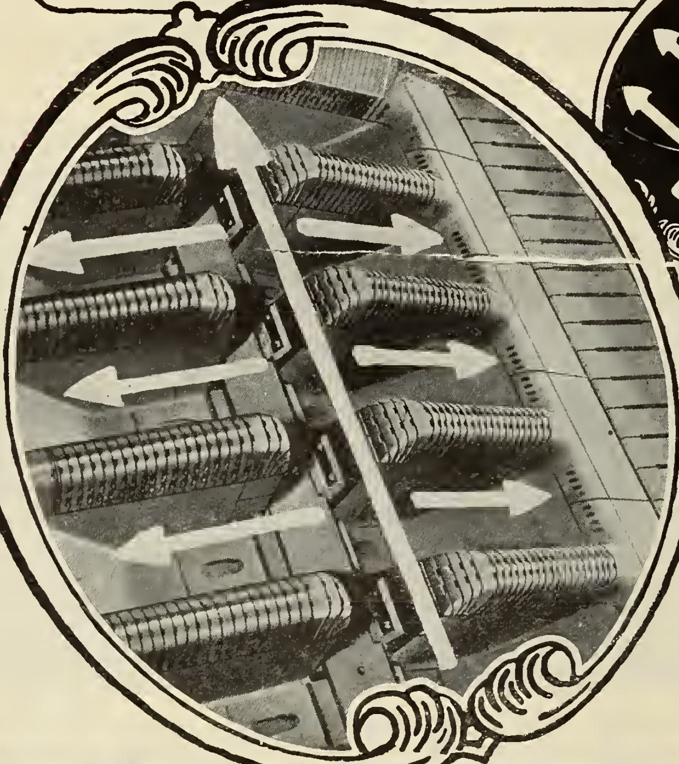
The multiple retort effect. Coal is underfed to the *lateral retorts* as well as to the main or central retort. It is not overfed from the main retort onto side grates as in other stokers employing side dump plates. Consequently, the principle has made possible for the first time; **a truly underfeed side-cleaning stoker.**

Heavy overload capacity. The *lateral retort* design provides a large reserve fuel capacity for meeting overload demands.

Low maintenance. The *lateral retort* construction also permits a simple, rugged construction; only two simple steam cylinders and a few moving parts buried deep in the green coal where they cannot burn out. The simple balanced dump plates—of the type that has proved so successful in the Jones "A-C" stoker type — insure an additional saving in maintenance.

Low initial and installation cost. The extreme simplicity permits a moderate first cost, and the side dump construction does away with basement ash pits and expensive excavation. For this reason the "*Lateral Retort*" Stoker is adaptable to any conditions in existing plants.

The construction and advantages of this stoker are thoroughly covered by a new catalogue. Ask for it.



Trade Mark

Under-Feed Stoker Co. of Canada, Limited
146 King Street West, Toronto

Sales Agents for Jones Under-Feed Stokers, Riley Under-Feed Stokers, and Murphy Automatic Furnaces.

Alta. and West Sask.:
Mr. J. Twomey,
Camrose, Alberta.

Man. and East Sask.:
W. W. Hicks & Co.,
Winnipeg.

British Columbia:
E. A. Earle, Limited,
Vancouver, B.C.

Quebec
The Cleaton Co. (Canada), Ltd., Montreal, Que.

RILEY JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

The "Lateral Retort" Stoker

Trade Mark

From Asbestos Rock to Stuffing Box Entirely Heat Resisting.

Why Does "PALMETTO"

give longer service than other rod packings, even under high pressure superheated steam and compressed air? It is simply because it is made of an unusually high grade of Canadian asbestos of such long fibre that the addition of cotton as a binding substance is not necessary.

"Palmetto" always gives the same uniformly long service, no matter how long in stock, and no matter how trying the climate.

"Palmetto" is frictionless

because it has graphite grease lubricant forced hot under pressure into each single strand before braiding.

Let us send you working samples to test under your own conditions no charge.

Greene, Tweed & Co.
Sole Manufacturers
109 Duane St., New York

REFRIGERATION DEPARTMENT

LINDE

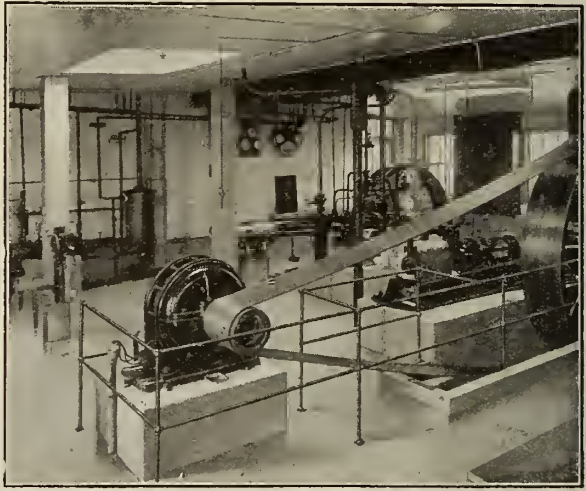
REFRIGERATING AND ICE MAKING MACHINERY

Made in Canada

For Refrigerating and Ice Plants.
Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

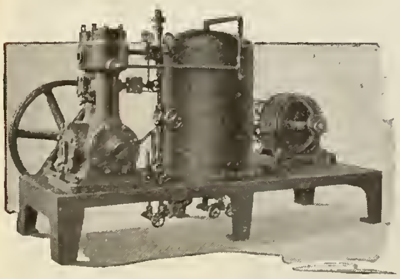


This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.
37 St. Peter Street, MONTREAL, Que.
TORONTO WINNIPEG VANCOUVER

VILTER

ICE MAKING AND REFRIGERATING MACHINERY



A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada

Use Nonpareil Cork Fitting Covers

When you put Nonpareil Cork Covering on brine and ammonia lines, **always** use Nonpareil Cork Fitting Covers on all fittings. Never try to cheapen the job by covering fittings with a different material—plastic or wrapped. The insulation must be continuous and identical along the entire line. Otherwise frost is sure to form, and, forcing its way back along the line, ultimately destroy the covering.

Nonpareil Cork Covering

For Brine and Ammonia Lines

is made for all pipe sizes, and Nonpareil Cork Fitting Covers for all fittings—standard or special—screwed or flanged. For the sizes commonly used, there are molded jackets in two sections. They fit up to or over the pipe covering, making an air-tight joint with no voids and eliminating all possibility of condensation and frost. Everything needed for proper application comes with Nonpareil Cork Covering and Fitting Covers. There are no extras to buy.

Improperly covered fittings are "weak spots" on insulated lines. Make your lines a unit from end to end—Nonpareil Cork Covering on the pipes and Nonpareil Cork Fitting Covers on all fittings.

Further information will be supplied promptly on request.
Write for a sample and literature—there is no charge.

Armstrong Cork & Insulation Company, Ltd.

902 McGill Building
Montreal, Que.

11 Brant Street
Toronto, Ont., Can.

When Overhauling

——Dependable Ammonia Valves, Fittings and Auxiliary Equipment are of paramount importance.

YORK Valves and Fittings of every size, style and type are made of either malleable iron, drop forging, or air furnace iron, tested and inspected at every stage of manufacture and guaranteed to give satisfaction under all usual working conditions.

Every heat of metal going into York Valves and Fittings is tested physically, analyzed chemically and inspected metallographically. All materials entering into the construction of York Products are subjected to similar rigid tests, insuring a uniform high grade product.

YORK Auxiliary Apparatus, such as Ammonia Drier-Cooler-Purifiers, Ammonia Distillers, Condensers, Receivers, Automatic Can Dumps and Fillers, Hoists, etc., all help materially in increasing the efficiency of the plant and the profits of its owner.

Our Engineers will assist you in selecting the apparatus best suited for your purpose, and in solving your ice making and refrigerating problems. Write us today.

CANADIAN ICE MACHINE CO., LTD.

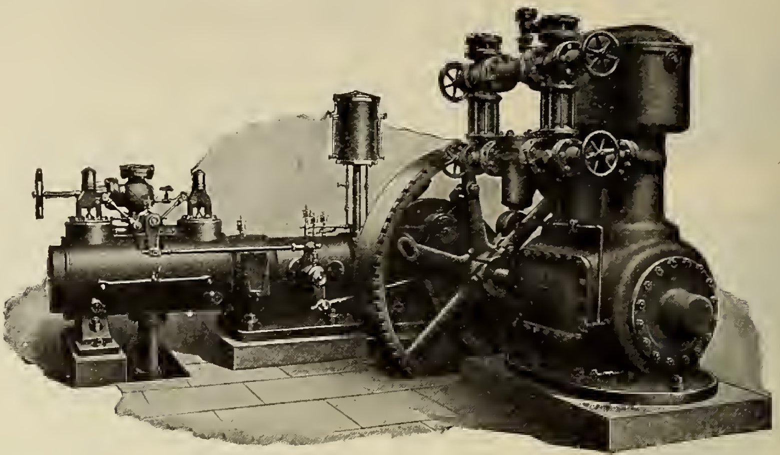
TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals;
MONTREAL: 324 Craig St. West; WINNIPEG: 1415 Whyte Ave.;
VANCOUVER: 1158 Homer St.

Representing
YORK MANUFACTURING COMPANY, YORK, PA.

FRICK COMPANY INC. TRADE FRICK MARK WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical



Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers--also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

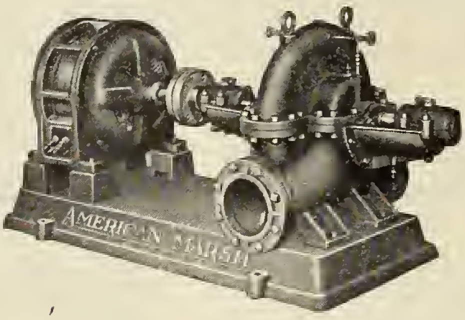
There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

---

AMERICAN-MARSH PUMPS

Centrifugal and Direct Acting



Designed for use in power plants where absolute reliability and high efficiency are essential. For over thirty-five years American-Marsh Pumps have been recognized as standard throughout the Dominion. There are over 160,000 in successful operation.

The sturdy rugged construction and heavy cast bronze fittings insure long life and a minimum repair expense.

American-Marsh Centrifugal Pumps are built with the same painstaking care that characterizes the construction of the direct acting line.

The Line includes :

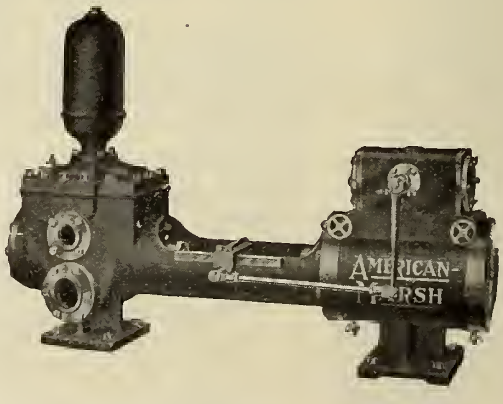
- Boiler Feed Pumps
- Air Compressors
- Deep Well Engines
- Centrifugal Pumps
- Jet Condensers
- Vacuum Pumps
- Condensation Pumps
- Sump Pumps

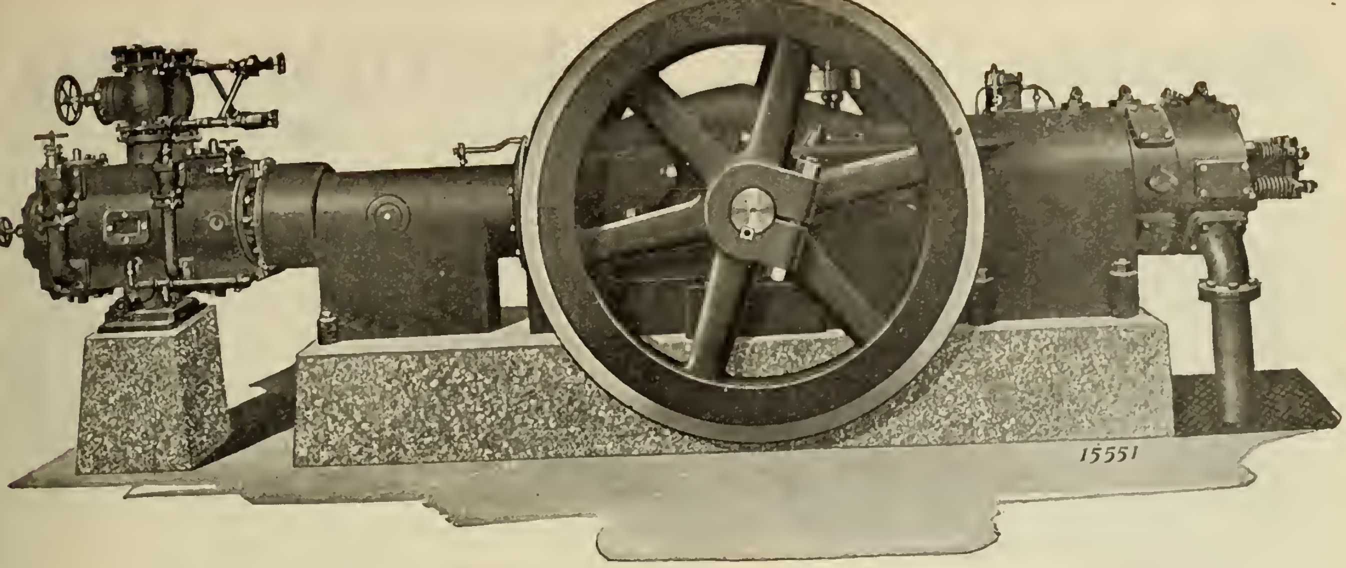
May we send you our general Catalog ?

AMERICAN STEAM PUMP CO.

BATTLE CREEK, MICH.

CANADIAN AGENTS:—A. R. Williams Machinery Co., Ltd., Toronto; Williams & Wilson, Ltd., Montreal; London Engine Supplies Co., Ltd., London; A. R. Williams Machinery Co., Ltd., Winnipeg; Mechanics' Supply Co., Ltd., Quebec; Gorman's Ltd., Edmonton and Calgary; J. T. Allan Ritchie, Vancouver.





Ingersoll-Rand

DIRECT-CONNECTED OIL ENGINE AMMONIA COMPRESSORS

For plants requiring approximately 30 tons of ice or 50 tons refrigeration per day

The Price Oil Engine, which constitutes the power end of Type POC-A Ammonia Compressors, has a guaranteed fuel consumption of 0.45 lbs. per brake horse power hour at full and ¾ loads. Fuel injection is direct, without the use of compressed air; ignition is by heat of compression only.

The double-acting ammonia cylinder is fitted with I-R Plate Valves, all discharge valves being located at the bottom of the cylinder. Gas passages are unrestricted and valve areas are unusually large, guaranteeing efficient compression.

This direct-connected unit is especially suited for carrying the reduced winter load of plants requiring large capacity during other seasons. The ease of starting and elimination of standby losses make this oil engine-ammonia compressor ideal for standby purposes.

Write for full information

Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

IR

Ice and Refrigeration Plant Equipment

AMMONIA COMPRESSORS

Built for either single or two-stage operation, and for belt, steam, oil engine or direct connected electrical motor drive.

AIR COMPRESSORS

Can be furnished in all sizes and for any commercial discharge pressure. These units are particularly suitable for supplying air for agitation. Air Lift Pumping or for general power purposes. Any type of drive.

AIR HOISTS

Built in five sizes for from 1,000 to 10,000 pounds capacity. These hoists are extensively used for lifting ice cans and for general hoisting work. They are easy to move about the plant, and simple to operate.

PNEUMATIC TOOLS

A complete line of riveters, drills, grinders, etc., for erection, assembly and repair work.

CAMERON PUMPS

For pumping brine, water and other liquids. These can be furnished in direct-acting type for steam or compressed air drive, or in centrifugal type for belt, motor, steam, oil or gas engine drive.

PRICE OIL ENGINES

Of the direct-injection, four-cycle type. Horizontal, single cylinder types of 50 and 100 H.P., and vertical, multi-cylinder types from 105 to 1,000 H.P. AC-2

Ingersoll-Rand

Durabla Gaskets Make Tight Joints

Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.

Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

DURABLA
TRADE MARK REGISTERED

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in. long.

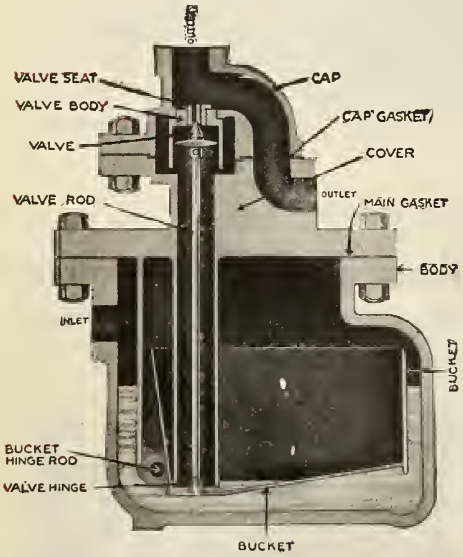
In thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Let us send you a trial order.

CANADIAN DURABLA LIMITED, MONTREAL
Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

The Guardian
of the dwindling coal pile—
THE STRONG TRAP



Serious coal shortages—peak prices, and inferior quality are constant menaces to economical operation of your steam plant.

Don't allow waste of the steam that costs so much to produce nowadays.

Standardize on Strong Traps

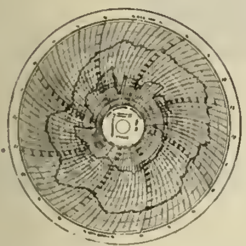
These dependable rugged traps effect astonishing fuel savings, while their simple, perfect construction ensures years of satisfactory service.

Do not fail to get our Booklets which explain why Strong Traps are invaluable steam savers. Our nearest Branch will gladly mail them, and recommend the type suited to your needs.

Canadian Agents:
THE CANADIAN FAIRBANKS-MORSE CO.
Limited
St. John Quebec Montreal Ottawa Toronto
Windsor Winnipeg Regina Calgary Vancouver Victoria

29

Are Your Feed Water Temperatures High?



Foxboro two-pen record of economizer water inlet and outlet temperatures. In this plant oil burning boilers are used, which accounts for the low range of temperature. The double record is an exceedingly effective check on economizer efficiency.

Careless or inefficient use of exhaust steam or accumulation of soot and scale in feed water heaters and economizers quickly shows up in increased fuel consumption.

Complete knowledge of feed water temperature is the first step toward the elimination of this large source of fuel waste.

Foxboro Recording Thermometers on your feed water heater outlets and economizer inlets and outlets give you accurate, continuous information about the operation of your feed water equipment.

The permanent dependability of Foxboro Recorders and their many exclusive design elements which insure accuracy and convenience make them the logical choice for this important service.

Let us show you why power plant engineers consider the Foxboro Recorder "The Compass of Industry."

Write to Dept. CF.

Foxboro feed water temperature chart, produced at one of the largest power plants in the country. The high temperature and small variation mean economy. A few days previously, when the instrument was installed, low temperature and wide fluctuations were revealed. The charts guided regulation and led to a saving of thousands of dollars.

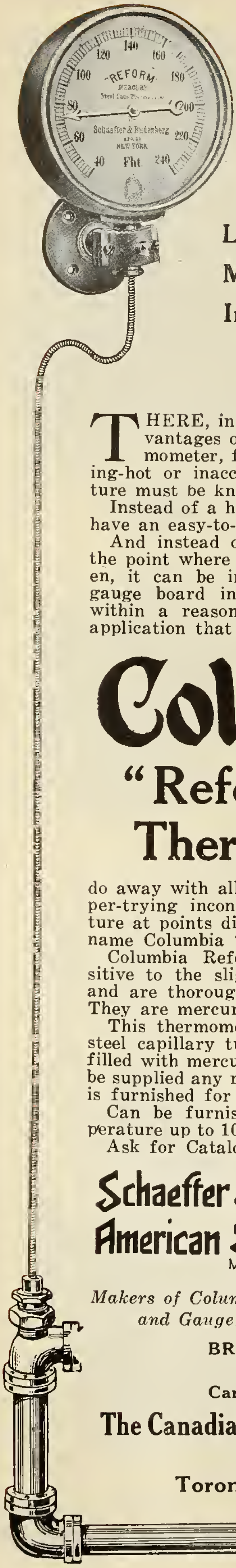
The Foxboro Co., Inc.

Foxboro, Mass. U.S.A.

New York Chicago Boston Tulsa Cleveland
Pittsburgh Philadelphia San Francisco Birmingham
Peacock Brothers, Limited, 179 Delorimier Avenue,
MONTREAL, CANADA.

FOXBORO
TRADE MARK
THE COMPASS OF INDUSTRY

5046



An "Extension"-Style Thermometer

**Like an "Extension" 'phone—
Mercury Bulb in one place,
Indicating Dial in another.**

THERE, in a nut-shell, you have the advantages of the Columbia Reform Thermometer, for use at any dark or scorching-hot or inaccessible point where temperature must be known.

Instead of a hard-to-read mercury *tube*, you have an easy-to-read *Dial.*

And instead of the dial being installed at the point where the temperature is to be taken, it can be installed on the wall, on the gauge board in engine room, or *anywhere* within a reasonable distance from point of application that is most convenient.

Columbia "Reform" Dial Thermometers

do away with all the old difficulties and temper-trying inconvenience of taking temperature at points difficult of access — hence the name Columbia "Reform" Thermometer.

Columbia Reform Thermometers are sensitive to the slightest temperature variation and are thoroughly accurate and dependable. They are mercury-actuated throughout.

This thermometer consists of a steel bulb, steel capillary tube and steel coil spring, all filled with mercury. The connecting tube can be supplied any reasonable length and the bulb is furnished for all applications.

Can be furnished for any range of temperature up to 1000° F.

Ask for Catalog G-33.

**The Schaeffer & Budenberg Mfg. Co.
and
American Steam Gauge & Valve
Mfg. Co. Division**

Makers of Columbia Recording Thermometers and Gauges with "TIME PUNCH"

BROOKLYN, N.Y.

Canadian Agency:
The Canadian Fairbanks-Morse Co.,
Limited
Toronto - Montreal

KERR

"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville Ontario

How Much Coal Are You Wasting?

Blindfolding yourself to the fact that your boiler room is different, because you can see no pipe line leaks, or the water alarms don't blow very often—doesn't help to pay for the needless fuel waste caused by the invisible losses within the boiler furnaces.

Get at the REAL FACTS and at the same time give your men a positive and simple guide that will enable them to keep the plant at top notch efficiency—by installing the

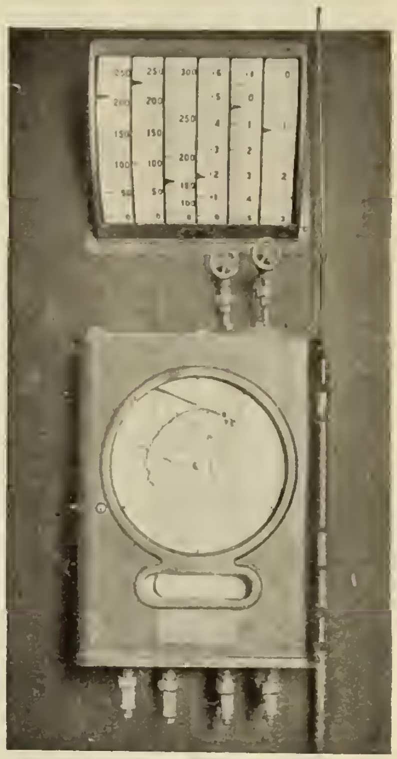
BAILEY BOILER PANEL

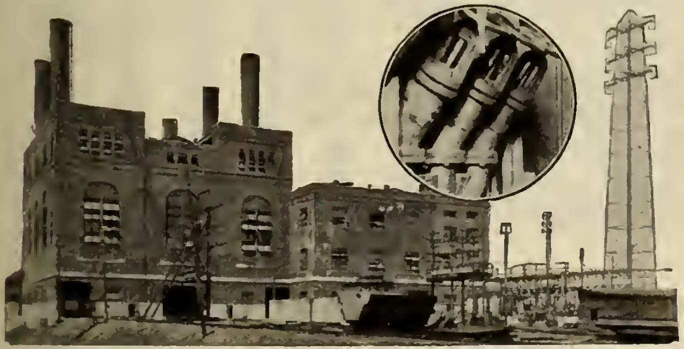
The Bailey Boiler Panel is a combination of the Bailey Multi-Pointer Gage and Bailey Boiler Meter.

It shows, almost immediately, the effect of improper furnace adjustment and enables the men to make the necessary correction before a large amount of preventable fuel waste has taken place. Good work on the part of the men is shown up by the charts as well as any inattention. The engineer can check the efficiency of his men as well as that of the individual boiler.

Let us send you fully descriptive Bulletins.

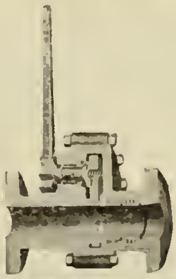
BAILEY METER COMPANY Limited
177 DELORIMIER AVE. - MONTREAL, QUE.





Plant of the Kansas City Power & Light Co. and (inset) part of their installation of Yarway Seatless Blow-off Valves. Sargent and Lundy engineers.

Yarway Seatless Blow-Off Valve (Formerly the Simplex). Fully described in Booklet B-410.



Yarway Double-Tightening Valve, companion of the Yarway Seatless for lines where two valves are desired. Also described in Booklet B-410.

YARWAY

This Splendid Plant of the Kansas City Power & Light Co. is equipped with Yarway Seatless Blow-off Valves

The new plant of the Kansas City Power and Light Company is an excellent example of a modern central station. No detail has been overlooked in providing for its efficient and economical operation.

For more than two years, 12 YARWAY SEATLESS BLOW-OFF VALVES have been in service in this plant. Recently 24 additional YARWAY SEATLESS were furnished for installation on new boilers that are being added to the existing equipment.

18 YARWAY JUNIOR SEATLESS VALVES also are installed here, on water column blow-down service.

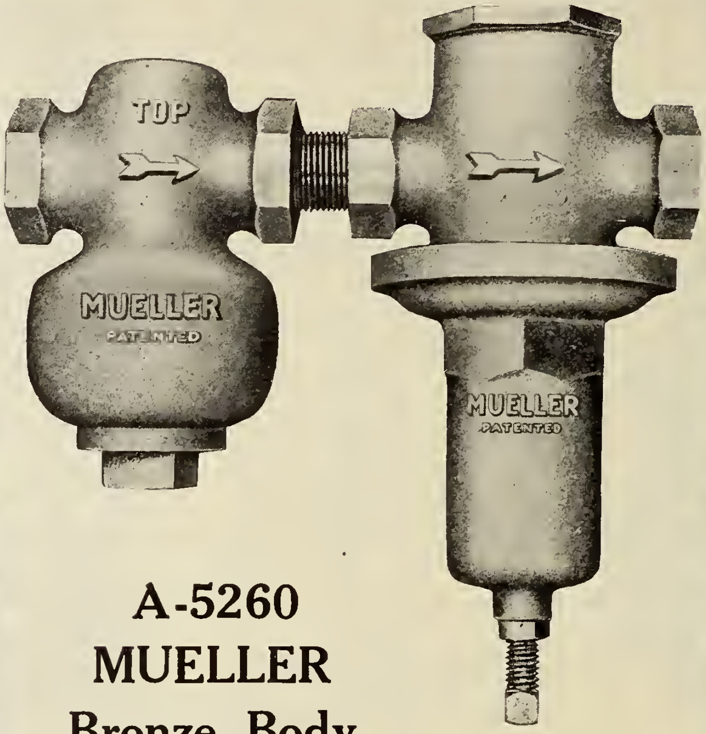
The performance of these YARWAY VALVES fits in well with the high operating standards prevailing throughout the entire plant.

Complete descriptions of the YARWAY BLOW-OFF VALVES are given in Booklet B-410. A free copy is here for you.

Yarnall-Waring Company
Mermaid Lane and Ardleigh Street
PHILADELPHIA

207 St. James St., Montreal
400 Penobscott Bldg., Detroit

POWER PLANT DEVICES *to save fuel*



A-5260
MUELLER
Bronze Body
Reducing & Regulating Valve

SPECIAL sensitive, wear-resistant composition diaphragm to insure accuracy—full seat opening to pass a large volume of water—simple in construction to permit of easy access to working parts—made from MUELLER Bronze and therefore non-corrosive—these features combine to place this valve in a class by itself. And these are the points we bore in mind in designing this Regulator, since careful investigation proved them absolutely necessary to provide a satisfactory valve for the regulation of pressure on cold water lines.

This Valve will fill your requirements for cold water pressure regulation—let us know your problem.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Illinois, U. S. A. Branches, New York and San Francisco

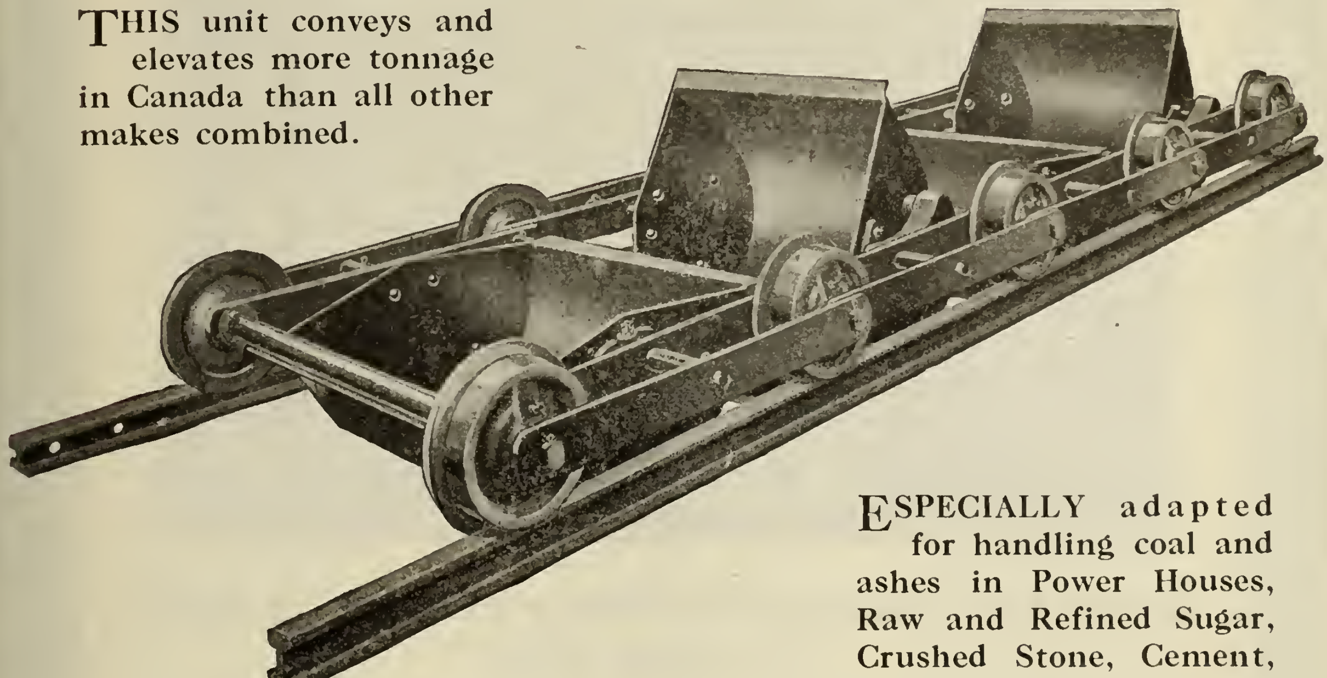
Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rods; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

"MEAD-MORRISON"

CANADIAN MM Co

Gravity Bucket Conveyors

THIS unit conveys and elevates more tonnage in Canada than all other makes combined.



ESPECIALLY adapted for handling coal and ashes in Power Houses, Raw and Refined Sugar, Crushed Stone, Cement, Hot Clinker Phosphate, Rock and other Bulk Materials.

AGENTS:

B.C. Equipment Company, Limited Vancouver
Harvard Turnbull & Company " Toronto
Powell Equipment Company, Limited Winnipeg
O'Hanlan Ferguson Supply Company Edmonton
Ferguson Supply Company Calgary

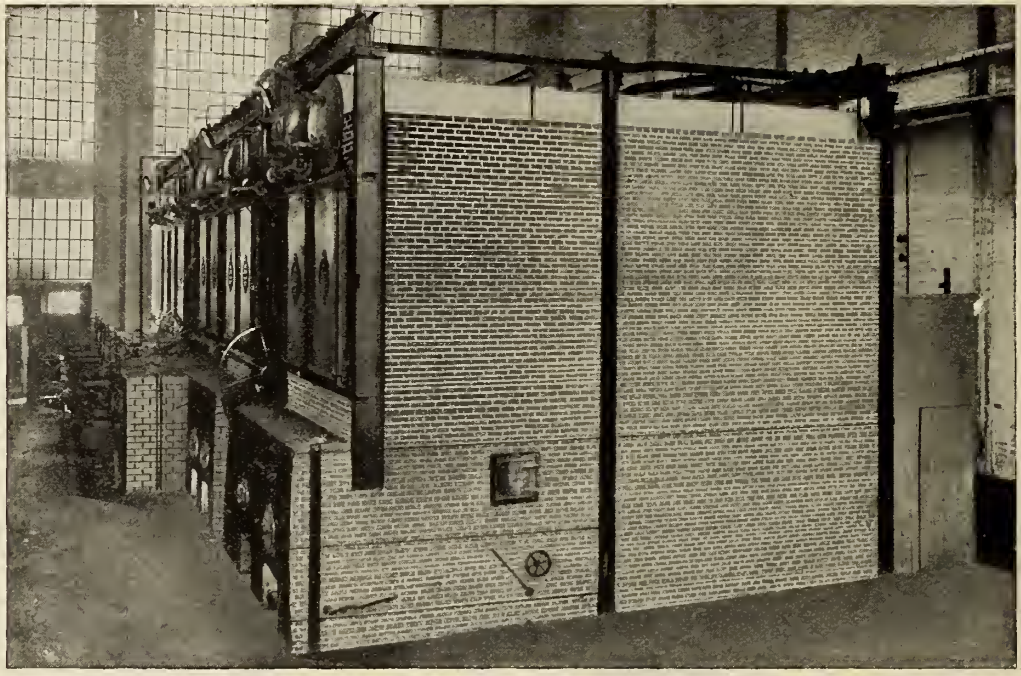
Made in Canada by

CANADIAN MEAD-MORRISON CO
LIMITED
CANADA CEMENT BUILDING
MONTREAL
WORKS: WELLAND ONT.

GOLDIE & McCULLOCH

Dependable Power Plant Equipment

Sectional Water Tube Boilers



Every Part Subjected to Steam Pressure is Made of Forged Steel

This important feature of the design and construction of G. & McC. Sectional Water Tube Boilers give them a great advantage over all types of ordinary boilers. Other features include large steam and water drums and connecting nipples of increased size, thus providing greater combustion area and increased steaming capacity.

The installation shown consists of 5 Double Drum G. & McC. Co. Sectional Water Tube Boilers at the Power Plant of the Canadian Government Railways, St. Malo, Que.

Catalogs, Plans, Prices and Engineering advice for the asking.

THE GOLDIE & McCULLOCH CO.,
LIMITED.

Head Office and Works: GALT, ONTARIO, CANADA

Toronto Office: Suite 1101-2 Bank of Hamilton Bldg. **Western Branch:** 248 McDermott Ave., Winnipeg, Man. **British Columbia Agents:** Robert Hamilton & Co., Vancouver, B.C. **Quebec Agents:** Ross & Greig, 400 St. James St., Montreal, Que.

POWER HOUSE

Members of the
Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
A Semi-Monthly Newspaper

Refrigeration a Mighty Factor in Economic Life

Canadian Field Extending Daily With Result that Power Plant Engineers Find it Intruding to Such an Extent as to Demand of Them a Sound Working Knowledge of the Cycle of Operations

FROM the time of its first application to the primary industries of Canada as in the chilling for export of butter, eggs, cheese, etc., its application in the field of purely local requirements as in the manufacture of ice cream, ice plants, dairies, hotels, clubs, butchers' shops, etc., mechanical refrigeration has been a mighty factor in our economic life.

Its field is extending and the number of installations is rapidly increasing, with the result that a number of engineers and others who formerly gave but little thought to the subject, find it today intruding under their notice to such an extent as to demand of them a reasonably sound working knowledge of the cycle of operations.

Temperature

The terms hot and cold are purely relative. They express a condition, viz., the temperature condition of a body, substance or place in relation to some other body, substance or place. Speaking non-techincally, a body having a temperature of 120 deg. F. is considered hot while 60 deg. F. is considered cold, because the former is about as hot as the hand can stand and, in this manner of speaking, the temperature of the human body is the basis for comparison.

Similarily, boiling water at 212 deg. F. is considered hot, and melting ice at 32 deg. F. cold—relatively to the human body.

On the other hand, boiling water is cold in relation to the flame which heats it, and melting ice is hot in relation to say anhydrous ammonia vaporising at—29 deg. F. under atmospheric pressure.

Considering the temperature range covered by these examples, the necessity for an instrument to correctly measure degrees of temperature is at once apparent; and a little reflection will serve to show how seriously handicapped were the early scientific investigators prior to the invention of the thermometer—without which the discussion of heat problems would be impossible.

With a proper appreciation of the importance of the thermometer, particularly in refrigerating work, will come a corresponding realization of the necessity for its correctness and reliability. Careful calibration and the application of the corrections thus obtained to observed temperature readings are essential if accurate results are to be obtained.

Whatever the engineer finds to do that is helpful should be done with all his might. There is no dishonorable work except that which is done without purpose. Labor that is not essential to human welfare is uneconomic. Men who do not fit in at serviceable jobs in Canada's industrial machinery are parasites. Hard work brings forth services, secures promotion, and develops economic power. It augments the earnings of the engineer and the capitalist alike, and promotes the happiness of the whole industrial army.

In measuring degrees of temperature, the thermometer makes possible the determination of heat quantities, which are expressed in terms of British thermal units, one B.t.u. being the quantity of heat required to raise the temperature of 1 lb. of water 1 deg. F. If, therefore, 5 lb. of water be raised through 20 deg. F., 100 B.t.u. will have been imparted to it, but its weight remains unchanged.

Heat is intangible, something like liquids and solids or manipulated like certain substances, but which, nevertheless, can be measured and handled in quite as positive though a different manner.

Cold does not exist; it is merely a state or condition caused by the removal of heat, which in theory may be intensified until the point of absolute zero is reached at—460 deg. F., at which point heat ceases to exist.

The second law of thermodynamics states that heat cannot of itself, i.e., without the application of external work, pass from a colder to a warmer body. Its natural tendency is to pass or flow from a higher to a lower temperature level.

An analogy is to be found in the case of water, which will readily gravitate from a higher to a lower level but must be pumped or lifted from a lower to a higher level. A helpful mental attitude is, therefore, to consider heat as something very real, something which can be moved about from place to place, abstracted from one body and imparted to another, converted into useful work or completely rejected if so desired.

Refrigerating Medium

In refrigerating work, the heat removed from the goods (or from the water in the case of ice making), is subsequently rejected to the condensing water and ultimately, if a water cooling tower is used, to the atmosphere.

Since the temperature of the condensing water during the summer months may be as high, or even higher than 80 deg. F., some low temperature medium or working substance must be introduced to first receive the heat at the lower temperature of the refrigerator; and mechanical means then employed to dispose at the higher temperature level of the condenser, of the heat absorbed by it.

Apparatus Required

Should a very inexpensive medium be discovered, so cheap to produce that it could be discarded with the heat absorbed by it, all the apparatus necessary to cool a tank of water, would be a pipe coil immersed therein and an expansion valve for regulating the flow of the substance through the coil. Its intrinsic energy would need to be very high otherwise the enormous quantities required would place it outside the realm of practicability. Such a working substance would be used as a fuel and, in this respect, would bear much the same relationship to the refrigerating plant as does oil to the internal combustion engine. It would be exhausted to the atmosphere after use.

Unfortunately, however, all refrigerating media are expensive, consequently it becomes necessary to provide apparatus for suitably rejecting the absorbed heat from the system so that the working substance may be again capable of performing useful work of refrigeration. Two additional pieces of apparatus are required to perform this function, viz., a compressor and a condenser. The system becomes then a closed one, the cycle of operations continuous and the refrigerating plant found to consist of the following four pieces of apparatus,—1. A refrigerator or evaporator; 2. A compressor or gas pump; 3 A condensor or liquifier; 4. An expansion or regulating valve.

Cycle of Operations

As the refrigerating plant comprises four fundamental pieces of apparatus, so the refrigerant or working medium undergoes four changes in one complete cycle of operations. An analogy is to be found in the case of the heat engine in which heat is received by the steam from the furnace at the higher temperature level of the boiler, portion of it transformed into work in the engine cylinder, the remainder rejected at the lower temperature level of the condenser and finally the condensate heated to the temperature of the boiler thus completing the four stages of the cycle.

In the refrigerating system the foregoing cycle is reversed, heat being received by the ammonia at the lower temperature level of the refrigerator, external work then done upon the medium in the compressor, the heat rejected to the cooling water at the higher temperature level of the condenser and finally the ammonia cooled to the temperature of the refrigerator where its condition is now in every respect the same as at the beginning of the operations.

These four stages of the ammonia compression refrigerating system will now be examined, to facilitate which it will be assumed that the temperature of the refrigerator is 5 deg. F. and that of the condenser 86 deg. F., these being the temperature levels adopted by the American Society of Refrigerating Engineers as a standard basis for rating the capacities of refrigerating machines.

Fourth Stage

It will be advantageous to examine firstly, the final stage of the cycle, representing the passage of the ammonia through the expansion valve.

Under practical operating conditions, the refrigerant (which reaches the valve as liquid) undergoes a throttling process at the expansion valve without the addition or substraction of heat, its heat content remaining unchanged. Its temperature is reduced from that of the condenser to the temperature of the refrigerator by the vaporisation of portion of the refrigerant, sensible heat being taken from the ammonia and rendered latent during the process, a drop in temperature resulting. This change in the state of the medium at the expansion valve is not peculiar to the refrigerating system. The same phenomena maintain at—for example, the blow-off or trial cocks of a steam boiler.

When any such under-water fitting is opened, the pressure on water passing the valve is reduced from that of the boiler, say 180 lb. gauge, to the pressure of the atmosphere, viz., zero gauge,—the corresponding drop in temperature from 379 deg. F. to 212 deg. F. being brought about by vaporisation of portion of the water. Consequently steam and water are together observed to pass to the atmosphere. The liquid is cooled at the expense of effective work of refrigeration. The amount evaporated during the change from 86 deg. F. to 5 deg. F. can be shown to be 16 per cent. The remainder, 84 per cent. is liquid at 5 deg. F., and is available for performing useful work in the refrigerator.

First Stage

The first stage represents useful work in the refrigerator. The refrigerator or evaporator may take the form of pipe coils immersed in a tank of water or brine, piping placed on the walls and ceilings of freezing rooms, a battery of coils over which air from the coil rooms is circulated by means of a fan, etc., etc., as the case may be.

If your plant is standard in every respect—if you have worked hard to build up efficiency to a point that reflects credit on yourself—surely you do not intend to rest on your laurels now. Somewhere in Canada there is probably a plant that is meeting the same conditions as yours—at a lower cost.

And there you will find a man who is not yet satisfied—a man who is still striving for a little more—a man who, although already high on the peak where the grade is steepest and the effort greatest, is still pushing upward.

Referring again to the heat engine cycle, the refrigerator is analogous to the steam boiler. In the latter, the quantity of steam generated per unit of time is proportional to the heating surface. Similarily, the quantity of ammonia vaporised in the refrigerator and consequently the amount of useful work performed, is, other things being equal, proportional to the evaporating or heating surface. The ammonia here undergoes an isothermal change since it is carried out at constant temperature; the quantity of heat absorbed being equal to 474.3 B.tu. per lb.

Second Stage

The second stage represents the work of compression, the object being to bring about such a state or condition of the working substance that the heat absorbed by it in the refrigerator may, by condensation, be rejected to the cooling water. The point should here be noted that the standard condensing temperature of 86 deg. F. contemplates a mean cooling water temperature of approximately 71 deg. F. (ranging from 65 initial to 77 final), the temperature difference of 15 deg. thus insuring a satisfactory rapid transfer of heat from the working substance to the water. Now, increase of pressure increases the dew-point (or temperature at which condensation takes place) of a liquifiable vapor; consequently since a condensing temperature of 86 deg. F. is demanded, it is found from tables of properties of saturated ammonia, that a corresponding pressure of 155 lb. gauge must be applied.

Anyone who has had occasion to inflate a pneumatic tire by means of a hand pump knows, firstly, that external work must be expended to compress the air and, secondly, that the work of compression generates heat.

Similarly, in the referating system, heat is imparted to the ammonia and its temperature increased accordingly when external work is applied. In what is known as the dry compression system (which is the system under review), the whole of the liquid which passed the expansion valve is assumed to be vaporised in the refrigerator, so that only dry and saturated vapor reaches the compressor. Compression proceeds adiabatically, i.e., at constant eutropy, or, without gain of heat other than that due to the external work applied, and without loss, the compressor walls being assumed perfect non-conductors of heat.

In such a cycle, the work done per lb. of ammonia is the difference in heat content at the beginning and end of compression. For the standard temperature levels of 5 deg. F. and 86 deg. F., where the refrigerant enters the compressor at 19.6 lb. gauge pressure and is discharged against a pressure of 155 lb. gauge, it can be shown that the heat content of each lb. of ammonia circulated is increased by 99.3 B.t.u. This quantity of 99.3 B.t.u. is the heat equivalent of the mechanical work expended in compression.

Third Stage

The third stage represents the work of condensation. The type of condenser familiar to most readers is, doubtless, the atmospheric type consisting of wrought iron pipe coils over which the cooling water is showered. The gas leaving the compressor is superheated, its temperature being 208.4 deg. F = 122.4 deg. of superheat. This sensible heat is first removed by the cooling water until the condensing temperature of 86 deg. F. is reached, after which the latent heat is removed at constant temperature and the refrigerant returns again to the expansion valve as liquid thus completing the cycle of operations.

The theoretical heat balance in a closed cycle of operations states, in broad terms, that the heat taken up by the working substance must be equal to the heat rejected from it. In the

(Continued on page 40)

Ash Handling—The Step-child of the Power Plant

Although Experts Admit Coal-handling Often is Featured as the Big Problem—Ash Disposal and the Cleaning of Fires Are of Practically Equal Importance in Cutting Costs

ON ONE point all authorities in Canada who have made a thorough study of ash disposal methods and costs are in full accord. They agree that ash handling is the stepchild of the power plant, that coal-handling is featured as the big problem while ash disposal and the cleaning of fires, actually of practically equal importance, are slighted.

A recent paper by John Hunter and Alfred Cotton gives the ash disposal problem the attention it deserves:

"Ash handling is just as important as coal handling. It is a simpler problem only to the extent that there is less ash than coal, but the coal disappears while the ash accumulates. The ash must be got rid of or the plant will be put out of commission.

"Except that there are several standardized types of conveyors, classification of methods of ash handling is not convenient and would serve no useful purpose. Each problem must be considered entirely according to its particular circumstances. The methods of offering the ash in the first place, the general conditions to be met, and the final disposition are all so varied and the possible combinations of each are so numerous that each installation is different from others in some respects.

Rudimentary Methods

"No doubt the most rudimentary method is that in which the ashes are hoed out of the fire doors and the ashpits onto the firing floor and are shoveled into wheelbarrows which are dumped outside the boiler room, either to fill up depressions or to be carted away. In some cases, the ashes are shoveled into industrial railway cars, which are then pushed to the dumping point. In some existing plants, a basement is out of the question, and even if a change were made to stoker firing, the ashes would still have to be hoed out of the ashpit. But the wheelbarrow can be replaced by either a mechanical or air conveyor.

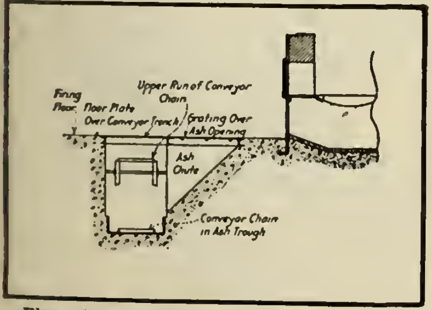

Firing Floor
Floor Plate Over Conveyor Trench
Upper Run of Conveyor Chain
Grating Over Ash Opening
Ash Chute
Conveyor Chain in Ash Trough

Fig. 1A—Block chain conveyor in trench.

"Figure 1A is a cross-section of a block-chain conveyor running in a trench under the firing floor. The ashes es are hoed on to the grating, through which they fall down the chute to the bottom of the trench. They are then drawn along by the chain, discharging into a bucket elevator as illustrated in Fig. 1B or onto an inclined chain conveyor carrying the ash into an elevated storage hopper.

Sufficient Supply Rate

"Where there is a plentiful supply of water, a flume may be carried along under the firing floor and the ashes raked into it through the openings. This is a very simple method, but it is seldom that a natural water supply and sufficient fall from the plant are available adequately to dispose of the ashes.

"When the boiler room is considerably below the ground level the problem is more complicated. In such cases there will seldom be a basement below the boiler room, partly on account of the expense of further excavation, and often because of difficulties with building foundations and water. Good examples are the boiler rooms of office buildings and hotels, where the boilers are generally a considerable distance below the street level and the building is closely surrounded by streets and other buildings. Whatever the final disposition may be, the ashes are invariably removed from the vicinity in motor or horse-drawn trucks. Here the important consideration is principally that of hoisting the ashes from the boiler room to the street. The crudest method is to load the ashes into ash cans and hoist them by hand-operated block and tackle to the street. This entails high labor cost.

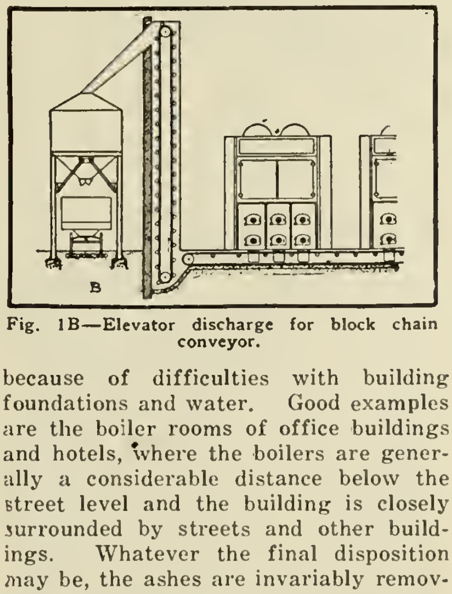


Fig. 1B—Elevator discharge for block chain conveyor.

Noise Hampers System

"In some instances, the air conveyor (the so-called steam-jet conveyor) has been used advantageously in hospitals, hotels and office buildings in crowded parts of cities, but it is not always applicable. Unless certain precautions are observed, such as connecting the air discharge into the chimney, the noise may entirely prevent the use of the system.

"Another method is the 'post box' elevator. The ashes are stored in the boiler room until the arrival of the ash truck. The elevator, which is of the bucket type, has a telescopic housing which is pushed up through the sidewalk opening and the chute extended to discharge into the truck. When the truck is filled and the elevator stopped, it is withdrawn below the sidewalk and the cover closed over the opening. The casing of the elevator is telescopic to allow of its retraction below the sidewalk, and the bucket chain is so designed as to allow the slack to pile up in an orderly manner at the bottom without becoming entangled.

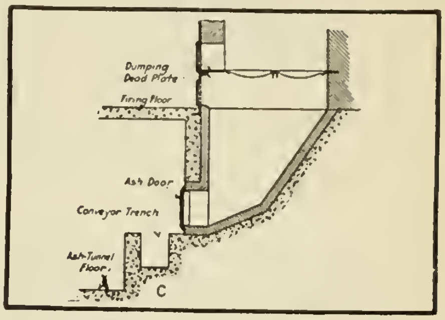


Fig. 1C—Conveyor trench at basement ashpit door.

"Where conditions allow, an ash storage hopper may be constructed within the building and a closed ash chute temporarily extended over the sidewalk to the ash truck. The storage hopper may receive ashes from a bucket car and whip hoist, a bucket elevator, or an air conveyor. It is not often that this method can be employed. The purpose of the building may entirely prevent the use of such a hopper, and the temporary extension of the ash chute over the sidewalk would not be permitted in the better or more crowded streets.

Hopper Ashpit Saving

"As the first operation where labor can obviously be saved is in avoiding hoeing and shoveling ashes at the outset, this leads naturally to a consideration of the hopper ashpit. The hopper ashpit is regular practice in the modern plant. Its size and general design will depend primarily upon the manner in which the ashes flow into it, the method of removal, and also upon the system of draft. The design begins at the top to suit the stoker.

"In hand-fired, forced-draft anthracite plants the top of the hopper will conform to the whole grate area. With stationary grates fine ash is falling constantly over the whole area. As the fires are hand-cleaned, a dumping deadplate will keep the ash away from the firing floor and allow it to fall directly into the hopper, the forced draft being temporarily shut off. With dumping grates the ash will also fall from most of the grate surface. The ashpit will most probably be a storage hopper, which will be emptied at intervals with the forced drafts shut off. Large capacity is necessary because of the high percentage of ash in this fuel. The discharge door must be airtight to avoid increasing the cost of generating the forced draft and the possible reduction of ashpit pressure's lowering the boiler capacity. If it can be dumped directly into railroad cars, the basement being deep enough for this purpose, the hopper can be quickly dumped through bottom doors.

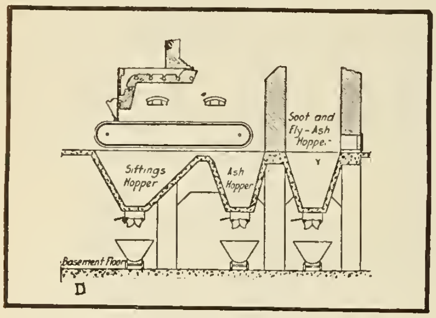


Fig. 1D—Chain grate with ash, siftings and soot hoppers.

Value of Conveyors

"Where conveyors are installed it is usual to use a side door and work the ashes out gradually into the conveyor to avoid choking it, as would happen with a straight dump. Figure 1C illustrates a layout of this kind. The conveyor will occupy the trench in front of the ash door. It may be mechanical, bucket or chain, or air or water, and is therefore shown schematically only.

"With forward-travel underfeed stokers, chain-grate stokers, front-feed inclined stokers, and others the ashes are dumped at the rear of the furnace and the top of the hopper will be the width of the fire but of small dimension from front to rear to accord with the stoker dump. This reduces the capacity for storage.

"With chain-grate stokers a hopper should also be provided for fine coal which sifts through the grates before ignition. Such an arrangement is shown in Fig. 1D. This coal is dumped into some means of conveyance to be returned to the stoker coal hoppers.

"Side-travel underfeed stokers dump at each side of the wind box for the whole depth of the fire. Hopper ashpits for this type of stoker may therefore have greater storage capacity since the top of the hopper extends to the front of the boiler. Fig. 1E illustrates an ashpit of this kind.

"In discussing the amount of storage required, it will be noticed that there are frequently two places where the ash is stored; in the ashpit and in the elevated ashbin, if there is one. In some instances small capacity may be sufficient, owing to storage being taken care of outside the ashpit. The method of conveyance from the ashpit will have considerable bearing on the ashpit capacity necessary. But 24 hours' capacity should usually be provided in case of breakdown of conveyors, etc. Consequently some of the attributes of different methods of ashpit conveyance which bear on ashpit capacity should be mentioned here. The largest ashpit capacity will be requisite with conveying systems which are operated intermittently. These will include instances where ashpits are dumped into industrial railroad cars or into conveyors which might be choked by the direct dumping of an accumulation containing large clinkers and therefore need hand feeding or at least manual attention. Where a continuous-conveyor system is used the ashpit may be much smaller, and sometimes the ashpit becomes simply a funnel or chute to guide the ashes into the conveyor.

"Since the required capacity depends upon the amount of ash that accumulates between emptyings, it is controlled by the rate of firing and the percentage of ash in the coal. Multiplying the weight of coal burned between dumpings by the percentage of ash and allowing 40 lb. per cu. ft. gives the storage space required. Allowance must be made for unburned coal coming in with the ash, for neglect to empty regularly, for possible increase in the load and consequently in the rate of combustion, and for possible change to dirtier coal. The careful engineer will make the capacity of his ashpits perhaps 50 per cent. greater than the calculations show, or even more. Also, sufficient space should be left above the top of the ashes in order to prevent burning and breakage of stoker mechanism.

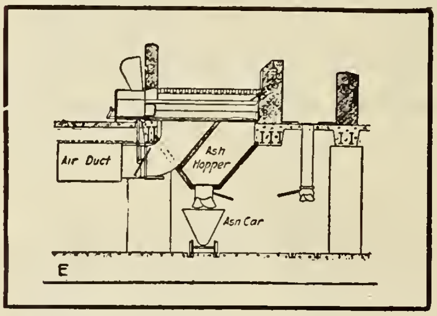


Fig. 1E—Hopper ashpit for side-travel underfeed stoker.

Hopper-Ashpit Design

"Ash hopper sides should slope at not less than 45 deg. in any case, and a minimum of 50 deg. with the horizontal is preferable. If one side is vertical the opposite side may have the minimum slope; but where two opposite sides slope, neither should slope less than about 55 deg. If the slope is too small, arching of the ash is likely to occur and this will increase operating costs owing to the frequent necessity of encouraging the flow by breaking away the ash with bars poked up through the discharge doors. Where the width of the hopper would necessitate too great height to get these required slopes, the ashpit may easily be divided so as to have a number of discharge openings.

"If a very small slope is used so as to get large capacity, access doors should be provided at the top of the slope so that the ashes may be pushed to the dump doors with a minimum of labor, and ample space should be left so that long ash tools can be wielded with ease.

Discharge Openings

"Large discharge openings should be used, though their size depends to some extent upon the method of firing. When small anthracite is burned with sufficient steam in the combustion air, no clinkers are formed and the ash is in small pieces and easily dumped. Modern intensive firing of bituminous coal tends to cause the formation of large clinkers, and the openings should be large enough to pass these without having to break them into smaller pieces to allow dumping. In earlier installations, door openings about 18 in. square and even less were common, while modern practice required 30 to 36 in. as a minimum, with many instances of clear openings 5 ft. square.

"In some instances the discharge door is in one of the sides of the hopper as in Fig. 1C and the attendant hoes out the ashes either into cars or conveyor. Whenever it can be adopted, however, the bottom discharge is undoubtedly the least costly in labor and well repays the added expense of the greater height of basement needed.

"Height of the bottom of the hopper above the basement floor depends upon the systems of conveyance adopted. It is greatest where standard railroad cars are used, about 8 or 9 ft. to clear the cars, and about 17 to 18 ft. if a locomotive must pass under. With industrial cars 5 or 6 ft. is sufficient, though a clear headroom of 6 ft. 6 in. to 7 ft. is preferable. With some conveyors it may be much less, but in any case there should always be sufficient vertical space to allow a bar to be pushed up into the hopper to clear away any ob-

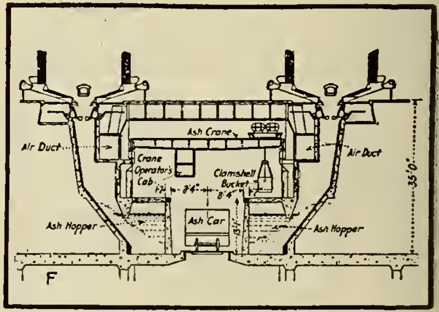


Fig. 1F—Double water-sealed ashpit layout for large plants.

struction. In designing new plants ample headroom should always be provided.

Ash Quenching Water

"Where storage takes place in the ashpit, water spray pipes should be provided for quenching the ashes. These pipes should be near the top and sheltered from the incoming ash. Or a substantial spray ring may be used. Many prefer to make the hopper sufficiently large for the ashes to remain long enough to cool naturally. By allowing some ash to remain when dumping, for the new hot ash to fall on, the doors and lining are protected and the ash gradually cools without the use of water. If too much water is used, it will leak from the dump doors and flow about the basement; and as it contains much fine ash in suspension, it will clog sewers and necessitate cleaning them frequently.

"Hopper-ashpits will usually be provided with doors to retain the ash and prevent the passage of air, and to allow of the ash being dumped or hoed out at intervals as desired. With hand firing and natural draft the doors need not be airtight so far as draft is concerned; but with chain grates and with closed ashpit forced draft the doors should be tight to avoid loss of air pressure and waste of blower power.

Excess Air Dangers

"Inleakage of air may reduce boiler efficiency in some cases by excess air passing the fire through the stoker ash dump; and when forced-draft stokers are heavily loaded, gas may escape through the dumping doors. Where much combustible gets into the ashpit, either through carelessness or imperfections in stoker design, leakage of air through ill-fitting dump door often causes sufficiently rapidly combustion in the ashpit to result in damage to grates, hopper structure, or dumping doors.

"Airtight ash doors are therefore highly desirable in almost all cases.

"There are several cases in which the dump openings may be sealed. The doors and faces may be machined, or the frame may be provided with a groove packed with asbestos rope, while the door has a rib or tongue which is squeezed into the asbestos packing by a crossbar and screw spanning the door. The latter method has been used with satisfaction in vertical doors like that of Fig. 1C. The door and frame may sometimes be left unfinished with sufficiently well-fitting smooth-faced castings that will prevent much ingress of air. The doors should usually be lined with firebrick to prevent warping due to hot ashes lying on them soon after dumping.

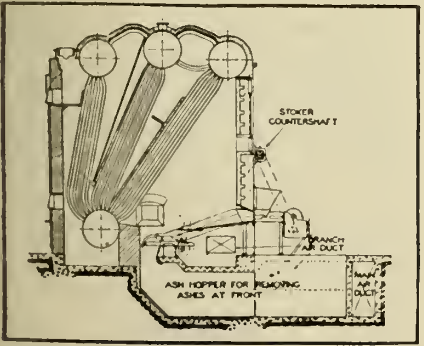


Fig. 1H—Ashes removed at front of boiler at boiler room floor level.

"Instead of using doors, closure may be effected by water seal. This method may be described as a U-tube with one leg forming the hopper ashpit while the other is open to the atmosphere and possibly to the entrance of a clamshell bucket. Water in the bend of the U-tube forms a seal and serves to quench the ashes.

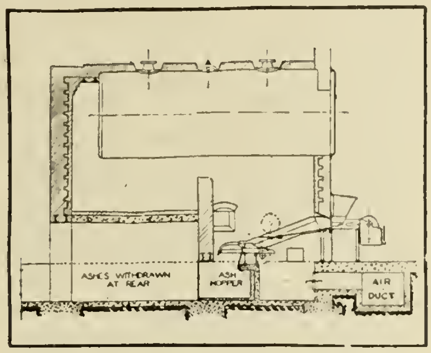


Fig. 1J—Ashes withdrawn at rear.

Water Sealed Ashpit

"An excellent example of this method is illustrated in Fig. 1F. The operation of this system is simple. More than sufficient water for the seal is provided by the waste cooling-water from the clinker grinders. The overflow is from one ashpit to the next, until it is finally discharged from the last ashpit.

"This system of ashpit requires considerable depth of basement; not less than 30 ft. from firing floor to basement floor."

Valve Opening Hints

The opening of steam valves and drain cocks should be done carefully, as many steam-pipe explosions have occurred when one boiler attendant has been replaced by another who was unaware of the order in which the valves and cocks were opened and closed.

The attendant should take it for granted that all low-lying steam pipes, especially long ones, all low-lying bends, junction valves, and all pipes between bulb valves are pockets in which water has settled while idle, and that large volumes of water will condense as soon as steam is turned into them. This water must be removed slowly, and very often much water in a pipe helps to create a vacuum, and as there is then no outflow a fairly full pipe may be thought to be empty.

A safe plan for coupling up a steam-pipe range is as follows: Open the drain cocks; these will either drain away the cold water or admit the air, which, if a water hammer should occur, will soften the blow. Close the cocks before opening the steam valve slightly. After a time close the steam valve and reopen the drain cocks. These operations may have to be repeated several times.

"THEORETICAL" MEN

To the mind of the average layman, an engineer is either a practical man or a theorist, with the college professor as the extreme example. By the same token the services of the young college graduate are frequently and perhaps universally depreciated by the time-honored conviction that his training has been confined to a sphere of knowledge entirely apart from anything encountered in the commercial solution of engineering problems. The fallacy in these contentions is apparent to the intelligent and tolerant citizen.

Theory is the summation of a long series of practical experiences, the possessor of the theory assimilating a digest of those experiences without the drudgery necessary to establish them. The difficulties which many employers are inclined to feel have been invited in hiring engineering graduates, are not infrequently results of an inability to understand or utilize latent possibilities. Despite opinions to the contrary, general opinion agrees that the young graduate is better equipped for inventiveness that his older confréres.

When the student casts aside the printed pages for those that the shop has to offer and when the man in the shop gleans the experience of his predecessors from the printed page, the line of demarcation becomes less real than imaginary. The engineer results.

VIBRATION VALUES

At first sight this title may seem to indicate a paradox. Vibration is generally regarded as an evil to be eliminated as far as possible. This form of motion very frequently makes itself directly evident in a manner unpleasant to the senses of hearing or touch, which probably in a large measure accounts for its general unpopularity.

Nevertheless, the subject is one that should receive consideration, not only with a view to facilitating the prevention of undesirable effects, but also in sight of the possibility of turning it to useful account.

It has been found that when the cooling water radiator of an internal combustion engine was mounted in such a manner that it was subject to what was considered excessive vibration, the cooling effect was improved 30 per cent. Again, metals under circumstances ordinarily influencing their decomposition have been found not to corrode so rapidly when under vibration.

There is no doubt that vibration has important effects on molecular and atomic conditions such as occur with heat engines, magnetic materials and chemical and other actions.

Boiler Tests a Vital Factor in Cutting Costs

Co-operation Between Management and Operator Works Wonders in Maintaining a High Average Efficiency Month After Month and That's What Determines Coal Pile Savings

WHEN a new boiler is purchased and installed the contract usually carries with it the purchaser's guarantee of efficiency which states that the company selling the boiler guarantees that the boiler so installed will have a guaranteed efficiency of boiler furnace and grates of not less than a stipulated per cent. when tested with coal of certain quality and under conditions specified. Every engineer and operator knows that before a boiler is tested it is carefully inspected, given a thorough cleaning and placed in prime condition.

The test is one of short duration ordinarily not exceeding 24 hours, frequently less and the boiler is usually operated at constant load and at its point of maximum efficiency. Selected coal is used for the test and skilled firemen are employed if it is possible to secure them.

Acceptance tests of this kind are very necessary and important since they serve to show what the boiler is capable of doing. They are also an indicator of how the boiler should be operated for best results. If tests are conducted at fairly regular and close intervals the results form a fair check on the plant operation.

However, a test of this kind does not represent actual operating conditions because of certain definite heat losses which are not accounted for in a short run. Boilers are not usually operated at constant load. In the average plant the load will be a widely varying one so that the boiler works at its point of highest efficiency only a small part of the time. When carrying a heavy overload or when running at much less than rating the efficiency usually is lowered materially.

Heating Surface Wanes

After a short period of operation the heating surfaces are less effective in conducting heat unless the soot is blown off at regular intervals. Soot blowing uses steam. Boilers are often banked at night causing a direct loss of heat not accounted for in a trial test.

Heat is lost when boilers are "blown off." Frequently blowing off is necessary when the feed water contains scale which settles in the bottom of the boiler. Bad feed water causes a heavy heat loss.

Analysis of flue gases may show a high percentage of CO_2 under actual test for 24 hours but average percentages are likely to be considerably less, indicating an excess of air and a consequent fuel loss. Very frequently little attention is given to the upkeep and the operation of a unit after it has been installed. The result is that a 24-hour test at normal rating often gives an efficiency of boiler furnace grates 10 to 15 per cent. greater than that shown by actual continuous operation over a long period of time.

Every day in your power plant peculiar conditions arise—"inexplainable. Isn't there a reason? Is there any satisfaction half as great as the discovery of the cause—the underlying law that governs an effect? When you refuse to seek a reason for a condition, the condition is your master. When you find the cause, you are its master.

You may never evolve an immortal idea but you can add something to the world's fund of information if you will untiringly seek the "why and wherefore."

Cut Heating Losses

Two factors mentioned above must be taken into account. One has to do with the necessary heat losses caused by the fact that actual average operating conditions are far from ideal. The losses caused thereby cannot be eliminated but may be kept low. Boilers must be blown off, but this loss can be minimized. Fires must be banked at night. However, records taken in some plants have shown that it is better economy to let the load run light on the whole battery of boilers rather than cut out one or more and carry a heavier load on the remainder.

The second factor is one which deals with the general condition of the plant. Heating surfaces can be kept clean if the operator is given the proper equipment and the incentive to use it. Scale can be kept out of the boiler. Air supply to the furnace can be closely controlled. Brickwork in settings can be kept in condition to prevent air leakage.

In short, the boiler can be kept in nearly as fit condition continuously as for a trial test, if attention is given to it. Coal should be selected with some care for it is almost always true that certain coals are better adapted to the operating conditions of the plant than other coals of equal cost and heat value.

A little additional equipment, a few extra appliances combined with a little knowledge, much interest and co-operation between management and operator will work wonders in maintaining a high average efficiency month after month. And high average efficiency is really the thing that counts because this is what determines the annual saving at the coal pile.

MAKING ICE IN A FURNACE

By Louis Craemer

Ice and melting clinker can be formed in the same furnace at the same time. It seems rather odd, if not impossible, but like Columbus and the egg, it's easy when you know how. The combination was anthracite with the usual amount of moisture, a traveling grate stoker, and forty degrees below zero weather.

I had been noticing that my fires were not in good condition, and I saw that unburned coal was going over the rear end of the stoker into the ash pit. The coal seemed to be in either large spots or, perhaps over the entire grate, and was underneath the usual burned out clinker.

I caught some of this coal on a shovel and found, to my amazement, that it was frozen solid. The explanation at once dawned on me. We investigated and found our forced draft fans were pumping outside air at forty degrees below zero through our fires, and literally freezing the coal next the grates while it burned freely at high temperature immediately over this frozen coal. Of course, we closed off the outside air and remedied the trouble, but for a while we actually made ice on our grates at the same time that we burned coal.

DESULPHURIZATION OF COKE

A study of the action of steam on coke, with regard to the reduction in sulphur content of the coke, is being made at the Pittsburgh, Pa., experiment station of the Bureau of Mines by A. R. Powell, physical organic chemist, and S. H. Thompson, research fellow of the Carnegie Institute of Technology.

PERSONAL

F. R. Allen, formerly with the Arthur S. Leitch Co., will shortly return to the same concern. Mr. Allen has been acting as manager of the Combustion Equipment Co. and it is possible the Arthur S. Leitch Co. may decide to represent some of the lines formerly handled by the Combustion Equipment Co.

Exhaust Steam Economy Vital to Fuel Saving

Effective Use of Every Possible B. T. U. Transmitted to Steam From the Fuel by the Boilers is Still of Decided Interest to Engineers in the Power Plants of Canada

THE economical and effective use of exhaust steam to-day, in the average industrial plant in Canada is becoming a factor of vital interest to the engineer. As a part of the problem involving fuel conservation, it requires far more attention than the layman would imagine.

In the past, a more or less general idea has been prevalent that once the latent energy of steam due to its high pressure, has been utilized, the residual steam is not of great account. Certain well operated plants under the supervision of high grade engineers might install condensers in conjunction with their main engines. This, however, was chiefly for the purpose of obtaining a partial vacuum, thereby to a great extent removing the resisting pressure of the atmosphere (i. e., 14.7 pounds per square inch at sea level), and increasing the power of the engine considerably. The engine would, thus, require less steam to produce the same power, than were it operating non-condensing.

To Effect Saving

In general, it was considered that the use of a condenser would save in the neighborhood of 20 per cent. of steam. On the other hand, the average plant, particularly of smaller type, in the first place could not afford a condenser installation, and in the second place could probably not realize its real value. Hence the engineer allowed his exhaust steam to escape, thereby losing in the neighborhood of 1150 potential B. t. u. in every pound of exhaust steam.

To-day the engineer is mainly concerned with the efficiency of operation in his boiler house and engine room. Fuel and steam economy is generally considered to be primarily his greatest problem. As efficiency improves so will general plant cleanliness and appearance, for the two go almost hand in hand and one cannot exist without the other.

Unit Cost of Steam

The average engineer has, in general, very little interest in fuel costs and steam accounting. Rather are bulk or volume figures of concern to him. The management, however, must consider these items if their operation is efficient, and through their accounting department they should have a monthly or even a weekly comparison of the unit cost of fuel per pound or b. h. p. of steam generated.

Here, we come to a mighty big consideration from the viewpoint of the management, the unit cost of steam produced. The question of effective use of every possible B. t. u. transmitted to steam from the fuel by the boilers is decidedly of interest to the management. When the maximum of developed heat energy is used where possible in plant process work instead of being allowed to dissipate into the atmosphere in the form of exhaust steam after the live steam has performed its primary function, then the fuel bills will be decreased, steam pressure on the main headers will be raised, the load on the boilers will be cut down, and sufficiently high pressure live steam will be available for usage where necessary to insure the greatest economy of operation.

> **Study, if you will, the whole history of mechanical development, and it will be at once apparent that the aim has always been, is, and always will be, to secure maximum attainment, in an economical manner, as quickly as possible; indeed but a moment's reflection will show that the principal aim of even the human body is economy in the expenditure of the bodily power and energy required to secure the attainment of efficient results.**

High Pressure Needs

There are, it is true, a great many stages in industrial plant process work where high pressure steam must be used because of the high degree of heating required, or for certain chemical reasons.

On the other hand, there are also a great many points where exhaust steam could be substituted for live steam to secure the temperature results desired. A part of the heat in the exhaust steam which would otherwise be wasted could thus be utilized.

With this in view we come to the kernel of the problem, from the viewpoint of the engineer, how to use the plant's steam most effectively, in order to reduce fuel bills by decreasing the consumption of live steam and hence the amount of fuel fired.

In practically every industrial plant, process work will be typical of the plant itself or of the product manufactured. Therefore no attempt will be made to mention considerable specific usage of such steam but rather, the possibilities that may cover all plants as a general rule will be considered.

An Economical Use

One of the most economical methods of utilizing exhaust steam is by a feed water heater in conjunction either with a condenser or hot well, or both. Thereby the heat contained in the exhaust steam, if the latter is collected from auxiliary machinery as well as the main units, is practically all saved by being transmitted to boiler feed water prior to its entry into the boiler. All plants, however, will not be equipped with condensing apparatus.

Hence, the problem may be limited to using the exhaust available for heating feed water in the reserve tank, should one be a part of the equipment.

If the exhaust steam contains an excessive amount of lubricating oils, etc., gathered from imperfectly lubricated engines or pumps, it can still be used for heating purposes via a heating coil in the feed water tank without the possibility of returning this oil to the boilers in the make-up feed.

Decide Steam Needs

There are many other points in practically every industrial plant where heating by steam is essential. Heretofore, the prevalent opinion has been that to adequately heat any such equipment, live steam must be used. This, however, will depend entirely upon the degree of heat required.

In such instances as grease-mixing kettles, sugar kettles and the many other types of process work so commonly found in industrial plants to-day, where a degree of heat approximating 200 deg. Fahrenheit as a maximum is demanded, exhaust steam up to 8 or 10 pound gauge pressure containing approximately 1160 B. t. u. per pound, will give ample heat for all requirements.

Use Good Judgment

For example, to heat a heavy, viscous grease mixture to 125 deg. Fahrenheit in a common kettle, steam jacketed, will require a greater volume of steam than a light oil heated by a double pipe coil.

Any number of such cases could be mentioned but they would be pertinent only to particular industries and hence of little service to this discussion. Suffice it to say that good judgment as to the rate of heating required will play an important part in determining whether exhaust steam could be used in place of live steam.

A little calculation of the number of B. t. u. required to raise the substance in question the requisite number of degrees, will frequently be most interesting provided the important points in the problem are known, such as, the specific heat of the substance, the inlet and outlet temperatures customary, the volume heated per hour, the pressure of the exhaust steam available, and the area of heating surface in use.

Efficient Boiler Selection

Human Element in Solving Problem of Actual Accomplishments

WE OFTEN hear of what it is possible to do with certain boilers or other devices in a power plant, how great savings can be obtained by doing one thing or another, all of which would be worth while were it not for the fact that too often these possibilities are ideal and not practical.

It is always desirable and even necessary to know ideal possibilities, but before we dangle them before a power-plant manager, let us determine if these novelties or improvements really show a net gain in the long run. The small plant particularly can not as a rule, use expensive apparatus requiring expensive operation.

The Human Element

The point is that high efficiency, capacity, etc., in a power plant is one of practical consideration in which the human element is perhaps the most important. It is all very well to talk about ideal conditions, but when making a choice, such as that of a boiler for a new installation, the practical end is the important one.

The first group of items to consider in selecting a boiler are space occupied, weight, capacity, first cost, adaptibility to particular conditions of operation and location. It is after the limitations set by these items have been fulfilled that the selection becomes difficult. The conditions then investigated are heating surface exposed to radiation; the correctness of the gas and water motions; workmanship; ease of cleaning, installing, examining and renewing tubes; and cleaning and repairing facilities in general.

Opinions Differ

The correctness of the water and gas motion is one item that causes much discussion and engineers differ in their opinions.

All, of course, agree that rapid circulation of the water is necessary to get good scrubbing action in order to remove the bubbles of steam from the wet surfaces. Rapid and free circulation can only be gotten, however, at the expense of some other item such as strength, ease of repair, expansion troubles, etc. To decide which boiler is the "happy medium" is a matter of personal judgment based on experience.

Space will not permit the consideration of each item mentioned above for the selection of boilers, but to illustrate the difficulty met with in forming a definite conclusion, take the case of the baffling which a boiler should have, a consideration which comes up when studying the gas motion.

The object of baffling is to direct the flow of hot gases. These baffles can be placed to cause the gases to flow across the tubes or along the tubes. Which shall it be? The points to consider when passing on the baffling are its influence on the heating surface, its cost of upkeep, ease of installation and repair, and its flexibility. The art of baffling is to minimize the inactive surface caused by dead gas pockets.

The conditions that carry out all these items can not be set down in exact mathematical terms and differences of opinion arise that can not definitely be settled. For example, it is desirable in a water-tube boiler to have the free area between individual tubes as small and the gas-pass as long as possible. The degree to which this can be done depends on the draft and it in turn is an item of cost. Therefore, the proper proportioning of these items is difficult and the personal element and experience always enter.

Efficiency Vital

So it is with any other item. We all desire high capacities, but there are practical limitations to capacities such as, for example, efficiency. It is difficult to determine the point in capacity beyond which efficiency drops off to such an extent that increase in capacity is obtained at a cost higher than that of additional heating surface. This point is approximately fixed, but the final decision is again a matter of judgment.

In the writer's opinion, the way to select a boiler for a new installation is to make a table of the following items, listing the limitations imposed by the conditions of the installation, and forming conclusions on actual practical results and not on any theoretical hypothesis:

Space occupied.
Weight.
Capacity.
First cost.
Adaptability.

After these items have been studied and the selection has narrowed down, the final selection is made by examining:

Surface exposed to radiation.
Correctness of water and gas motion.
Workmanship.
Ease of cleaning, installing, renewing, examining tubes.
General repairing facilities.

Each item is studied from the viewpoint of what has been accomplished in practice and what the boiler manufacturer guarantees. Theory can be studied, but it must be remembered that selection of boilers is not a research problem but a practical problem of actual accomplishments. The research and design phase of boilers should be discussed also and improved methods of steam generation studied. At any rate a healthy discussion of only one item at a time would be beneficial to all men in the field.

LIQUID SLIP REGULATOR

Peak loads may be materially reduced by the addition of a fly-wheel on the motor shaft and a means of utilizing the stored energy of this fly-wheel when peak loads occur.

This is accomplished with induction motors by increasing the slip of the motor at these periods through the introduction of resistance in the secondary circuits. This resistance may be in the circuit permanently or introduced by automatic slip regulators. The best known types of slip regulators are the magnetic contactor type, and the liquid type.

C.A.S.E. Notes

The 34th annual convention of the Canadian Association of Stationary Engineers will be held at the Central Technical School, Toronto on June 25, 26, 27 and 28. The 200 members of the C. A. S. E. in Toronto, of which R. McLaren, chief engineer of the Massey-Harris Co. is president, have energetic committees at work and a big successful convention is assured.

The Central Technical School has the best equipment on the continent for teaching practical operating engineering and this feature will attract many to the convention. There will also be lantern lectures and addresses by exhibitors in the auditorium, special contests, banquet, etc.

Invitations are being mailed direct to every engineer and manufacturer in Toronto and nearby cities and towns. Other invitations are being prepared for exhibitors to send to their customers.

This is a good opportunity to meet engineers and other industrial representatives personally.

As spaces are allocated as orders are received, it is an advantage to reserve space now. A booth is $25 or table space $10.

Special provision has been made for heavy exhibits of stokers, large grates, etc., a room with a concrete floor being available for this class of equipment.

The regular meeting of Toronto No. 1 C. A. S. E. was held April 3rd in Cumberland Hall. The subject for discussion, in connection with the Educational Program, was Boiler Efficiencies and Evaporation Tests.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

CAMPBELL BRADSHAW - - - Editor.
G. J. SOUCY - - Advertising Manager
B. G. NEWTON - - - - - Manager

SUBSCRIPTION RATE
Canada, $2.00; United States, $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year, other countries, $3.00. Single copies, 25c. Advertising rates on request.
THE MACLEAN PUBLISHING COMPANY, LIMITED
143 UNIVERSITY AVENUE, TORONTO, CANADA
JOHN BAYNE MACLEAN, President
H. T. Hunter, Vice-President.
H. V. Tyrrell, General Manager.

Real Economy

THE lesson of economy is hard to learn. It is beset by powerful temptations and steadfast determination is required to master them.

Money spent to-day for more efficient apparatus takes care of the "rainy day" tomorrow.

In applying this type of thrift to power plant problems—by forcing the expenditure of money for the things necessary for the intelligent conduct of your everyday duties—you are not only doing something tangible to lower the operating cost of your employer's plant but you are giving impetus to the motion of the present tide of business.

Mr. Manufacturer.

SERVICE—that's the present-day price of success!

It's what the power plant engineer demands, for he knows that modern machinery is constantly being improved with regard to facility of operation and the necessity for doing things "right" is apparent to him on every hand.

The high cost of power interruption forces him to realize that care taken before trouble arises is a gilt edge investment.

A prime mover that runs "perfectly" is always due to conscientious work in the factory and painstaking installation in the power house.

Get busy—think of some new service for the man, who, surrounded with automatic control systems and safety devices is to-day obtaining results surpassing those obtained by ten of his fellows in the not very distant past.

Your opportunity is here—but the other fellow is going to grab it if you don't hurry.

Practical Knowledge

MUCH knowledge which the world has acquired with inordinate travail and entravagant expenditure of time and money is summed up by science to-day in a few definite laws and principles.

In no field is greater use made of these laws than in that of engineering, yet there remain many complex problems in which the engineer has to make good with but little, if any, aid from science.

An example of the long ago often cited is the high degree of perfection to which the reciprocating engine was brought, in spite of the lengthy "time lag" in the science of thermodynamics. Steam engines were running successfully long before Joule had determined his equivalent and subsequent to this many decades elapsed before the development of thermodynamics had become of any practical service to the engineer.

Is it not the case that to-day in engineering schools many students too often learn to calculate, and having acquired facility, become indisposed to think? It must at least be admitted that it is much easier to find a student who can determinate accurately the reaction exercised by a steam jet than to find one who can picture the mechanism by which this reaction is impressed on the nozzle box.

The older school of engineers, less adept perhaps in mathematical methods, were forced to think mechanically in forming mental pictures of the distribution of the forces in which they were interested.

To-day a student with his slide rule can solve in a few minutes problems on which his predecessors spent hours; but should his knowledge be superficial, he is liable to go astray when confronted with every-day power house problems for which, as yet, formulae supply no remedy.

Building Confidence.

THE action of the American Society of Mechanical Engineers, in adopting a code of ethics as a rampart for the protection of the reputation of each individual in its membership of 20,000, is striking proof of the determination of the modern engineer in every field to build for himself a bulwark which will protect and conserve his career. Ultimately it is expected the principles of this code, which rest on the very foundation upon which the structure of society is built—confidence—will apply to the entire engineering profession.

In the power plant field in Canada it has long been recognized that it is best to deal fairly and honestly. Manufacturers and engineers in every walk of life are well aware that confidence is the basis on which their ultimate success must rest—that "a man who is poor in trust is the poorest of God's creatures."

Confidence manifests itself every day in our actions toward one another. A power plant owner must believe in the knowledge of his engineer, for knowledge alone can beget that confidence in the man in responsible charge of a plant essential in making his advice and equipment recommendations worth while.

Heating and Ventilating

THE objects sought by heating and ventilation—the maintenance of the air and temperature in a building in the best possible condition for the health of the people using it—are so interdependent that it is always unwise to consider them apart.

In an interesting experiment recently concluded in England an airtight glass case was constructed of sufficient size to allow two or three men to stand upright inside it and an electric fan was installed, operated by a switch outside.

The men were shut inside the case and allowed to breathe the contained air until they began to show signs of collapse, indicating that the proportion of carbon dioxide had risen very considerably and the proportion of contained oxygen was seriously diminished. The electric fan was then set in motion, with the result that the men immediately revived, regaining their normal feelings entirely in a very short time after their liberation.

This experiment would tend to show that chemical purity is not of the same relative importance as that of the movement of air.

Questions and Answers

Queries are invited on the every-day problems of engineers in all industries. Correspondents should sign communications with their full names and post office addresses, which will be withheld on request.

Overhauling Boilers

What is the proper method of procedure when a boiler is to be cut out of service in order to give it a thorough overhauling?—A. N. W.

Burn down fires until all available heat has been extracted, at this point there will be a drop in pressure with damper wide open, meantime the water level has been regulated so that it shows near bottom of glass. Shut all steam valves on boiler, admit some feed water to prevent a rise of pressure to blow off point and then close all dampers. Allow boiler to stand 24 hours before emptying so that it will cool off gradually, keeping the scale and mud soft and easy to remove.

Centrifugal Pumps

On what does the action of centrifugal pumps depend?—O. A.

Centrifugal pumps depend for their action on the pressure produced by the centrifugal force of a quantity of water rotated rapidly by the vanes of an impeller and then thrown out at the periphery. The partial vacuum formed in the centre allows the atmospheric pressure to force water through the suction opening to replace that continually thrown out by the impeller.

Boiler Corrosion

Is zinc of any value in preventing boiler corrosion?—A. H.

Boiler plate corrosion is sometimes due to galvanic action. By placing zinc plates inside a boiler a galvanic action is sent up which attacks the zinc first, destroying it, and leaving the boiler plates unharmed. The zinc is renewed as often as required.

Safety Valve Hammer

How can I eliminate the hammering of a spring-loaded safety valve on a boiler?—O. M., Toronto.

The hammering is probably due to too long or too short a connection for the valve as, under such conditions, when the steam pressure in the boiler rises to the pressure at which the valve blows off, there would be rapid alternations of higher and lower pressure under the valve to synchronize with vibrations of the weighing spring. With the majority of spring-loaded safety valves, however, the hammering of the valve can be eliminated by increasing the amount of "blowdown" of the valve.

Clinkering Coal

I am using coal in a hand-fired boiler that clinkers badly. How can I fire my boiler to reduce the trouble?—B. N., Toronto.

Carry a thin fire, promptly covering the brightest spots of the fuel bed with fresh coal to prevent holes from burning through to cause the coal to drop to the ashpit. Stir the fire as little as possible. Keep the bed level by stoking. Levelling the fuel bed with firing tools is likely to cause clinkering by gathering together the ash or shifting the ash to a hotter part of the fuel bed.

Maintain the ashpit as cool as possible, keeping the doors open and regulating the draft with the uptake or stack damper. Promptly quench any ashes or coal that may fall through the grates and should the ashpit be watertight, keep water standing in it. Should that be impracticable, blow steam under the grate. A pump exhaust or any other supply of waste steam turned into the ashpit will prove beneficial.

Wire Wound Coils

Is there any advantage in increasing the number of turns in the rotor of a wound-rotor induction motor?—A. W., Montreal.

Increasing the number of turns in a wound-rotor induction motor increases the voltage between collector rings and decreases the current, making possible collector rings and brushes of a smaller capacity. This simplifies and cheapens the control as the providing of cast-iron grids or other forms of resistance increases when the current exceeds a certain value. The minimum limit to this is reached when the cross-section of such grids is as small as it can be made for mechanical strength and there is no advantage to be gained in reducing the current below that point.

Code of Ethics

I understand the American Society of Mechanical Engineers recently adopted a code of ethics and if I have been correctly informed I would like you to publish the salient points in it?—Engineer.

You have been correctly informed. The code commands personal honor, fairness to contractors and workers, and interest in the public welfare. The text, adopted by a membership of approximately 20,000, is as follows:

"Engineering work has become an increasingly important factor in the progress of civilization and in the welfare of the community. The engineering profession is held responsible for the planning, construction and operation of such work and is entitled to authority which will enable it to discharge this responsibility and to render effective service to humanity.

"That the dignity of their chosen profession may be maintained, it is the duty of all engineers to conduct themselves according to the principles of the following Code of Ethics:

"1. The engineer will carry on his professional work in a spirit of fairness to employees and contractors, fidelity to clients and employers, loyalty to his country and devotion to high ideals of courtesy and personal honor.

"2. He will refrain from associating himself with or allowing the use of his name by enterprises of questionable character.

"3. He will advertise only in a dignified manner, being careful to avoid misleading statements.

"4. He will regard as confidential any information obtained by him as to the business affairs and technical methods or processes of a client or employer.

"5. He will inform a client or employer of any business connections, interest or affiliations which might influence his judgment or impair the disinterested quality of his services.

"6. He will refrain from using any improper or questionable methods of soliciting professional work and will decline to pay or to accept commission for securing such work.

"7. He will accept compensation, financial or otherwise, for a particular service, from one source only, except with the full knowledge and consent of all interested parties.

"8. He will not use unfair means to win professional advancement or to injure the chances of another engineer to secure and hold employment.

"9. He will co-operate in upbuilding the engineering profession by exchanging general information and experience with his fellow engineers and students of engineering and also by contributing to the work of engineering societies, schools of applied science and the technical press.

"10. He will interest himself in the public welfare in behalf of which he will be ready to apply his special knowledge, skill and training for the use and benefit of mankind."

Water of Condensation

What provision is made in vertical engines for getting rid of water accumulations on the top of pistons?—A. R. A., Brantford.

A somewhat similar query was answered several months ago in Power House but for the benefit of many new subscribers since the dawn of 1923 we would repeat that when warming up, preparatory to starting, and during the first few minutes of running, water of condensation is taken care of by the drain cocks, a certain amount also being carried away with the exhaust through the slide valve opening.

When the engine is running up to normal speed and load, there is usually provision for a sudden slug of water in the shape of a spring-loaded relief valve of ample size to relieve the cylinder.

In some types of engines the valve itself is held up to the face by a spring, which is heavy enough to hold it under ordinary conditions, but will allow it to lift from the face under a sudden shock such as that caused by the presence of water in the cylinder.

Water in the cylinders materially impairs economy in the use of steam but if it is carried over with the steam in large quantities it can be guarded against by the use of suitable separators. What cannot be avoided in ordinary engines with saturated steam, is the condensation of a certain amount of the steam on its admission to the cylinder, due to the cylinder walls having been cooled off during the exhaust period of the previous stroke.

This condensation represents a distinct loss. If there is water constantly present in the cylinder the loss is, of course, considerable, but generally the condensation which has occurred during admission is re-evaporated during expansion.

If the engine is a simple one, that is, single cylinder non-condensing, this reevaporation is of no value as the heat abstracted from the cylinder walls to perform the evaporation is merely carried away in the exhaust.

If the engine is a compound one, we get the benefit of this heat in the next cylinder.

Differential Pumps

To settle an argument will you tell me the purposes of the two plungers of a differential pump?—Robert Steel, Montreal.

One plunger of a differential pump acts between the suction and delivery valves, operating them, while the other is on the discharge side or on top of the discharge valves. The plunger between the valves has twice the cross-section area of the outer one. On the suction stroke the large plunger lifts a volume of water equal to twice the volume of the smaller plunger and on its return stroke it drives this volume through the valve, however, as the smaller plunger is now receding, one-half the volume of the water fills up the space left by it, the remainder being discharged out of the pump.

Radiator Paints

Could you give me any idea of the relative efficiency of bronze and enamel pipe and radiator paint?—H. W.

Painting a bare pipe with gold or aluminum bronze, recent tests indicate, decreases the efficiency of the radiating surface about 20 per cent. but if a coat of white enamel is applied on top of the bronze approximately 95 per cent. of the original efficiency will be restored.

All radiating surfaces dissipate heat as the result of conduction, convection and radiation. The dissipation due to conduction and convection varies in proportion to temperature difference, while heat lost by radiation varies as the fourth power of the absolute temperature. This means that if the absolute temperature is doubled, the heat radiated is increased 16 to 1.

At low temperatures the portion of total heat dissipated by radiation is small, so that the difference in the efficiencies of the two paints is less than at higher temperatures, because while the radiant energy given off by the enamel increases very rapidly, the mirror-like surfaces of the bronze hold this component of the total heat down on higher temperatures and consequently cause a greater difference in the heat dissipation of the two classes of paint to result.

Gas and Coal

Can you tell me how many thousand cubic feet of natural gas with 1,000 B. t. u. per cubic foot equal 1 ton of coal containing 11,000 B. t. u. per lb.?—W.S.

One short ton of 2,000 lbs. of coal containing 11,000 B. t. u. per pound is equivalent to 22,000 cu. ft. of natural gas containing 1,000 B. t. u. per cu. ft. One long ton of 2,240 lbs. of the same coal is equivalent to 24,640 cu. ft. of natural gas of the same thermal value.

$$\frac{11{,}000 \times 2{,}000}{1{,}000} = 22{,}000 \text{ short ton basis}$$

$$\frac{11{,}000 \times 2{,}240}{1{,}000} = 24{,}640 \text{ long ton basis}$$

One short ton of this coal is equivalent to 3.52 barrels of fuel oil, specific gravity .9589, containing 18,640 B. t. u. per lb., or 6,255,111 B. t. u. per barrel. One long ton is equivalent to 3.94 barrels of this same oil.

$$\frac{11{,}000 \times 2{,}000}{6{,}255{,}111} = 3.52 \text{ short ton basis}$$

$$\frac{11{,}000 \times 2{,}240}{6{,}255{,}111} = 3.94 \text{ long ton basis.}$$

Practical Gasket Hints

By Henry Bohmer, Jr.

The greatest difficulty I have encountered during my ten years of experience with gaskets has been to convince engineers that it is not necessary to tighten a thick flexible metallic gasket with the same extreme pressure as must be applied to thin non-flexible gaskets.

The idea seems to prevail that a gasket, in order to prevent leakage, must have as little thickness as possible and must be squeezed so thin that the distance between the faces of the flanges is a very close approach to absolute zero.

Very often when applying gaskets we see the engineer or pipe fitter slip a pipe over the wrench, thereby increasing the wrench's leverage and making it possible to still further increase the pressure against the gasket. As a result the gasket is squashed. If it is made of corrugated metallic material it is flattened out so much that the corrugations can do no good whatever.

Adopt Safety Measure

It is poor practice to slip a pipe over any wrench on any gasket because wrenches are generally made of a proper and safe length to fit the nuts for which they were intended, and nut sizes are usually standardized to fit certain bolt diameters. This is a logical safety measure that has been almost universally adopted so that the bolt will not be subjected to too great tension. An extra long handled wrench, unless used with extreme care, is liable to either break the bolt or strip the threads.

One serious objection to the very thin gasket is that no matter how it is constructed it can have but little expanding or contracting capacity, consequently all expansion and contraction must be taken care of in some other manner—by means of pipe bends or expansion joints. A thicker gasket, having elastic properties, will naturally take care of considerable expansion and contraction. In many cases I have known thick flexible gaskets to take care of all the expansion and contraction in the line—under ordinary temperature conditions of non-superheat practice.

To Avoid Leakage

Where temperatures are high, or where temperatures fluctuate considerably, copper, brass and other metallic gaskets having a co-efficient of expansion different than that of the joint, should not be used. On account of the difference in the co-efficient the gasket and the joint tend to expand and contract independently of each other. The tightly bolted joint being much stronger than the thin gasket will compel the gasket to expand and contract along with it. Breakage and leakage of a serious nature are, therefore, often the result.

A gasket made up of steel, which has the same co-efficient of expansion as the joint, overcomes this latter trouble entirely, but if it is thin and non-flexible it does not overcome or assist in overcrowding the longitudinal expansion troubles.

Use Proper Wrench

Hence when applying thick flexible metallic gaskets, be certain that a

(Continued on page 40)

The Operator's Point of View

The Key to Success

I am glad to see that Power House takes an interest in its subscribers, for that is one of the things that assure it of lasting success.

Now as to the feeling of the few engineers who think they are paying for the advertising pages let me tell you that with all the different kinds of machinery that are being made nowadays if a man can't afford innumerable costly sets of books he can get a lot of valuable information by studying the advertisements in Power House.

There is another thing I like about Power House and that is that it tries to help any man who is in a hole, out of it and that is something every publication does not do.

I would sooner pay $2 a year more for a small book full of good information than $10 a year for a large book full of worthless information. I save every copy of Power House I receive, putting each copy away after reading into my bookcase for future reference.

I know that Power House is going to help me secure my second class papers within a few months and any time I can suggest any new ideas I will gladly send them along, although I am out of work at present.

L. G .ACKROYD, 199 Van Horne St.,
Toronto, Ont.

A Hint to Employers

I am sure many of your readers who have answered advertisements in technical publications or newspapers would be grateful if employers were to announce, in the medium in which their advertisement appeared, when the position had been filled, as there is always a certain amount of satisfaction in knowing that a matter is definitely closed and if you will publish this letter in Power House I will appeal to employers to make a practice of doing so.

Surely they often overlook the fact that the obligation is not entirely on the part of the applicant but a mutual affair.

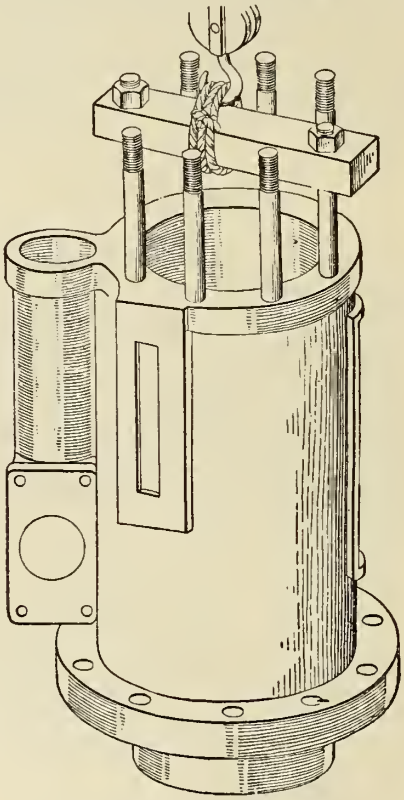
Another point I would like to make is that, in my opinion, employers do not generally give sufficient data regarding the vacancy in their advertisements, such as the size and approximate location of the plant, the nature of the industry for which the power is generated, etc., as if fuller information were given it would often, I feel sure, prevent engineers seeking posts they are unlikely to obtain, either because their qualifications are greater than those required and the salary asked greater than the position carries, or the reverse.

You will I hope try to find space for this letter, as it does seem to me that anything that can be done to make things easier for any member of our profession, who is at present out of work, should be done.

There is no doubt in my mind that it is simply failure to realize the other fellow's point of view that once in a while makes employers rather remiss in this respect.—M. E.

Handling Engine Cylinders

A few months ago I was called in to help to overhaul two oil engines. In removing the cylinders, which were to be rebored, the engineer started to wrap a chain about the cylinder head studs with the intention of looping it over the crane hook. I prevented him from doing this as I feared it would bend the bolts.



Lifting Cylinders With Care

We then obtained a 6 by 6 timber and bored two holes in it large enough and far enough apart to take the two opposite studs. We then passed a sling around the timber and on to the crane hook as shown in the illustration. This plan removes all danger of bent studs. The pull on the studs is vertical and the cylinder will lift off the holding down studs without any trouble.—J. S.

Iron Pipe Sizes

The following information will be new to some of the younger generation of engineers and of interest to others.

Practically all engineers handle standard iron pipe from ⅛ inch up. Most of them have to do with sizes such as 8 inch, 10 inch or larger. There are men who talk about ⅛, ¼, ⅜, ½ and ¾ inch iron pipe and other sizes who would be surprised when told that the internal diameter of these pipes are altogether different from the named sizes, and if they do know it they have not taken the trouble to find out the reason the pipes are not made the sizes their names indicate.

Take as an illustration the five small sizes named, their internal diameter will closely approximate ¼, ⅜, ½, ⅝ and 13/16 inch respectively. Sizes above 11 and 12 inches are usually named according to their external diameter.

The reason given for this apparent ambiguity is quite feasible when known. There is standard, heavy, extra heavy and double extra heavy iron pipe. Each grade has a different thickness, the heavier the thicker, of course. If the extra thickness was added to the outside diameter there would be great difficulty in threading the pipes and no possibility of threading them at all with solid, or one piece bushings, and one piece dies. If the standard ⅛, ¼, or ⅜ inch pipe was made with an internal size the same as named there would be very little opening through them when the internal area was reduced in forming any of the heavy grades.

JAMES E. NOBLE,
173 Macdonell Ave.,
Toronto, Ont.

Over 99 Per Cent.

The write-up of the Regina Parliament Buildings Power Plant in a recent issue of Power House calls for a few comments from engineers interested in efficiency and furnace design.

I am afraid the "special correspondent" proved the efficiency of Mr. Blackburn, the chief engineer, but neglected completely to verify the wonderful boiler efficiency corresponding to the claimed evaporation of 9.99 pounds water per pound of Drumheller coal. I have no hesitation in saying this claim is ridiculous. If the clamed evaporation were correct, it would mean that the boilers were giving an efficiency of about 99½ per cent. Readers can verify this for themselves from the heat value of the coal in question. The best grade of Drumheller coal as tested by the Research Dept. of the University of Alberta, gives 10,185 B. T. U. per pound;

and the average of nine mines in that district as 9960 B. T. U. Hence, a boiler that utilized all the heat units could not possibly evaporate more than about 10.5 pounds water per pound best grade coal. It is to be noted that the special correspondent states that the water is "frankly bad," and yet in his evaporation calculation he makes no allowance for loss due to blowing down.

It is quite likely that the boilers in question are giving average efficiency which is nearer 6 pounds water per pound coal than 9.99 pounds as claimed. If they are evaporating more than this, then the special correspondent would be doing western engineers a favor by giving them some details of the furnaces and the operation of same.

Of course, in a small plant like the one described, with only two boilers and two first-class engineers in charge, not to mention the assistant engineers, one would naturally expect rather better than average efficiency.

J. A. CARRUTHERS, M. M., Lethbridge, Alta.

IGNITION OF COAL

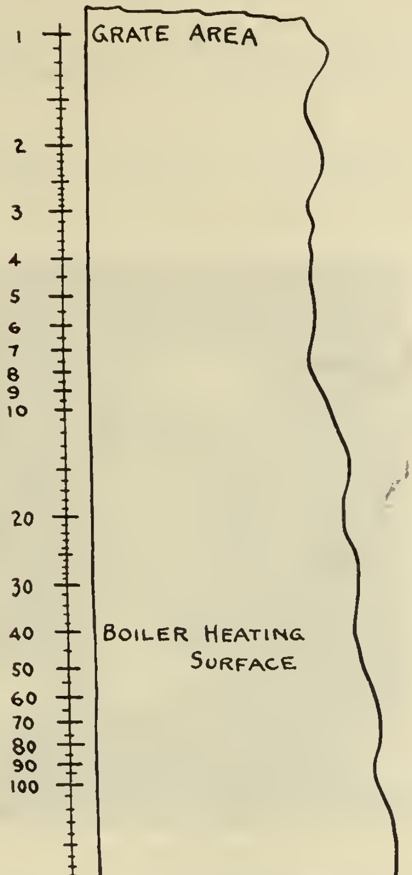
There is no definite temperature at which coal bursts into flame. The phenomenon of flame from coal is due to the combustion of volatile matter driven off from the coal, the character of such matter varying under different conditions; hence, the temperature at which the coal flames varies widely and is dependent upon surrounding conditions, and therefore the flaming temperature of a coal does not serve as an indication of the ignition point. Strictly speaking, it is the true ignition point, but since it varies so widely its valuation is meaningless. Moreover, any definition of ignition temperature based on the spontaneous emission of heat from coal is equally unsatisfactory, because experiments have proved that coal is giving off heat of combustion or some phenomenon akin to combustion at all temperatures. To be sure, the combustion at low temperatures is slow, but it is nevertheless evident. As the coal is raised in temperature by an outside source of heat it produces more and more heat from its own combustion, but there is no point in this process where the change in rate of heating is sufficiently abrupt to be regarded as indicating a definite ignition temperature.

Proportioning Charts

Here is a proportioning chart that will be found practical in more ways than one.

For example, a well known ratio in hot water boilers is 1 to 40 to 200, the areas being respectively the grate area, the boiler heating surface and the radiating surface.

For any boiler, then, all you have to do is lay a slip of paper alongside the scale as I have indicated and make marks opposite the 1, the 40, and the 200. For any radiating surface, now, all you have to do is—move the slip of paper downward to whatever radiating surface is wanted and the two upper marks will immediately tell the grate area and the boiler heating surface without the need of figures or even mental calculations. Just try it and see how easy it is.



Proportioning Heating Chart

For instance, 1000 ft. radiating surface, bring the lower mark down opposite that figure and the upper lines will tell that the grate area must be at least 5 sq. ft. and the boiler heating surface must be 200 sq. ft.

No matter what proportions you want to work out, and no matter how many different figures there may be, they can be all proportioned at once in the same way.

A little experimenting will quickly show you in how many different ways a scale of this kind may be used. It can be used for recipes, multiplying, dividing and proportioning.

W. H. SCHAPHORST, M. E.

Personals

W. C. Hall is in charge of the new office the Canadian Comstock Co. has opened at Room 28, 18 Toronto St., Toronto.

Ben F. Lamson, for the past four years assistant city engineer, has been appointed city engineer of St. Catharines, Ont., at a salary of $3,000 a year.

John T. Farmer, chief engineer of the Combustion Engineering Corporation, with offices at 314 Corictine Bldg., Montreal, was at the head office of his company in Toronto, Thursday, March 29th. He reported a very optimistic business trend in the Montreal district. Mr. Farmer was recently elected chairman of the Montreal section of the Canadian Association of Mechanical Engineers.

A. J. T. Taylor, president and general manager of the Combustion Engineering Corporation, is now in Vancouver, B. C., arranging for the removal of his family and household to Toronto. He is expected to return to the city about April 10th. Mr. Taylor formerly was president and general manager of the Taylor Engineering Co. of Vancouver. The latter company is now acting as Western representative of the Combustion Engineering Co.

T. M. Jones, formerly sales engineer of Clayton, Neil, Jones, engineers and manufacturers of rotary pumps, with works at Sault Ste. Marie, left April 6th for Manchester, England, where he will be associated with the firm of Mather & Platt. The Toronto office of the Sault Ste. Marie firm is to be closed so that all business can be transacted by Mr. Neil from the office at the works.

W. L. McFaul, former deputy city engineer, has been appointed city engineer and manager of the waterworks department of Hamilton, Ont., for a period of six months. Mr. McFaul will assume his new duties April 14. He graduated from Toronto University with the degree of Bachelor of Applied Science in 1913. From then until May, 1914, he was employed as an assistant in the city engineer's department of Arthur, Ont., on waterworks, street railway and roadway construction. From

May, 1914, until September, 1916, he was Assistant City Engineer, Sault Ste. Marie, Ont., having charge of all work on roadways, sewers, sidewalks and bridges.

In September, 1916, he was appointed City Engineer of Sault Ste. Marie, and held the position until June, 1921, except for the period from November, 1917, until February, 1919, during which time he was in the Canadian army and overseas.

F. H. Breor, formerly associated with the Arthur S. Leitch Co., has joined the sales force of the Combustion Engineering Corporation.

A. W. Roberts, manager of the Allen General Supply Co., 105 Yonge St., Toronto, who has been ill for two weeks suffering from sciatica, has returned to his office.

The annual meeting of the Corporation of Professional Engineers of Quebec was held at the headquarters of the Engineering Institute of Canada in Montreal. A large number of members attended from all parts of the province and officers were elected for the ensuing year. The meeting was presided over by A. R. Decary, M.E.I.C., superintendent engineer for the province of Quebec and newly-elected president of the corporation.

The report for the year showed that the membership has now reached 921, an increase of 416 since 1921. The following were elected to replace the retiring councillors: For the district of Montreal, C. N. Montserrat, Olivier Lefebvre and J. M. Robertson; for the district of Quebec, J. E. Gibault.

The election of officers then took place with the following result: President, A. R. Decary, M.E.I.C.; vice-president, K. B. Thornton, E.E., M.E.I.C.; honorary secretary-treasurer, Frederick B. Brown, M.Sc., M.E.I.C. The other members of council are—J. M. Robertson, M.E., M.E. I.C.; Lt.-Col. C. N. Montserrat, M.E.I.C.; Olivier Lefebvre, B.Sc., M.E.I.C.; A. B. Normandin, B.Sc., A.M.E.I.C.; J. E. Gibault, B.Sc., A.E.I.C.; registrar, Adhemar Mailhiot, B.Sc., Mem. C.I.M.M.

Building Hints

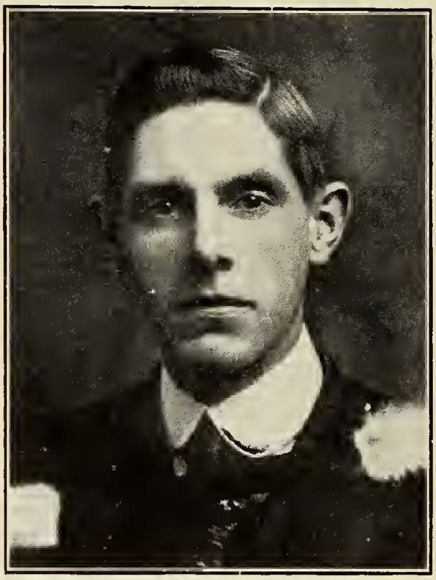
Barnes Manufacturing Co., Detroit, manufacturers of scales, will open a factory in Windsor, Ont. A suitable building has been leased at 325 Assumption Street, Windsor.

Board of Education, Peterboro, Ont., have approved the erection of a combined Collegiate and Vocational School to cost approximately $500,000. The grant from the government towards this project is $140,000.

Coast Range Steel Co. are now occupying permanent offices on the 14th floor of the Standard Bank Building Vancouver. The company is a British concern, and preparations are now being made to install blast furnaces in the plant at Vancouver. H. J. Landahl, one of the officials of the company, has just returned from England where plans are being approved. John Steta is the secretary at the Vancouver office.

One thousand men are now employed on the new power project on the St. Maurice River in Quebec Province. The undertaking is being engineered by the St. Maurice Power Co., and when completed will mean an additional 120,000 h.p. for the Shawinigan Power Co.

There is a project on foot at St. Catharines to build an artificial ice arena to cost approximately $135,000. A site for the building has already been secured. It is expected that the arena will be ready for the hockey season this year.



W. G. WOONTON, B.A.Sc.

W. G. Woonton, chief engineer of the McCormick Manufacturing Co., London, was formerly lecturer in the Department of Electrical Engineering, University of Toronto. He also for a time was chief engineer of the London Street Railway, assistant mechanical engineer of The British Acetones, Toronto, and lecturer for the Khaki University of Canada in various camps in England, Ireland and Scotland.

Hospital for Incurables, Montreal, which was recently destroyed by fire, will be rebuilt at a cost of $1,000,000. It is proposed to combine with it a hospital for tubercular patients. Tentative plans have received the sanction of Archbishop Gauthier.

The members of the Gas Committee of the St. Thomas, Ont., city council in session April 3 recommended that a new purifying set, estimated to cost $20,000, be installed as soon as possible at the Municipal Gas Works, and that application be made to the Ontario Municipal and Railway Board for permission to issue debentures to cover the cost. Superintendent Robert Christie reported that a second bad break had appeared in one of the steel tanks at present in use, and both life and property were endangered by the condition.

Authority for the construction of an electric or steam railway from Emerson, on the international boundary, to Fort Churchill, on the Hudson Bay, is asked for by the Manitoba Waterpower Electrical Company in a bill introduced in the Manitoba Legislature April 3. The railway would run through Winnipeg to the north via the eastern shore of Lake Winnipeg, the provisions of the bill show. The company is in no way associated with the Manitoba Power Company.

The greatest announcement in many years in connection with industry in the district of Timiskaming is the report from Quebec City, which declares a lease is to be granted on April 25 to interests who will develop Des Quinze Rapids, at the north end of Lake Timiskaming. Telegrams sent to the Quebec capital have not yet brought definite advices as to who the interests are who are securing the right to develop not far under 100,000 hydro-electric horsepower.

The two known facts are that the lease is to receive sanction of the Quebec government on April 25, and that the condition applying to Ontario is that the Quebec government will impose an export tax of 50 cents per horsepower.

New Catalogs

Feed Water Heaters in Their Relation to Steam Plant Efficiency.—H. S. B. W. Cochrane Corp., Philadelphia, Pa., Canadian Representative, Canadian Allis Chalmers Co., 212 King St. W., Toronto, Ont. Publication No. 1112 describes the influence of feed water heating upon steam plant efficiency and touches briefly on the various types of Cochrane apparatus for measuring, heating and treating boiler feed water.

In the Power Plant.—Hicarb is a refractory having heat resisting properties withstanding temperatures far beyond those found in the extremes of actual service. It is also proof against the action of acids, rust and corrosion.

When painted over the surface of fire brick linings it retards fusing and burning out thus prolonging their life. It is also used on terra cotta, concrete and metal surfaces for the same purpose.

Cracking, chipping or breaking off of pieces of fire brick is also prevented by its use. Clinkers do not form readily, and the few that do are easily brushed off with the slicer bar with no possible danger of taking part of the lining.

Its makers, Adams & Jewell, Rome, N. Y., claim that Hicarb increases the life of all furnace linings 50 per cent. to 100 per cent.

ARE YOU THINKING

of Buying Steam Plant Equipment?

DO YOU WANT INFORMATION

on Any of the Following :—

- WATER TUBE BOILERS
- SUPERHEATERS
- MECHANICAL STOKERS
- OIL BURNING EQUIPMENT
- ELECTRIC CRANES
- COAL & ASH CONVEYORS
- WATER SOFTENERS
- PURIFIERS
- FILTERS
- TUBE CLEANERS
- TUBE CUTTERS
- TOOLS, ETC.

Write Mentioning "Power House"

BABCOCK & WILCOX, LIMITED

Toronto Office:
Bank of Hamilton Building

ST. HENRY—MONTREAL

A manufacturing plant in which low pressure steam for process purposes is supplied from a turbine of special design is described in a profusely illustrated leaflet issued by the De Laval Steam Turbine Co., of Trenton, N. J.

This turbine operates automatically either as a straight condensing turbine, as a back pressure turbine, as a bleeder turbine, or as a mixed flow turbine or as a low pressure turbine, in such a manner as to maintain a balance between power requirements, low pressure steam requirements, hot water requirements, and the amount of power available from water power.

This is accomplished by a third pressure in addition to the high pressure and low pressure valves ordinarily controlled by the steam governor in a mixed flow turbine. The utilization of exhaust steam for heating and process purposes, or the production of power as a by-product from steam used at low pressure, offers surprising economics, and this leaflet will, therefore, repay careful study in these times of high fuel costs.

Announcements

An order of record size has just been received by the Canadian Allis-Chalmers Ltd., Toronto, for the supply of hydraulic equipment to the Quebec Development Corporation. This corporation has already commenced construction work on its power plant on the Saguenay River, close to Lake St. John, which calls for an ultimate installation of twelve turbines of 37,500 h.p. capacity each.

The order received by the Canadian Allis-Chalmers is for the first eight of these units. The turbines will be of the vertical type, 112½ r.p.m., 37,500 h.p. at 9/10 gate opening.

Construction has been started by Dwight P. Robinson & Co., Inc., on an extension to the "South Power Station" of the Aliquippa Works of the Jones & Laughlin Steel Corporation, near Woodlawn, Pa.

The improvement includes preparation of site, foundations and condenser well, and the erection of an extension to the building to house a 10,000 k. w. steam generator unit with condenser and all other appurtenances. The installation of a new turbine driven pump in the pump house, with connections to steam and water mains, is also included.

Dwight P. Robinson & Company have also under way in the Pittsburgh District an extensive addition to the Colfax Station of the Duquesne Light Company.

The Charter Gas Engine Company of Sterling, Ill., announces the purchase of the entire "Meitz" Oil Engine (also known as "Meitz and Weiss") business, heretofore carried on at 128-138 Mott Street, and 430 East 19th Street, New York City, by the August Meitz Corporation and the Reliance Oil Engine Corporation.

The first "Meitz" Oil Engine was built in 1895 by Meitz and Weiss.

The Charter Gas Engine Company are now moving from New York City to their plant at Sterling, Ill., all of the physical assets comprising the "Meitz" Engine and in the meantime are filling repair orders from New York City, so that there will be no interruption in repair service to "Meitz" engine users.

A number of the personnel of the August Meitz Corporation organization have been engaged for work by the Charter Gas Company, insuring a thorough working knowledge of the manufacture of "Meitz" engines.

Book Reviews

Longmans-Green & Co., "Elementary Internal Combustion Engines," 207 pages, price $1.75.

Gas, oil, petrol and other combustion motors are outlined along elementary lines in this work. Features of the two-stroke and four-stroke cycle types are compared and collated. The general design and points of construction of governors are touched upon, while the subject of ignition is explained and illustrated in some detail. Indicating of gas engines is developed graphically including an interpretation of the diagrams frequently obtained.

In connection with gas engines is a chapter of gas producers, describing the performance of several well-known types. The theory of the operation of the gas producer is illustrated in detail by numerical examples.

The chapter on oil engines, which is a new feature in this edition, gives much in the way of illuminating information on Diesel and semi-Diesel engines.

"Elementary Internal Combustion Engines" is a clear exposition of the subject, logically arranged.

Longmans, Green & Co., "Efficient Boiler Management," Charles F. Wade, 266 pages, illustrated, price $4.50.

Much has been written concerning the very general waste of coal and also concerning what may be termed the "scientific side of the chemistry of combustion," featuring fuel analysis and refined scientific operation of boiler furnaces, but little about the practical application of the scientific principles of steam generation to the operation of everyday, customary and typical steam plants. This lack, the author endeavors to rectify in the presentation of his subject.

He first concisely but constructively discusses coal, its formation, value and utilization for steam generation, outlining the chemistry of combustion and describing the methods which should be followed in firing boilers. An instructive chapter is devoted to a discussion of types of furnaces, and then the author takes up various questions affecting economical boiler operation—the air supply, composition and regulation of furnace and flue gases, feed-water heating, quality and characteristics of steam—before discussing types and performances of steam boilers. The discussion of the steam generator is brief but well illustrated by examples of well selected apparatus.

The efficient maintenance of boiler plants—cleaning of flues, care of mountings, the proper housing of the plant, etc.—is well brought out and a constructive discussion of brick work settings for boilers, featuring defects and their costly results, is noteworthy. Another section of importance is the chapter devoted to the losses due to radiation of heat and means of mitigating such waste. Steam mains are also given considerable thought and a short but helpful chapter describes the approved examination of a boiler plant for defects and losses.

V. Van Nostrand Co., Mechanical Laboratory Methods, by Julian C. Smallwood, M. E., 423 pages, illustrated, price $3.50.

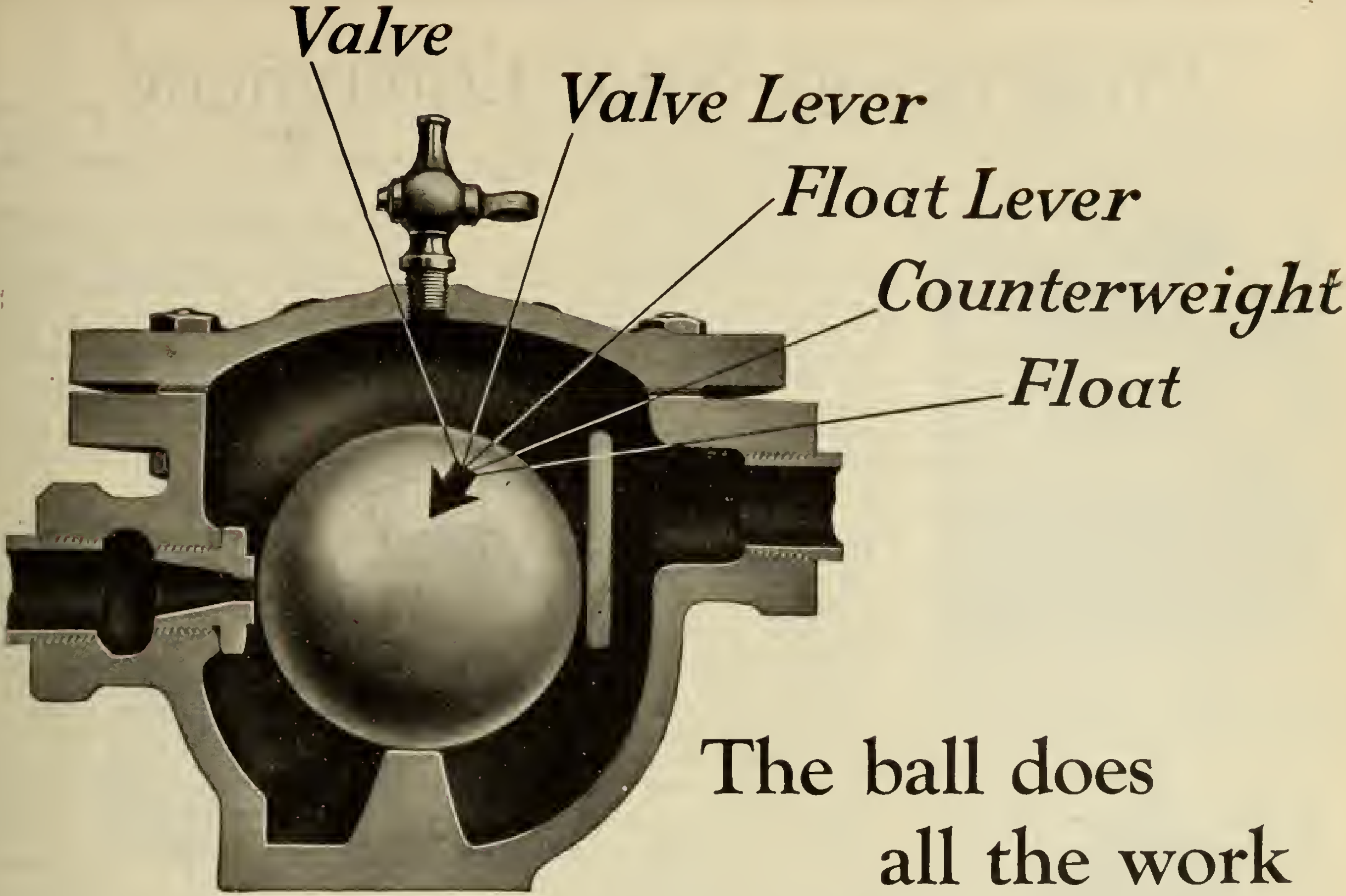
The first of the three sections of this book is devoted to instruments, their errors, methods of calibration and their use. Under this heading various apparatus such as gauges, brakes, indicators, planimeters, meters, thermometers, calorimeters and belt and oil testers are discussed. Looking over these pages in a general way, one is critical of the statement that the slip of a belt may be accurately found by counting the speeds of the driving and driven pulleys, and one wonders what coefficient of contraction means when applied to a weir.

The next part of the book, containing about forty pages, deals with fuels and their composition and the methods of calculating their heating values. It also contains data for estimating and measuring the products of combustion.

The last 160 pages deal with the testing of power plant units including steam engines, steam pumps, boilers and auxiliaries, gas engines, refrigerating machines, air machinery, water motors, electric motors, and miscellaneous machines. As the space occupied suggests, this subject has been treated quite fully and in accordance with the latest rules, so that the discussion will be found helpful.

Genius isn't nearly so valuable in a power plant as common sense.

It isn't a bit queer that efficient plants are invariably clean plants.



IT would be impossible to make an efficient steam trap with fewer parts than those used in the Johns-Manville Trap. There are only three parts—the rolling ball, the discharge bushing and the body—the ball is the *only* moving part.

The ball does all the work

THIS is a cross section of the Johns-Manville Steam Trap. All the usual complexity of steam trap mechanism is simplified into just one moving part—a hollow copper ball.

It is so simple that it cannot get out of order, which gives it a reliability that is making thousands of satisfied users come back for more. It is a trap that you can install and forget—for it needs only the occasional inspection that any good piece of machinery deserves.

The Johns-Manville Steam Trap starts cold, discharges both water *and air*, and absolutely prevents steam leakage.

The trap is light and small, yet with no sacrifice of capacity. There are no adjustments. Its cost is low.

Investigate the Johns-Manville Steam Trap in the engineering way—test one.

CANADIAN JOHNS-MANVILLE CO. LIMITED

Toronto Montreal Winnipeg Vancouver Ottawa

Johns Manville Service
Covers this Continent
Through—
Asbestos
and its allied products
INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

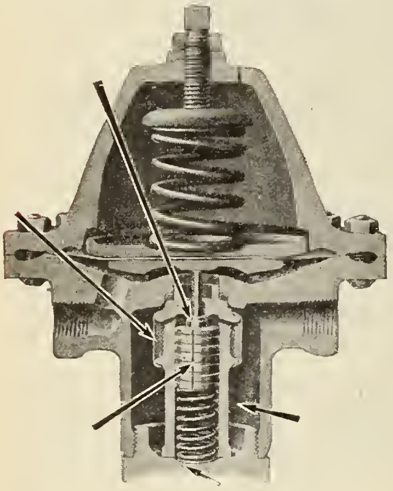
JOHNS-MANVILLE
Power Plant Materials

Progress in New Equipment

Cash Reducing Valves

A pressure reducing and regulating valve equipped with a self-contained strainer placed close to the valve seat is believed by the manufacturers, A. W. Cash Co., 214 McLelland Bldg., Toronto, to insure more accurate operation, increase the life of the wearing parts and obviate the necessity and expense of installing a separate strainer on the inlet line.

Steam at initial pressure entering the regulator on the inlet side passes through the strainer, which precipitates all but the finer particles of foreign substance to the sediment chamber below. It then flows through a series of inlet ports, passes on through the seat opening, through the diaphragm chamber, and through the outlet side into the delivery or working pressure line.



Assume that the initial pressure is 100 lbs. and that the valve is set to deliver 40 lbs. As soon as the delivery pressure exceeds 40 lbs., its action on the under side of the diaphragm will raise the diaphragm spring and permit the valve proper to close, or to restrict itself to the point where proper reduction is effected. When the delivery pressure falls, the action of the diaphragm spring will force the valve open to the proper point to restore the required reduction.

W-S-M Gas Producers

The mechanical gas producer as distinguished from the hand-poked, hand fed stationary type has come to be recognized in the gas-making industry as one of the most efficient types of apparatus for making producer gas from coal. The W-S-M Gas Producer Type L No. 8 designed by the Wellman-Seaver-Morgan Co., of Cleveland, Ohio, will be manufactured at an early date in Canada by the John Inglis Co., 14 Strachan Ave., Toronto.

The generally accepted rating of a gas producer is the pounds of coal it can gasify per hour. The W.S.M. producer has an efficient gasifying capacity from 1500 to 2750 lbs. of bituminous gas coal per hour. The most desirable fuel is a bituminous coal of the following composition:

Volatile matter	30% to 40%
Fixed Carbon	50% to 60%
Ash under	15%
Ash fusing at	2200° F. or over.

Using coal of this quality, the producer has an over-load capacity of over 3600 pounds.

The producer is fitted with a mechanical coal feed. It consists in the main of two principal elements. The upper or measuring wheel is rotated at a variable speed whereby the rate of coal delivery is regulated to the demand for gas, and at the same time the coal is measured.

The direction of rotation is against the descending coal, which tends to lift it and prevents choking in the spout from the bin. The lower revolving drum delivers the coal to the producer. The feed is operated by a rock shaft having an intermittent motion. Adjustment is obtained by a handwheel attached to a screw nut by which the length of the driving lever is altered.

A safety device is provided to prevent breakage in case of an obstruction becoming wedged in the distributor. The feed is provided with a hand operated coal gate located in the upper part of the feed case, and serves to shut off the supply when desired.

In each base, two cleaning holes are placed for cleaning deposits of tar and soot which may tend to choke the coal delivery.

How McClary's Get Power

ONE of the cleanest and most compact in the country. This is the reputation that has been earned by the power plant of the McClary Mfg. Co., London.

This achievement is attained in a large way by the fact that the power for McClary's is obtained from hydro, while a second means is the fact that they have a man like George E. Moll, the industrious chief mechanic, who has been in charge of the power plant for no less than 20 years. Previous to joining the forces of McClary's as chief engineer, Mr. Moll was a locomotive engineer—starting as a cleaner and moving up to fireman and engineer. The chief engineer holds the opinion that cleanliness is one of the essentials of a good power house and his plant is one of the best.

Should the Hydro service be interrupted, the plant is equipped with a 300 h.p. vertical compound high speed Leonard engine. This engine is connected direct to a Westinghouse generator of 550 volts capacity. The steam is generated by four Leonard boilers of 125 h.p. each, consuming 11 tons of coal every 24 hrs. These boilers work continuously at 115 pounds pressure.

Two duplex air compressors, one high and the other low pressure, give the necessary pressure for spraying enamel, air lifts and atomizing oil for the oil burners. Six enamel ovens are heated to 1,000 degrees by the use of fuel oil. The plant is equipped throughout with water sprinklers for fire prevention. Equipment includes pumps capable of pumping 1,000 gallons of water per minute, and the plant reservoir has a capacity of 197,000 gallons of water. The pumps are so arranged that they can pump from the large Webster heater, capacity 500 h.p., or water can be pumped from the reservoir to the boilers.

Mr. Moll has a staff of four engineers and three firemen and claims that engineers should be graded according to their plant and the salary should also be stipulated in ratio to the capacity of the power house. This chief engineer states that he would far rather have a practical engineer than a man with an overload of technical knowledge only.

DISCHARGING OIL TANKERS

For the purpose of discharging oil from tank vessels it is necessary to arrange some flexible connection between the tanker and the barge which is being filled. As a rule rubber or metallic hose is employed for this purpose, but both types are liable to burst as a result of chafing in use. This drawback had led to the development of mechanical steel pipes with flexible joints, and in this type of appliance a British firm has introduced a notable development. It is based upon what is called a "divided pipe joint," which was designed and made by this firm some years ago in connection with fire floats.

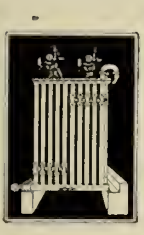
AIR COMPRESSOR BULLETIN

The Canadian Ingersoll-Rand Co., have issued a bulletin K-311, on the class ED-1 air compressors. This line of compressors is manufactured entirely at the Sherbrooke, Que., plant, and are of the power-driven, single-stage, straight-line type. The bulletin gives complete details of the construction of the compressors, and is well illustrated.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W



Sturtevant Fuel Economizers recover the heat usually lost up the stack and keep it in circulation. The results are greater efficiency and reduced operation costs.

Ask for Folder 609.

B. F. Sturtevant Co.
of Canada, Ltd.
Montreal Galt Toronto

VICTORIA FOUNDRY COMPANY LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations
Write for our latest catalogue
Patterns **Machine Work**

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order. Apply Box, 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

SAWMILL MACHINERY—MODERN DESIGN—most satisfactory to operate. Apply Box 105, Power House.

SAWMILLS—PORTABLE — DOUBLE EDGES; also all kinds sawmill machinery. Apply Box 106, Power House.

FOR SALE

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. **Inside** dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

WELDING

ELECTRIC AND ACETYLENE WELDING—of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

BELTING BARGAIN

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

BELTING OF ALL KINDS—NEW OR USED pulleys, saws, cable, hose, etc., shipped subject to approval at lowest prices in Canada. York Belting Co., 115 York St., Toronto.

REPAIRS

A. D. FISHER MANUFACTURING CO., 77 Front St. East, are prepared to build special machinery, dies, tools and all kinds of repairs; prompt service.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES
4750 PAGES @ $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and **Operation** of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers.—Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now—today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you , 1 monthly until $12 is paid.

Signature ____________
Occupation ____________
Employed by ____________
Residence ____________
Reference ____________

SEE BUYERS' GUIDE PAGES 42-44-46-48-50

REFRIGERATION

(Continued from page 22)

compression refrigerating system the total heat taken up is equal to the heat absorbed in the refrigerator plus the heat equivalent of the mechanical work done upon the medium in the compressor. The former has been shown to be 474.3 B.t.u. and the latter 99.3 B.t.u.; therefore the heat rejected to the cooling water = 573.6 per lb. of ammonia circulated.

Ton of Rèfrigeration

When the steam engine was first invented it was used as a locomotive, and as horses had until then been used for traction purposes, steam engines were naturally rated in horse-power capacities, the mechanical horse-power being soon established as equal to work done at the rate of 33,000 ft. lb. per minute. Prior to the advent of the refrigerating machine natural ice had been used for cooling and it followed as a matter of convenience to rate refrigerating machines in tons of ice melting capacity. Taking the latent heat of fusion of ice at 144 B.t.u., the quantity of heat absorbed by the melting of one ton at 32 deg. F. is

$$2{,}240 \times 144 = 322{,}560 \text{ B.t.u.}$$

A refrigerating machine capable of performing this amount of effective work per day of twenty-four hours continuous operation is rated as a one ton machine, and a commercial ton of refrigeration is therefore at the rate of 322,560 B.t.u. per day, or 13,440 B.t.u. per hour, or 224 B.t.u. per minute. A plant capable of performing useful work at the rate of 322,560 B.t.u. per hour, would, of course, be rated at a 24 ton machine.

Horse Power Per Ton

It has been shown that the amount of useful work performed in the refrigerator per lb. of ammonia circulated is, under the conditions set forth, 474.3. B.t.u., therefore the quantity of ammonia to be calculated in order to produce a refrigerating effect of one commercial ton is

$$322{,}560 \div 47.3 = 680 \text{ lb. per day.}$$
$$= 28.3 \text{ lb. per hour.}$$
$$= 0.472 \text{ lb. per minute.}$$

It has also been shown that the heat equivalent of the external work performed on each lb. of ammonia handled by the compressor is 99.3 B.t.u., therefore the heat equivalent of the external work per commercial ton of refrigeration is

$$99.3 \times .472 = 46.87 \text{ B.t.u.}$$

If the volumetric efficiency of the compressor (V.E. being the ratio of the actual weight of ammonia pumped per unit of time to the amount calculated from the piston displacement) were 100 per cent. it can readily be shown from the foregoing that the compressor horsepower per ton of refrigeration would be 1.10.

Since, however, the volumetric efficiency of vertical single-acting machines operating under the standard gauge pressures of 19.6 lb. and 155 lb. is approximately 84 per cent., the compressor indicated horse-power becomes,

$$\text{c.h.p.} = \frac{46.87 \times 777.5}{33000 \times .84} = 1.315$$

The quantity 777.5 is the mechanical equivalent in ft. lb. of one B.t.u. and the resultant horse-power is based on the assumption that compression is adiabatic. In practice, however, the compression curve falls away from the adiabatic with the result that the mean effective pressure is decreased, so that the actual c.h.p. becomes approximately 1.26 per ton of refrigeration.

As knowledge is sought in the power house, laboratory, office and factory, the twin brother of the teacher—the editor—must perform his valued function. Sharing of knowledge is characteristic of human progress which could not long thrive without the mediums of exchange of thought and experience afforded by the activity of the editor.

The volumetric efficiency of horizontal double-acting machines is about 7 per cent. less than for single acting machines but the c.h.p. per ton of refrigeration is not materially increased thereby because the piston rod of the former type of machine accounts for about 5 per cent. of the difference in efficiency while the remaining 2 per cent is accounted for by the extra clearance required—factors which have no bearing on this question. The c.h.p. per ton of refrigeration depends, of course, upon the operating conditions.

GASKET HINTS

(Continued from page 31)

wrench of the correct length is used and then tighten only enough so that the leakage is prevented. Do not tighten too tight. Any further tightening after leakage is stopped simply reduces the elasticity of the gasket and does not give it an opportunity to "breathe" as it should simultaneously with the expansion or contraction of the pipe lines.

I, therefore, regard the matter of tightening as most important of all and want to impress it upon all users of flexible metallic gaskets. By being as careful in tightening the gasket as one is when tightening an ordinary steam engine stuffing box, or when taking up the wear in a bearing, the best results will be obtained. Take it easy. Don't strain muscles, wrenches, bolts, gaskets, or anything. If directions are always carefully followed much labor and fatigue will be avoided.

Copyright, 1923, by Hexitallic Gasket Co., Camden, N. J.

Don't talk efficiency to the big Boss; talk dollars worth of coal saved per year.

Improving Power Plant Efficiency

THERE are three way of improving power-plant efficiency—maintaining the efficiency of the operating cycle, selecting the proper equipment, and improving the equipment by changes in design. Although in coal-burning plants over-all thermal efficiencies of about twenty per cent. have been obtained under favorable conditions, even in the largest plants the average for a year is far below this figure. Fifteen per cent. is about the best that the average large station is doing, with many plants, having ratings for twenty thousand to thirty thousand kilowatts capacity, operating at ten per cent. or less. Instead of producing a kilowatt-hour on seventeen or eighteen thousand British thermal units, the average figure will be from twenty-three thousand to over thirty thousand.

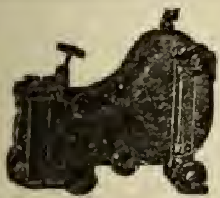
There are many conditions in plant operation that tend to reduce the average over-all efficiency; some of them are controllable and others are not so readily handled. Load factor undoubtedly has an effect, but cases are on record where, in plants of considerable difference in size, the smaller plant operating at about forty per cent. and a larger one at sixty per cent. load factor, the smaller plant showed thirty per cent. less coal consumption per unit output than the larger station. Even though these conditions may exist, taking two plants that alike as to equipment, if both are operated with equal proficiency, the station with the highest load factor will develop the highest over-all average efficiency.

For years it has been possible to obtain an over-all boiler-and-furnace efficiency of over eighty per cent. with large stoker-fired boilers without the use of economizers, yet the average in many of the large plants is down around sixty-five per cent. or less. There are a few exceptions to these figures where efficiencies up to about seventy-seven per cent. have been obtained without the use of economizers. The maintenance of equipment has a marked effect on over-all efficiency and is very largely under the control of the operating force.

The wide difference in average operating efficiencies of two plants under similar conditions can be attributed to operating methods and the selection of the kind and size of equipment to serve the load. When selecting equipment, it is not always possible to obtain the arrangement that will give the highest over-all efficiency, or engineers have not felt justified in doing so.

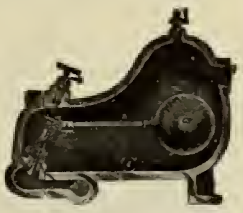
While power-plant engineers are waiting for the higher economy to be obtained from new designs, the present differences between the average over-all plant efficiency and that which can be obtained with present design of apparatus offer a fruitful field for careful study and improvement.

HINTS TO BUYERS



McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.



Send for Catalogue
THE GARTH COMPANY
Craig Street-MONTREAL, CAN.
WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK
Nature's Water Softener
Copyright 1920—The Refinite Co.
For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

THE VENTURI METER

Measures hot and cold water, sewage, brine, chemical solutions, oil, gas. air and steam. Bulletin on request.

BUILDERS IRON FOUNDRY, PROVIDENCE, R.I.

Canadian Representatives: General Supply Co. of Canada, Ltd., Ottawa, Montreal, Winnipeg, Vancouver; Allen General Supplies, Ltd., Toronto, Ont.

REGISTERED J TRADE MARK

Jardine's Self-feeding Tube Expanders

All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co., Ltd.
Hespeler, Ont.

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T. J. CUNERTY** *Company*
Room 240 17, Queen St, East Toronto

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

AMMONIA PLANT EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.
Under-feed Stoker Co. of Canada, Ltd. Toronto.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Beldam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamiesou Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co.,: Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd., Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited. Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Bolco Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. McLaren Limited, Montreal, Que.

BELT HOOKS
Bristol Co., The, Waterbury, Conn.
D. K. McLaren, Limited, Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, FABRIC
D. K. McLaren Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. McLaren, Limited, Montreal, Que.

BELTING, SOLID WOVEN
D. K. McLaren, Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

CORD CLOTHING
D. K. McLaren Limited, Montreal Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd., Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can, Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Bolco Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Suply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can, Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford,

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co. Ltd., The.

BRASS GOODS
Crane'e Limited, Montreal.
Jas.. Morrison Brass Mfg. Co.. Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren, Limited, Montreal, Que

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville. Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd. Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Bolco Supply, Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

"SAFETY" PLASTIC METALLIC PACKING

Packing in bulk.

This packing is made of an alloy of the FINEST ANTI-FRICTION METALS which, combined with the BEST LUBRICATING MATERIALS which always remain in the packing, make it practically Self-Lubricating and Frictionless. It is

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL

In fact there are many Engines, Pumps, Compressors, Expansion Joints, Valves, etc., on which this packing has been in use for over 12 years with the very best satisfaction.

Let us send you further particulars also about our "Safety" Superheat Sheet Packing.

STEEL MILL PACKING CO. - WINDSOR, ONT.

AGENTS WANTED

Packing in Cotton Tubes.

Established 1899

2

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT

REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING

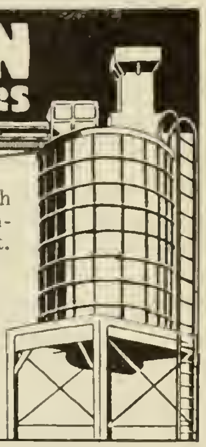
Oil Burning Systems Installed

Full line of Power Plant Equipment and Supplies.

LAURIE ENGINE CO.

(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL.

AMERICAN STEAM ASH CONVEYORS



Give lowest costs per ton of ash handled. Satisfactory performance guaranteed. Ask for booklet.

CANADIAN REPRESENTATIVES:
CLEATON CO., (Canada) Ltd., Montreal.
GORMANS, LTD., Calgary, Edmonton, Vancouver.
WM. A. GOOLD, Winnipeg.

Conveyors Corporation of America
326 W. Madison Street, Chicago, Ill.

NORTHERN CRANE WORKS, LTD.
Walkerville, Ont.

EDWARD VALVES

Sufficient reserve strength and absolute dependability have made them a dominant figure in the valve world.

Send for catalogue.

The Edward Valve & Mfg. Co.

General Office and Works: East Chicago, Indiana.

CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal; Valve Engineering Co., Toronto.

INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE

OF POWER HOUSE

"Featherweight"

MAGNESIA
KEASBEY & MATTISON CO.
FEATHER WEIGHT
85%
AMBLER, PA.
SECTIONAL COVERINGS

Save Coal

by using

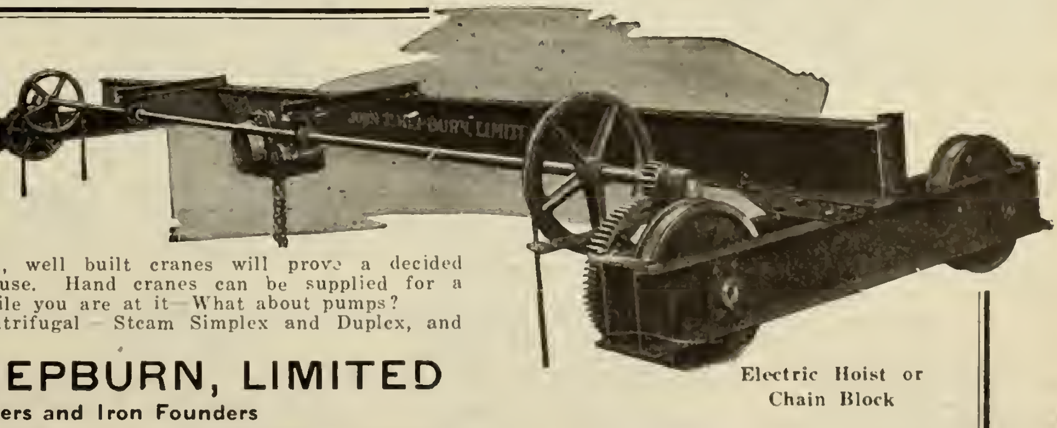
85% Magnesia Sectional Covering

The extra saving in coal (power) and dryness of your steam should decide you in favor of K. & M. "Featherweight" 85 per cent. Magnesia Pipe and Boiler Covering.

Would you like to know just why this widely used boiler covering is the most durable and most efficient fuel conserver of all pipe and boiler coverings? Then send for free booklet. It contains much valuable information for engineers.

Keasbey & Mattison Co., 25 Front St. E., Toronto.

HEPBURN CRANES



These easily manipulated, well built cranes will prove a decided saving in the Power House. Hand cranes can be supplied for a moderate outlay. And while you are at it—What about pumps?
We make all kinds—Centrifugal—Steam Simplex and Duplex, and Power Pumps.

Electric Hoist or Chain Block

JOHN T. HEPBURN, LIMITED
Engineers and Iron Founders
18-60 VAN HORNE STREET - TORONTO, CANADA

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CARBONIC ACID GAS
Laurie & Lamb, Montreal.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro,- Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS. DOUBLE PIPE
Frick Co., Waynesboro Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLINGS
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DOORS, CAST IRON, AIR TIGHT
Conveyors Corp. of America, Chicago, Ill.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injetor Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can, Link-Belt Co., Toronto, Ont.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR DRIVES
Sterling Engine Co., Buffalo, N. Y.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N. Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER HEATERS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., Erie, Pa.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.

FILTERS, WATER
Frick Co., Waynesboro, Franklin Co., Pa
Graver Corp., East Chicago, Ind.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane, Limited, Montreal.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N. Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOORING, SUBWAY
Irving Iron Works Co., Long Island City, N.Y.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FUEL ECONOMY DEVICES
The Boiler Repair and Grate Bar Co., Toronto, Ont.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Johns-Pratt Co., The, Hartford, Conn.

MADE IN CANADA

DEPENDABLE WRENCHES

Williams' line of "W. & B." Screw Wrenches are strong, sturdy, dependable tools.

Machinists' Knife Handle and "Railroad Special" Wrenches are recommended for the heaviest service; 7 sizes; 6 to 21 inches.

Agricultural Wrenches meet the demand for a good tool at a moderate price. 5 sizes; 6 to 15 inches.

J. H. WILLIAMS & CO., Limited
"The Wrench People"
78 Thorold Road St. Catharines, Ontario

SONDERGLASS

"The Unbreakable Boiler Gauge Glass"

Two Glass Tubes in One

The different metals used allow for expansion and changes of temperature to which the glass is subjected, and add greatly to its pressure-resisting qualities, as each of these metals has different degrees of expansion. The inside of the tube expands in proportion to the temperature of the steam or hot water and the outside according to the temperature of the air.

There are no others "Just as Good"

LYTLE ENGINEERING CO. LIMITED
404-406 St. James Street, Montreal
VALVE ENGINEERING COMPANY
174 King Street West, Toronto

"MONO" TRADE MARK REG. U.S. PAT. OFF. BOILER BAFFLES ARE MONOLITHIC

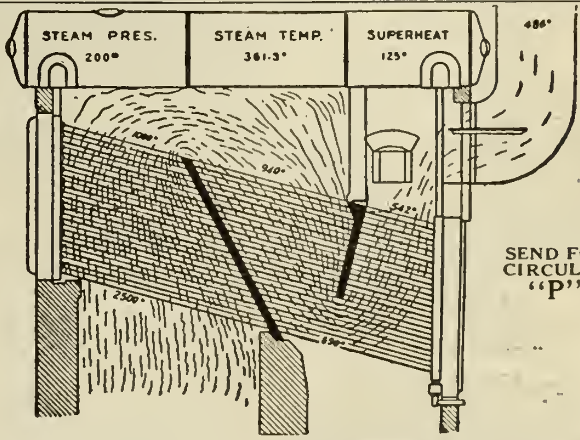
AND "HUG THE TUBES" AT ANY ANGLE

AND ARE NOT DAMAGED WHEN TUBES ARE WITHDRAWN, REPLACED OR BY THE USE OF A TURBINE CLEANER. OUR ENGINEERS ARE AT YOUR SERVICE TO HELP YOU SOLVE YOUR COMBUSTION PROBLEMS. THE CUT ON THE RIGHT IS AN EXAMPLE OF WHAT WE CAN DO FOR YOU.

KING REFRACTORIES CO.

Sole Canadian Representatives:

GRANT E. COLE CO.
21-23 River St., Toronto, Canada
Represented in Vancouver, Winnipeg, Montreal, Halifax.



SEND FOR CIRCULAR "P"

Bronze
to
Bronze

DART

At
the
Joints

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HAND-HOLE
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Peldam Asbestos (Canada) Co., **Toronto.**
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.

GASKETS, LEAD, COPPER AND SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio,
Penberthy Injector Co., Windsor, Ont.

HANGES, GAUGES, AMMONIA, OIL, GAS, AIR
Schaffer & Bundenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & **Valve Co., Division, Brooklyn, N. Y.**
John Moncreif, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Bristol Co., The, Waterbury, Conn.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto. Ont.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenhurg **Mfg. Co., and American** Steam Gauge & Valve Co., Div- Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg **Mfg. Co., and American** Steam Gauge & Valve Co., Division, **Brooklyn, N. Y.**

GAUGES, WATER
Babcock & Wilcox, Ltd., Montréal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., **Hamilton.**

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., **Montreal.**

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Geliuas & Pennock, **Reg'd, Montreal**
Canadian Steam Boiler & Equipment Co., Toronto.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E. London, Ont.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRATE BARS, FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.
The Boiler Repair and Grate Bar Co., Toronto, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicago, Ind.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Graver Corp., East Chicago, Ind.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal,
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INDICATING THERMOMETER, SARCO
Sarco Co., Inc., New York.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Bristol Company, The, Waterbury, Conn.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.
Celite Products Limited, Montreal, P.Q.

INSULATING POWDER

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LACE LEATHERS
Can. Johns-Manville Co., Ltd., Toronto.
D. K. MacLaren Ld., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can, Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LINK BELTING
Can. Link-Belt Co., Toronto. Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mo.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MARINE CASTINGS
Mueller Mfg., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

METERS, F.M.
Canadian General Electric Co., Toronto.
The Bailey Meter Co., Cleveland, Ohio.
Can. Johns-Manville Co., Toronto.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Engineering and Machine Works of Canada, Ltd., St, Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. **Anderson**, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.

OILING SYSTEMS
Lunkenheimer Co., Cincinnati, Ohio.

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos Canada Co., Toronto.
Beveridge Suppy Co., Montrea.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago. Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, H. P. ROD
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont.

PENSTOCKS
W. M. B. Scarfe & Sons, Pittsburgh, Pa

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
H. Mueller Mfg. Co., Limited, Sarnia, Ont
The Superheater Co., Limited, Montreal

PIPE COVERINGS, STEAM, BRINE AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal,
Page-Hersey Tubes, Ltd., Toronto. Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE STEEL
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINER
Can. Fairbanks-Morse Co., Ltd., Montrea
Engineering and Machine Works of Canada, Ltd., St, Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

Why FIBRICO JOINTLESS FURNACE LINING **is better than fire brick—**

This plastic, jointless furnace lining is better than fire brick because:

1. It is jointless.
2. It is plastic.
3. It is air and gas tight.
4. It will stand 3100° F.
5. It will save fuel.
6. It can be installed by inexperienced labor.
7. It will outlast fire brick.
8. It can be used in any boiler, furnace or oven.
9. It can be used where ever fire brick is used.
10. It cannot be excelled for patching broken and burned out linings.

JOINTLESS FIRE BRICK CO

1142 Clay Street, Chicago, Ill.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B.C.; Winnipeg, Supply and Fuel Co., Winnipeg; Gorman's, Ltd., Calgary, Alta.

De Laval Oil Purifier

The Commonwealth Edison Company, of Chicago, Ill., rely upon De Laval Oil Purifiers as the sole means of removing water and sludge from the lubricating systems of the 3000 kw. turbo-generators in their new Calumet Station. The De Laval Purifier at Calumet is shown at the side.

Additional De Lavals are used to purify lubricating oil in the other stations of this Company, and several De Laval Transformer Oil Purifiers are also operated.

The De Laval Company, Ltd.
Peterborough, Ont.
Winnipeg Vancouver
Montreal Edmonton

Annual Convention

Canadian Association of Stationary Engineers

of the Dominion of Canada, Inc.

In conjunction with

Annual Exhibition of Power Plant Equipment

June 25, 26, 27, 28

To be held in the

Central Technical School

Toronto, Ontario

Remember it! Boost it! Come to it!

For further particulars write GEORGE J. SOUCY, Chairman
48 Moore Avenue, Toronto

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co,, Toronto, Ont.

PUMPING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Pratt & Cady, Hartford, Conn.
Smart-Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Mon'real.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont.

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, GAS
Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co., (Inc., Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

OIL PUMPS FOR FUEL OIL BURNING SYSTEMS.
Albany Pump Co., Toronto, Ont.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMP TANK, RECEIVER
American Steam Pump Co., Batle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co,, Ltd., Toronto.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Bristol Co., The, Waterbury, Conn.
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Tayor Instrument Co., Toronto, Ont.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamieson Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Inde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SAFETY STEPS (Irving Life Step)
Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co,, Ltd., Toronto.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N. Y.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester Mass.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.

Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd. Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill

SPECIAL MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co,, Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch, Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM ENGINES
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM JETS
Green Engineering Co., East Chicago, Ind.

STEAM SPECIALTIES
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd,, Toronto.
Can. Fairbanks-Morse Co., Montreal.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
The Reliance Gauge Column Co., Cleveland, Ohio.
Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM CALORIMETERS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Division, Brooklyn, N. Y.
Sarco Co., Inc., New York.

STEAM TRAPS
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Julian D'Este Co., Boston 14, Mass.
Sarco Co., New York, N. Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons, Co., Wm., Pittsburgh, Pa.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.

STOKERS
Canadian Planet Engineering Co., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd., Montreal.
Green Engineering Co., East Chicago, Ind.
Underfeed Stoker Co., of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
Sturtevant, Co., B. F., Toronto and Boston.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co, Pittsburg, Pa.

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd,, The, Montreal.

B CO. LTD.

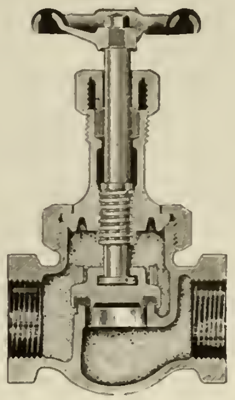
Spring Repairs

Overhaul and repair your buildings before the Spring Rains and the Spring Sun find the weak spots in them.

ROOFING — Rubber, Plastic and Liquid. Also Sheathings, Wall-board, etc.
ROCKFACE — White Water Paint, easily applied and inexpensive. Will not flake or peel off. Wood or Masonry.
PLIBRICO—Jointless Fire Brick for putting your furnace linings back into shape, after the strain of the winter months.

Beveridge Supply Co., Limited
628-630 St. Paul St. West
Montreal

PRATT & CADY VALVES



P&C CO

It is real economy to install Pratt & Cady Bronze Union Bonnet Renewable Disc globe and angle valves. It is so easy to replace parts subject to wear that you are sure to take advantage of this feature.

P. & C. Folder No. 2 describes this valve in detail. May we send you a copy?

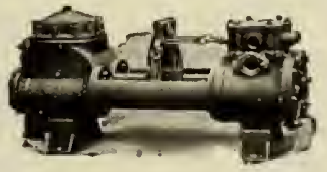
Reading Steel Casting Co., Inc.
Pratt & Cady Division
General Sales Office: Bridgeport, Conn.

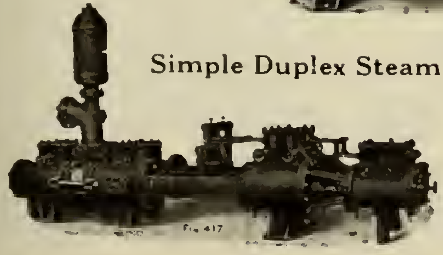
CANADIAN REPRESENTATIVES:--CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.

The
John H. McGowan Co.
Cincinnati, Ohio, U. S. A.

Builders of Pumping Machinery

Our 70 years' experience in designing and manufacturing pumping machinery places us in a position to analyze any situation and make recommendations as to the type best suited for same.

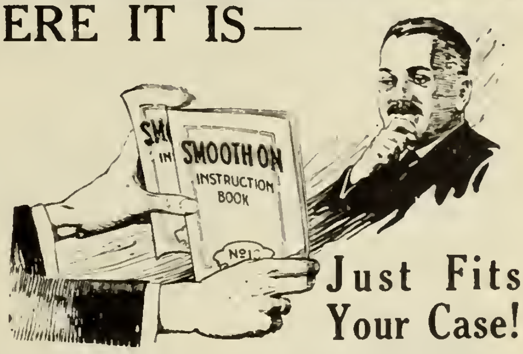




Simple Duplex Steam Power for all conditions of Service.

SMOOTH-ON IRON CEMENTS

HERE IT IS—



Just Fits Your Case!

Many engineers have learned from experience not to say, "That will have to come down for repairs," until after they have tried Smooth-On Cements. For Smooth-On saves dismantling in a large proportion of cases.

SMOOTH-ON
Instruction Book No. 19

Just off the press, contains 144 pages of engineering information and shows many instances of how time and money were saved by engineers through the use of Smooth-On Cements for making power plant repairs. This book shows you "how it is done" quickly and economically without dismantling machinery or pipe lines. Write today for your copy —IT'S FREE.

Smooth-On Cements are sold in 5-lb., 10-lb., and 25-lb. tins; also in larger sizes.

THE CANADIAN ASBESTOS CO.
Dept. 52-D, 36-48 Youville Sq., Montreal, Que.
If your supply house cannot supply you, write us direct.

Building a one-piece furnace lining without special forms.

BETSON'S PLASTIC FIRE BRICK

REG. U.S. TRADE MARK PAT. OFF.

Makes practicable, solid, one-piece furnace linings, including front and back arches, side walls and baffles. It costs but little to install in any make or type of boiler. It saves fuel, annoying shut-downs, costly repairs, and increases the amount of power from the fuel used.

Complete details of the many uses, methods of installing, how to order, measurement blanks, etc., are contained in a booklet of information which we will gladly send you. Tell us the individual to whom it should be addressed.

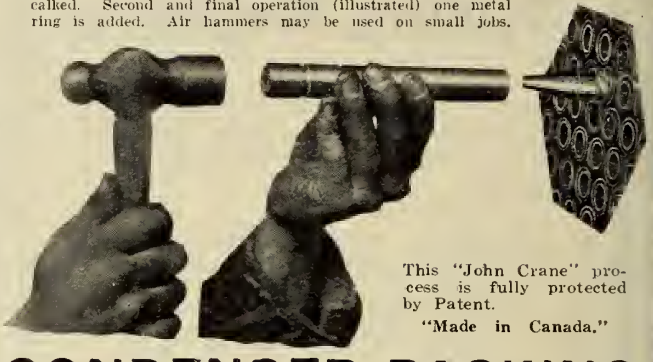
Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6, Rome, N.Y.
Canadian Distributors
INTERNATIONAL CHEMICAL CO.
26-6 Adelaide St., Toronto, Ontario, Canada.

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

First, one metal and two expansion rings are pushed in and calked. Second and final operation (illustrated) one metal ring is added. Air hammers may be used on small jobs.



This "John Crane" process is fully protected by Patent.

"Made in Canada."

CONDENSER PACKING

John Crane Metallic packing for Condensers holds the tubes firmly but without a crushing grip. It permits lateral expansion and contraction of tubes overcoming destructive stresses. Eliminates electrolytic decomposition of tube ends. Easy to apply and very durable.

The class of engineers who are taking to this process speaks for its value.

Investigate! Full data upon request.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
Beldam's Asbestos Packing & General Mfg. Co., Ltd.
Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B.C.
"MADE IN CANADA."

SUPERHEATER, STATIONARY
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, LOCOMOTIVE
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STEAM SHOVEL
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N. Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Canadian Johns-Manville Co., Ltd., Toronto
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE
Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co. Brantford.

TANKS, OIL, KEROSENE, GASOLINE
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

TANKS, WATER
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

TACHOMETERS
Bristol Company, The, Waterbury, Conn.

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

THERMOSTATS
Sarco, Inc., New York, N.Y.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N. Y.

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que

TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Sarco Co., Inc., New York, N.Y.
Wason & McDonald Co., Philadelphia
Taylor Instrument Co., Toronto, Ont.

TACHOSCOPES
The Reliance Gauge Column Co., Cleveland Ohio.
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS
Canadian Sirocco Co., Ltd., Windsor, Ont.
American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Schaeffer & Budenburg Mfg. Co., and Am-
Sarco Co., Inc., New York, N.Y.

TRAPS, DUMPING
Grant E. Cole Co., Toronto, Ont.

TACHOMETERS
Bristol Company, The, Waterbury Conn.,

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Sturtevant Co., B. F. Toronto and Boston.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal.
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES OF ALL KINDS
Reading Steel Casting Company, Inc.
Pratt & Cady Division,
Bridgeport, Conn.
Reading Steel Casting Company, Inc.
Reading Valve and Fittings Division,
Bridgeport, Conn.
The Edward Valve Mfg. Co., East Chicago, Ind.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Shell Bar Boico Supply, Ld., Toronto.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.

WALKWAYS, (Irving Subway)
Irving Iron Works Co., Long Island City, N. Y.

BOICO BOILER COMPOUND

routs the most stubborn cases of boiler formations, quickly, thoroughly and economically. Hurts nothing but scale.

ANTI-CLINKER SHELL BAR GRATE

Ample air space gives perfect combustion ensuring maximum heat, without waste, from the last bit of fuel.

ONE-PIECE JOINTLESS FURNACE LINING

"Plibrico" gives your furnace greater resistance. Lasts longer and installed quicker than brick.

TIP-IT PATENT WELDING PROCESS

Tools with shanks of carbon and high-speed steel tips save time and money.

SHELL-BAR BOICO
Supply, Limited
1-15 Saunders Ave., Toronto

Sales Agents: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

ELK FIRE BRICK

Coupled with

OUR SPECIAL SERVICE MEANS ECONOMY

Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd.

Sun Life Building, Hamilton, Ont.

SMOOTH JOURNALS KEPT SMOOTH

A lining of Magnolia Anti-Friction Metal never squashes out of a properly designed bearing, yet is soft enough to let dirt and grit sink in below the critical surface, instead of cutting the journal in trying to push the contact surfaces apart. That this positive protection is actually present and does not appreciably diminish the anti-frictional qualities of the bearing, has been thoroughly established. Long life has characterized Magnolia anti-friction metal bearings in cement plants, brick yards, etc., where other bearing metals proved themselves to be costly luxuries.

Insist to your dealer that only Magnolia Anti-Friction Metal will be accepted and you will soon be able to see its superiority.

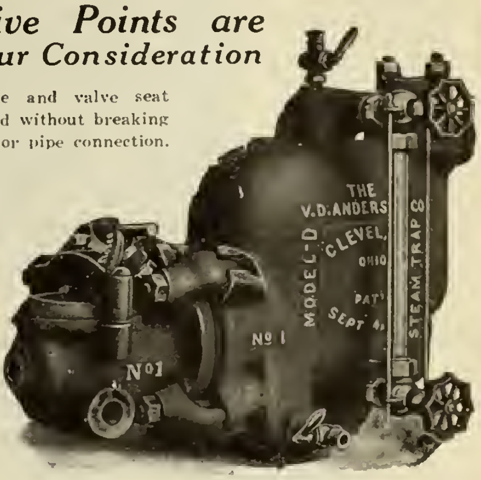
Magnolia Metal Company
113 Bank St. - New York

Chicago Fisher Bldg. San Francisco Pacific Bldg. Montreal 37 Shannon St.

MAGNOLIA ANTI-FRICTION METAL
TRADE MARK

ANDERSON MODEL "D" STEAM TRAP

These Five Points are Worth Your Consideration



1. Both the valve and valve seat can be removed without breaking a steam joint or pipe connection.
2. The valve is always sealed with at least three inches of water, making the escape of live steam impossible. The strainer and sediment chamber prevent sediment or scale getting into the valve.
3. A glass water gauge fitted to the trap makes it possible to ascertain at a glance whether the trap is working properly.
4. Made for high or low pressure or exhaust steam. Will lift water against back pressure 5 lbs. less than pressure of trap.
5. Built of best possible materials for the purpose. Every part interchangeable.

THE V. D. ANDERSON CO.
1935 West 96th St. — Cleveland, Ohio

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

WESTERN REPRESENTATIVES:
THE TAYLOR ENGINEERING CO., LTD.,
VANCOUVER, B.C.

THE SUPERHEATER CO., LIMITED.
Transportation Bldg., Montreal

MADE IN CANADA
WORKS AT SHERBROOKE, QUE.

Tycos

temperature instruments

Supply the power plant operator with a temperature instrument for every purpose.

Glance thru this list. There is a *Tycos* application for each one.

Air ducts,
Bearing Temperatures,
Blow off lines,
Boilers,
Coal pile temperature & Alarms,
Condensers,
Economizers,
Feedwater Heaters,
Feedwater Lines,
Furnace Temperatures,
Furnace Drafts,
Generator Temperatures,
Gravity overhead tank heaters, temperature and alarms,
Hot water heaters,
Hot wells,
Pressure lines,
Steam lines,
Superheaters,
Superheated steam mains,
Transformer temperatures and alarms
Vacuum lines and tanks.

Let us send you a reference catalog showing *Tycos* in the Power House. Ask for Part One.

Taylor Instrument Companies
Canadian Plant, Toronto, Ont.
There's a Tycos or Taylor Temperature Instrument for Every Purpose

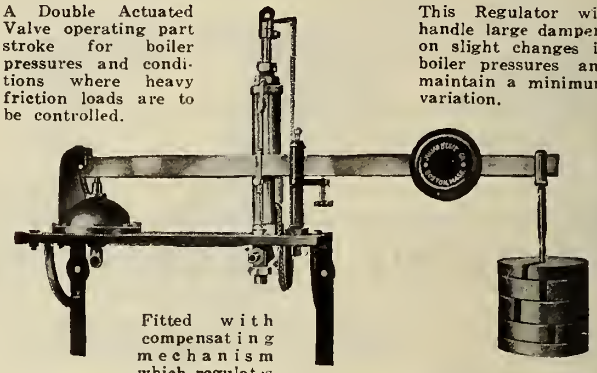
891

D'ESTE

Hydraulic Damper Regulator

A Double Actuated Valve operating part stroke for boiler pressures and conditions where heavy friction loads are to be controlled.

This Regulator will handle large dampers on slight changes in boiler pressures and maintain a minimum variation.



Fitted with compensating mechanism which regulates opening and closing.

Our Catalogue No. 50 of CURTIS ENGINEERING SPECIALTIES sent on application.

Julian d'Este Company
Main Office: 26 Canal St., Boston 14, Mass.

INDEX TO ADVERTISERS

American Steam Pump Co.... 12
Anderson Co., V. D. 51
Armstrong Cork and Insulation Co., Ltd. 11
Audel Co., Theo 39

Babcock & Wilcox 35
Bailey Meter Co. 17
Betson Plastic Fire Brick Co. 50
Bristol Co., The 4
Builders Iron Foundry 41
Buyers' Directory 42, 44, 46, 48, 50
Beveridge Supply Co. 49

Can. Fairbanks-Morse Co..... 14
Canadian Ingersoll-Rand Co... 13
Can. Johns-Manville Co....... 37
Classified Adv. Section 39
Cole Co., Grant E. 45
Conveyors Corp. of America.. 43
Counerty, T. J. 41
Crane Packing Co. 50
Can. Mead-Morrison Co. 19

DeLaval Steam Turbine Co... 7
DeLaval Co., Ltd., The 47
Dart Union Co. 45
D'Este Co., Julian 52
Diamond Specialty Ltd. 7
Durabla Mfg. Co. 14

Elk Fire Brick Co. 51
Engineering & Machine Works of Canada 5
Edward Valve Mfg. Co. 43

Foxboro Co. 15
Flexible Metallic Packing Co. 50
Frick Company 12

Garlock Packing Co. .... Inside Front Cover
Garth Co., The 41
Goldie & McCulloch Co. 20
Greene, Tweed & Co. 6
Gutta Percha & Rubber, Ltd... 3

Hints to Buyers 41
Hepburn, John T. Co. 43

Jardine, A. B. 41
Jenkins Bros. 9
Jointless Firebrick Co. 47

Kerr Engine Co. 16
Keasbey & Mattison Co....... 43

Laurie Engine Co. 43
Laurie & Lamb 4
Linde Can. Refrig. Co. 10
Lunkenheimer Co. .... Inside Back Cover
Lytle Engineering Co. 45

McLaren, D. K. Co. 2
McGowan Co., John H. 49
Magnolia Metal Co. 51
Moncrieff Ltd., John 51
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Mueller Mfg. Co. 18

Northern Crane Works 43

Pilley Packing & Flue Brush Mfg. 41
Pratt & Cady Co. 49

Reading Steel Casting Co. .. 49
Refrigeration Dept. 10
Refinite Co. of Canada 41

Schaeffer & Budenberg Mfg. Company 16
Smooth-on Mfg. Co. 49
Superheater Co. 51
Sturtevant & Co., Ltd., B. F. 3
Steel Mill Packing Co........ 43
Sexton, W. R. Boiler Setting Co. .... Front Cover
Shell Bar Boiler Co. 51

Taylor Instrument Co. 52

Underfeed Stoker Co. of Canada, The 8

Victoria Foundry Co. 39
Vilter Mfg. Co. 10
Valve Engineering Co. 45

Wall, W. J. 51
Waterous Engine Works Co... 1
Watson, M. Barry 39
Watson & McDaniel Co....... 41
William & Co., Ltd., J. H. 45

Yarnall-Waring Co. 17
York Mfg. Co. 11

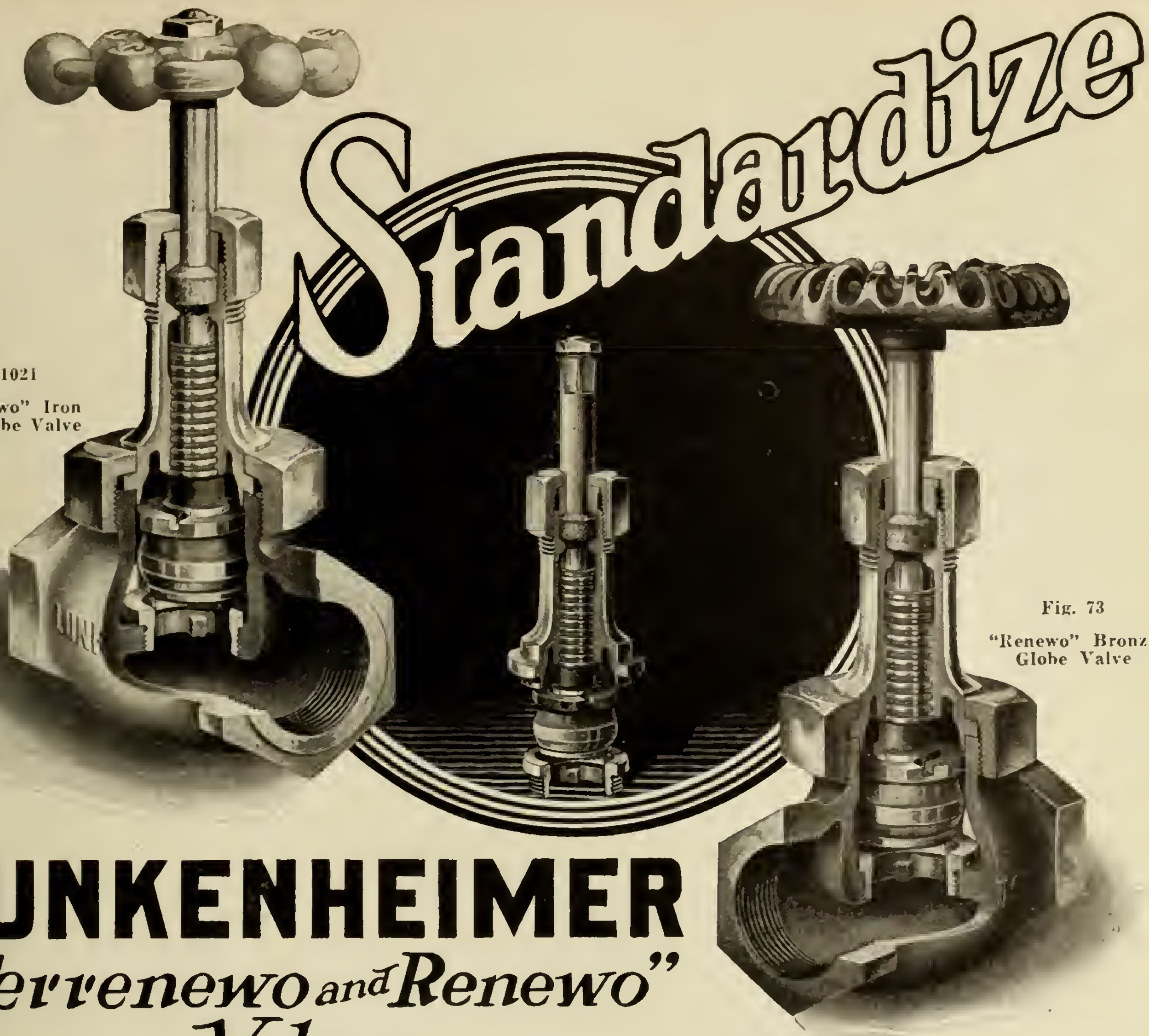


Fig. 1021
"Ferrenewo" Iron Body Globe Valve

Fig. 73
"Renewo" Bronze Globe Valve

LUNKENHEIMER

"Ferrenewo and Renewo" Valves

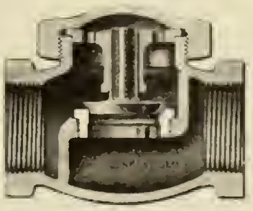


Fig. 863
"Renewo" Bronze Horizontal Check Valve

Fig. 898
"Ferrenewo" Iron Body Horizontal Check Valve

The Iron Body "Ferrenewo" for low pressures and the Bronze "Renewo" for high pressures enables standardization of these Valves throughout the plant with ECONOMY and SERVICE assured—economy, in that maintenance of up-keep is reduced to the minimum and prolonged satisfactory service, because of proved correct design, high grade materials and workmanship.

The seating surfaces are regrindable and all parts including the nickel seat and disc are renewable.

Write for a copy of Catalog 58DC

102-26-43

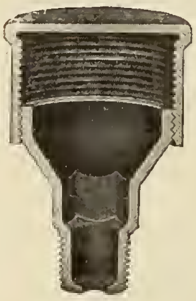
THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO CINCINNATI, U.S.A. LONDON
EXPORT DEPT 129-135 LAFAYETTE ST. NEW YORK

"America's Best since 1862"

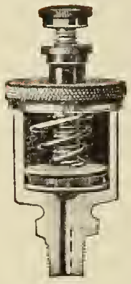
MORRISON

OILING DEVICES

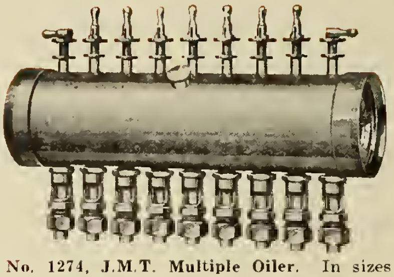
You Can Depend Upon At All Times



No. 1171.

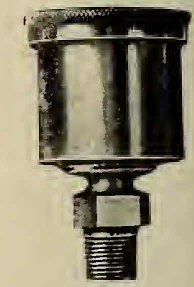


No. 1173.



No. 1274, J.M.T. Multiple Oiler. In sizes from 1 pint to 3 gals. capacity.

No. 1197.

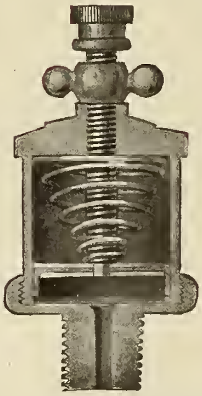


No. 1187.

Oil Cups

No. 1187—Brass, with or without syphon.
No. 1192--Glass Body, Slide Top, Adjustable Feed.
No. 1197--Glass Body, with Quick Stop and Sight Feed.

No. 1178.
Four of our many styles of Compression Grease Cups. We have cups for every purpose.

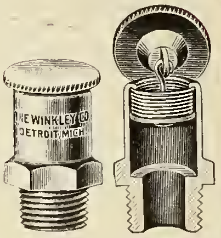


No. 1179.

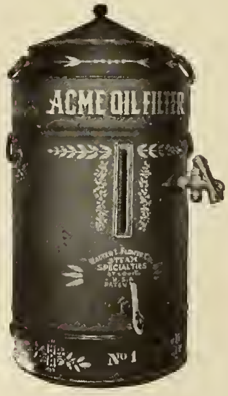
No. 1229—Marine Oil Box, Cast Brass— No soldered joints to give way. Save trouble and expense in upkeep.

No. 1194

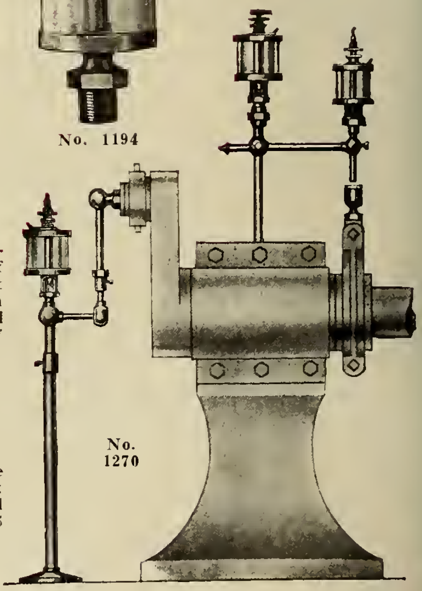
No. 1230—Oil Gauges for Dynamo. With or without drain tap. Four sizes: ⅛", ¼", ⅜" and ½".



No. 1243—Oil Hole Covers. Top closes automatically. In various sizes and styles.



No. 1291 Oil Filter— Permits the use of ample lubrication yet cuts the oil bill in half by reclaiming all the oil. Capacities, 7 to 50 gals.



No. 1270

No 1270—Adjustable Centrifugal Crank Pin oiler. Made in all sizes and types, 10-36 inch stroke.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. West - - Toronto

POWER HOUSE

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street, E. C. NEW YORK, BOSTON, CHICAGO

Vol. XVI—No. 8 Publication Office, Toronto—April 20, 1923 Published Semi-Monthly Canada, $2; U. S. $2.50 a year

Zero weather—a raging snow storm—yet ashes in the storage tank do not freeze—are easily and quickly removed. When AMERICAN STEAM JET ASH CONVEYORS from intake to storage tank are designed, erected and operated in accordance with our instructions, we guarantee non-freezing of ashes in tank and economical ash handling. Ask for booklet which lists guarantees and exclusive engineering features.

Conveyors Corporation of America
326 West Madison Street, CHICAGO.

Canadian Representatives:
CLEATON CO. (Canada), Ltd., Montreal.
GORMANS, LTD., Calgary, Edmonton, Vancouver.
WM. A. GOOLD, Winnipeg.

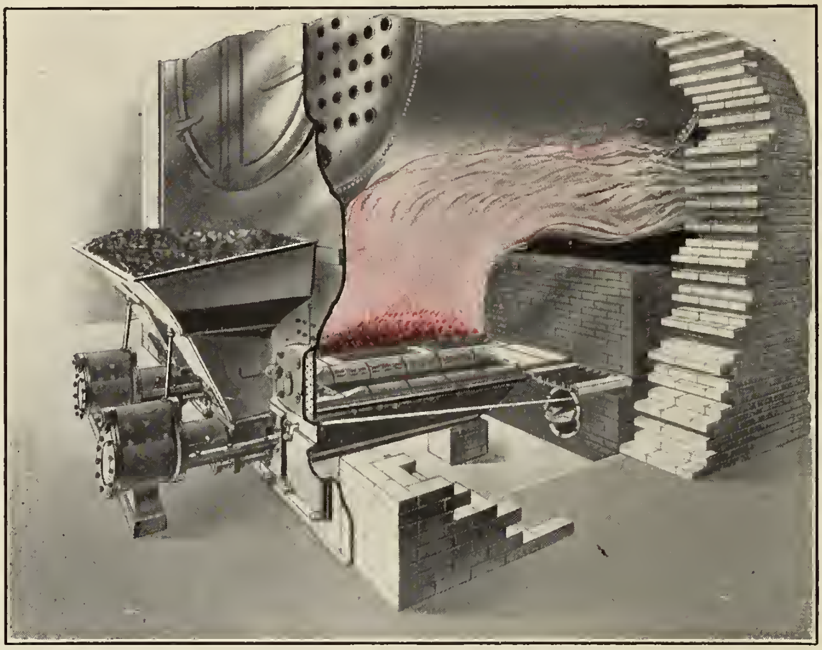
AMERICAN
STEAM ASH CONVEYORS

MACLEAN STOKERS

Save Fuel

Eliminate Smoke

Easy to Install



Save Labor

Reduce Upkeep

Easy to Operate

IT IS a remarkable fact that although the power house lends itself to far greater profit-making economies from relatively small investments than any other department of the average industrial plant, it is often the most neglected.

The importance of boiler room efficiency at minimum costs can be appreciated only in its relation to dependent operations in other departments and as a burden on the ultimate production cost.

The MacLean Underfeed Stoker is scientifically designed and built to take care of this problem.

It starts right in to save money from the day it is installed.

Working automatically, it feeds the fire just the right amount of coal, varying the feed in accordance to varying demands for steam. In this way a constantly uniform steam pressure is maintained regardless of sudden load fluctuations.

It burns all classes of bituminous coal. There are no siftings of unburned coal to the ashpit because there are no grates. Easy to install, easy to operate, it is adaptable to practically every type of boiler and all classes of steam plants.

Let us estimate the savings to be made in your plant. No obligations whatever.

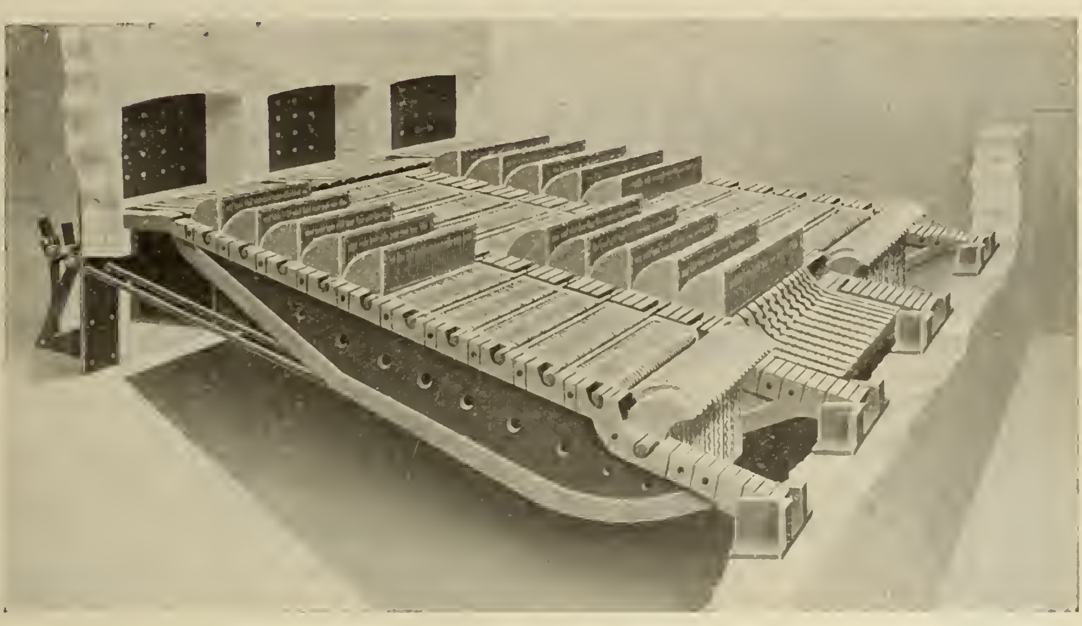
DESIGNED BUILT AND CONTROLLED BY CANADIANS

TRADE MARK REGISTERED

MacLean Underfeed Stoker Company, Ltd.

95-97 KING STREET EAST, TORONTO, CANADA

The Coal it Saves—Soon Pays its Cost



THE FILES STOKER

Pays for Itself in One Year

Below is a copy of one of the many letters we have received, telling of the efficiency and economy of the Files Hand-Operated Stoker

Re FILES HAND STOKERS.

Gentlemen:—

Frequently we receive letters from manufacturers, asking for information and our experience with the "Files Hand Stokers"—the most economical and efficient system of burning coal with the utmost conservation of labor.

As these inquiries are becoming more and more frequent, our better plan will be to furnish you with a letter to pass on, outlining our experience and satisfaction.

In September, 1920, we placed an order with you for two 150 H.P. Tubular Boilers, specifying our desire to have them equipped with "Files Hand Stokers." This we did on the recommendation of our United States Engineering Department, who had installed "Files Hand Stokers" in some seventeen plants, finding in them a decided saving and advantage over flat or shaking grates.

Speaking for ourselves, we have found them most satisfactory and economical, particularly so in regard to the elimination of smoke, rapid disposal of ash and clinker, thorough cleaning of fires without disturbing the active fire, and in maintaining an even bed of fuel.

We are able to keep a clean fire at all times; we have no cleaning period, for with the "Files Hand Stoker" the grate can be cleaned at peak load. It is only a matter of working one rod on each section, which can be done in less than two minutes.

The better the coal the better the result, but almost any kind of coal that will burn free can be used. With good coal, however, it is an easy matter to procure 150% boiler rating, which in reality is 12½ lbs. evaporation per pound of coal. Generally speaking, evaporation is around 7 or 8 lbs., and often as low as 5 or 6 lbs.

Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel.

And what we have done and are doing with them others can do.

We know they effect a saving; we know they are a convenience; they have proved satisfactory in every particular, and we have no hesitation in recommending them.

Yours very truly,

THE MERIDEN BRITANNIA CO., LIMITED.

Why not Profit by others Experience?

Waterous

BRANTFORD, ONTARIO, CANADA

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Gripping!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

LUNKENHEIMER

Bronze Gate Valves

Due to correct design, the use of only the best materials procurable, and skilled workmanship, long and satisfactory service is assured. Longevity of the Valves as a whole is further enhanced by renewability of any worn or broken parts.

The extensive line of Lunkenheimer Gate Valves permit of a selection for any specific purpose and for general prevailing pressures, making possible the standardization of these Valves throughout the plant with the resultant assurance of satisfactory service and economy of maintenance.

Catalog 58DC portrays the entire line. A copy will be sent upon request.

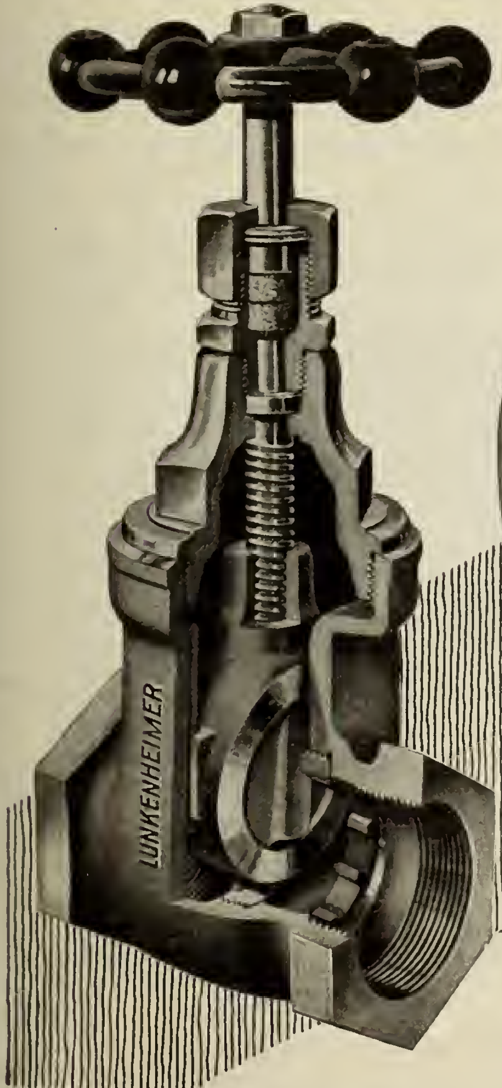


Fig. 768.
Medium Wedge Disc Gate Valve. Inside Screw, Stationary Stem. Screw Ends.

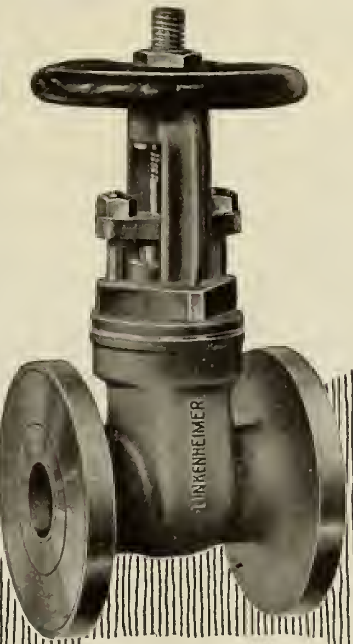


Fig. 832.
Medium Wedge Disc Gate Valve. Outside Screw, Rising Stem. Flange Ends.

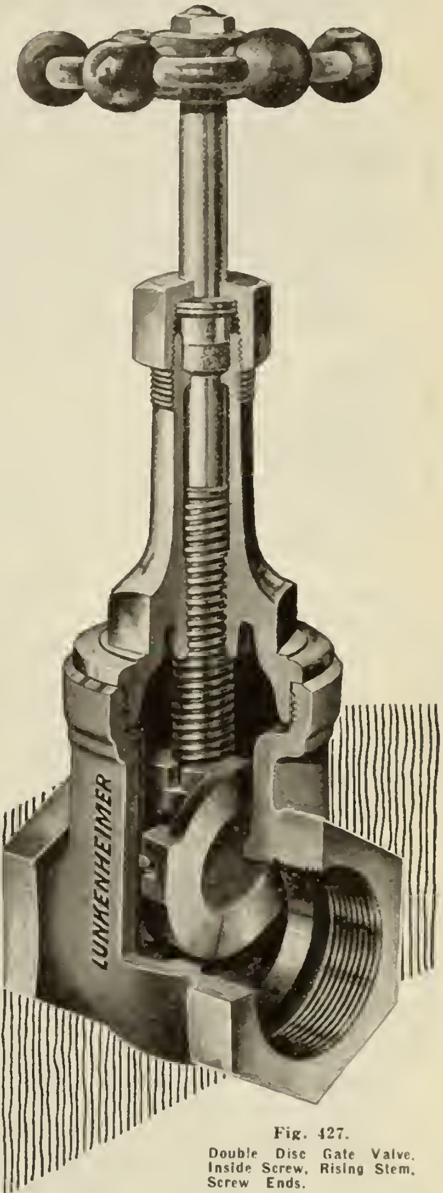


Fig. 427.
Double Disc Gate Valve. Inside Screw, Rising Stem. Screw Ends.

For Economy and Service
Standardize on Lunkenheimer
Products

"America's Best since 1862"

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO CINCINNATI, U.S.A. LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

11012-10-43

SARCO

Products that Increase Efficiency and Cut Costs

STEAM TRAP SARCO. Costing only one-third as much as "float" traps, the Sarco enables you to trap every point where condensation forms, thereby saving steam and fuel. No installation expense—fits into the line like an elbow, Has only one moving part—nothing to get out of order or require adjustment. Will not air bind. Booklet J-35 on request.

RADIATOR TRAP SARCO. A highly sensitive, factory-adjusted trap that keeps steam lines free from condensation. No water hammer or air binding. Maximum closing pressure — will not leak. Line contact between the cone and seat prevents scale deposit. Easy to clean. Exceptionally heavy construction. For vacuum, vapor and low-pressure steam heating systems. Write for Booklet J-109.

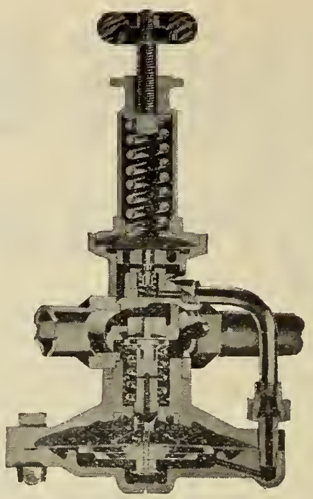
SARCO TEMPERATURE REGULATOR. Self-contained and automatic. Does not require electricity, compressed air or water. No rubber or leather diaphragms to give trouble. Factory-calibrated for desired range. Operates on steam, water and gas valves. Positive in action. Send for Booklet J-74.

SARCO INDICATING THERMOMETER. Manufactured under the famous Fournier patents, by expert thermometer makers in our own laboratories. Dial may be placed any distance from the sensitive bulb up to 500 feet or more. Indicates temperature of bulb only. For any desired range from minus 90° F. to plus 3000° F. Booklet J-153 on request.

SARCO STRAINER. For use in any installation where it is necessary to protect valves or other parts against the action of scale, sediment, etc. The large sieve area insures thorough straining without interruption of flow. Can be placed in horizontal or vertical lines, or at any angle. Blow-off connection permits cleaning strainer by simply opening valve. Quickly taken apart and reassembled. Ask for Booklet J-201.

Any Sarco Instrument sent on trial for 30 days.

SARCO CO., Inc.
239 Broadway, New York City
Buffalo Chicago Cleveland Detroit Philadelphia
PEACOCK BROS. LTD., Montreal.



Fisher Pressure Regulator.
(Type 90.)

A Money-Saver—WHY?

1. Because Fisher Pressure Regulator, Type 90, delivers to an operation or process exactly the amount of low pressure required—no more—no less. It maintains the desired low pressure without fluctuation, regardless of variations in high pressure.

2. When an operation or process is interrupted, this valve automatically cuts off the low pressure and remains closed until the demand at that point is renewed, when it automatically releases just the required low pressure.

Thousands are in use for curing, drying, bleaching, dyeing, vulcanizing, evaporating and similar processes in textile mills, cotton seed oil mills, sugar refineries, tobacco and rubber plants, lumber mills, etc.

Fisher Pressure Regulator, Type 90, saves enough to pay for itself in a very short time.

Send for Bulletin 210, which gives complete information about this wonderful valve.

The Fisher Governor Company
944 Fisher Avenue
Marshalltown, Iowa, U.S.A.

Flue gases can be reduced 50 degrees by careful firing and clean boiler surfaces

Such is the substantial saving that can be effected by recording and measuring your flue gas temperature with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.
Recording Pyrometers

Of course, the temperature of outgoing gases can be decreased by economizers, or by a change in the baffling — but such changes are costly and the economy depends upon the cost of coal.

The information supplied by Bristol's Pyrometers, as to the temperature of uptake gases leaving the boilers, is of prime importance as an aid to super-efficient plant operation.

Hundreds of Bristol's Pyrometers are recording flue gas temperatures in prominent power plants. Let us tell you more about what they could do in your plant. Our new Catalog O-1401 is waiting for your address.

The Bristol Company, Waterbury, Conn.

Canadian Distributors:

Eastern Territory: Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory: Gorman's, Ltd., Edmonton.

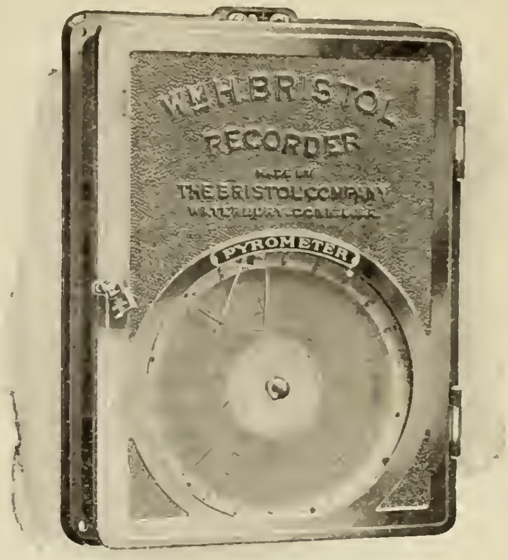
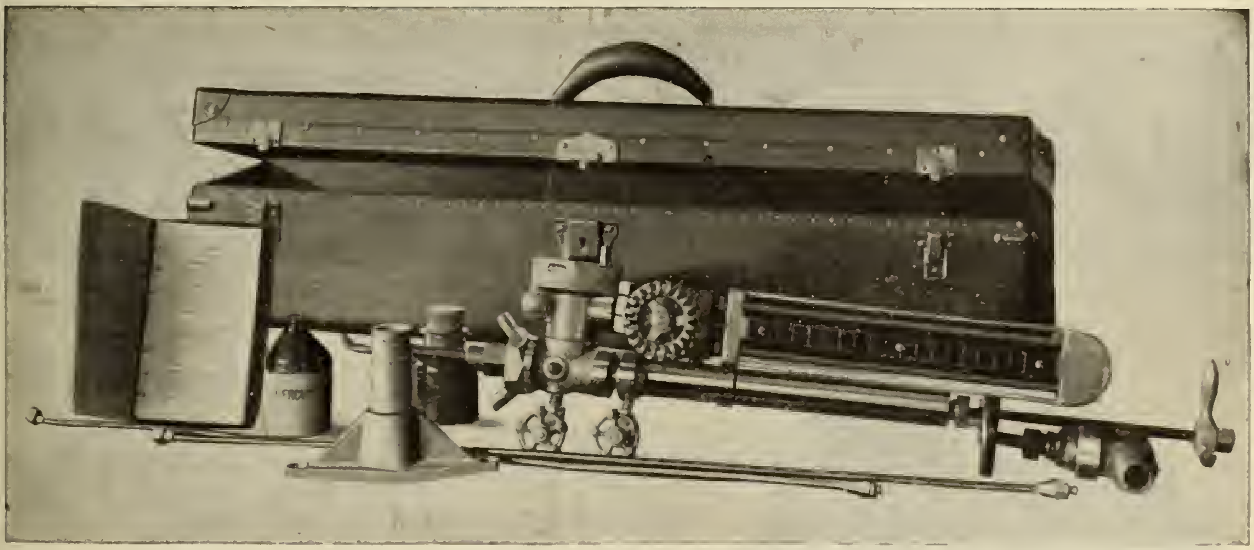


Fig. 1007

A suit has been filed in the United States Federal Court against a Pyrometer manufacturer who is infringing patents owned by the Bristol Co. covering Automatic Cold End Compensation for Thermo-Electric Pyrometers.



Cory-Royer Flow Indicator

Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

CHAS. CORY & SON INC.

183-7 VARICK STREET - - NEW YORK CITY

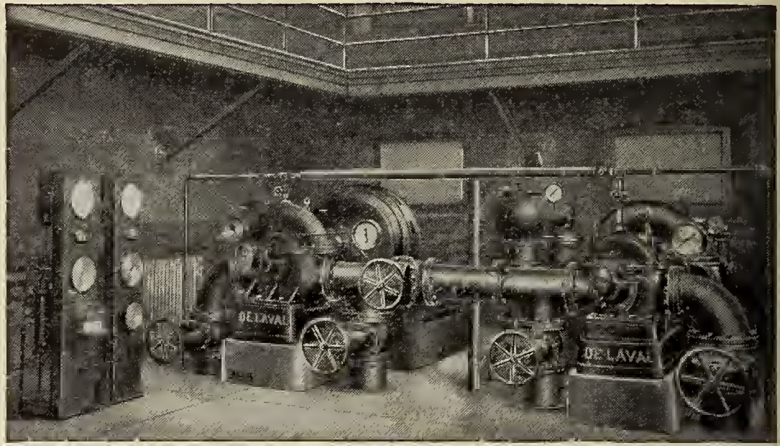
VANCOUVER
P. A. Goepel,
525 Pender St. W.

Est. CORY 1845

TORONTO
The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers

BROCKVILLE USES ELECTRIC PUMPS

WITH STEAM AUXILIARIES



As shown in the photograph, the two De Laval pumps supplying water to Brockville, Ont., are so arranged that either one or the other can be used, or the two pumps can be operated in either series or parallel, as required. The construction of the De Laval centrifugal pump insures high maintained efficiency, due to the fact that all parts subject to wear are easily renewable, being manufactured to limit gages on an interchangeable basis. The labyrinth wearing rings in particular, which prevent leakage from the discharge back to the suction, are superior to ordinary flat wearing rings both in effectiveness and in durability, assuming equal clearance in both cases. De Laval centrifugal pumps have shown unimpaired efficiency after four years' continuous use, pumping Mississippi River water. They have other features which recommend them for electric driven plants, including low starting torque, power limiting characteristic, and high average efficiency over a wide range of load. If you are interested in pumping water by steam, electricity, water power or internal combustion engines, ask for our Catalog B-100.

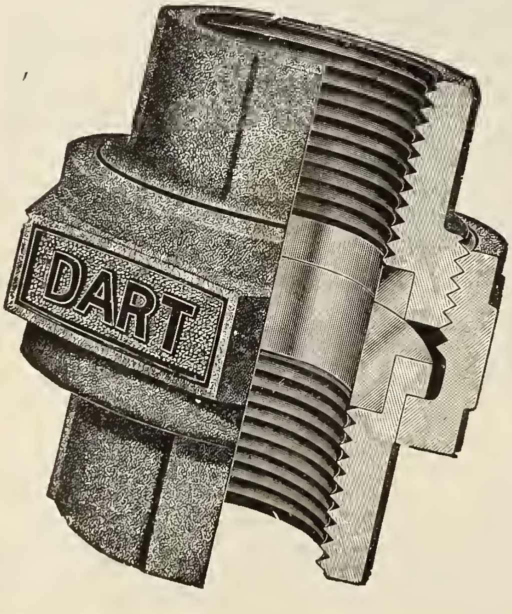
DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

265

DART UNIONS



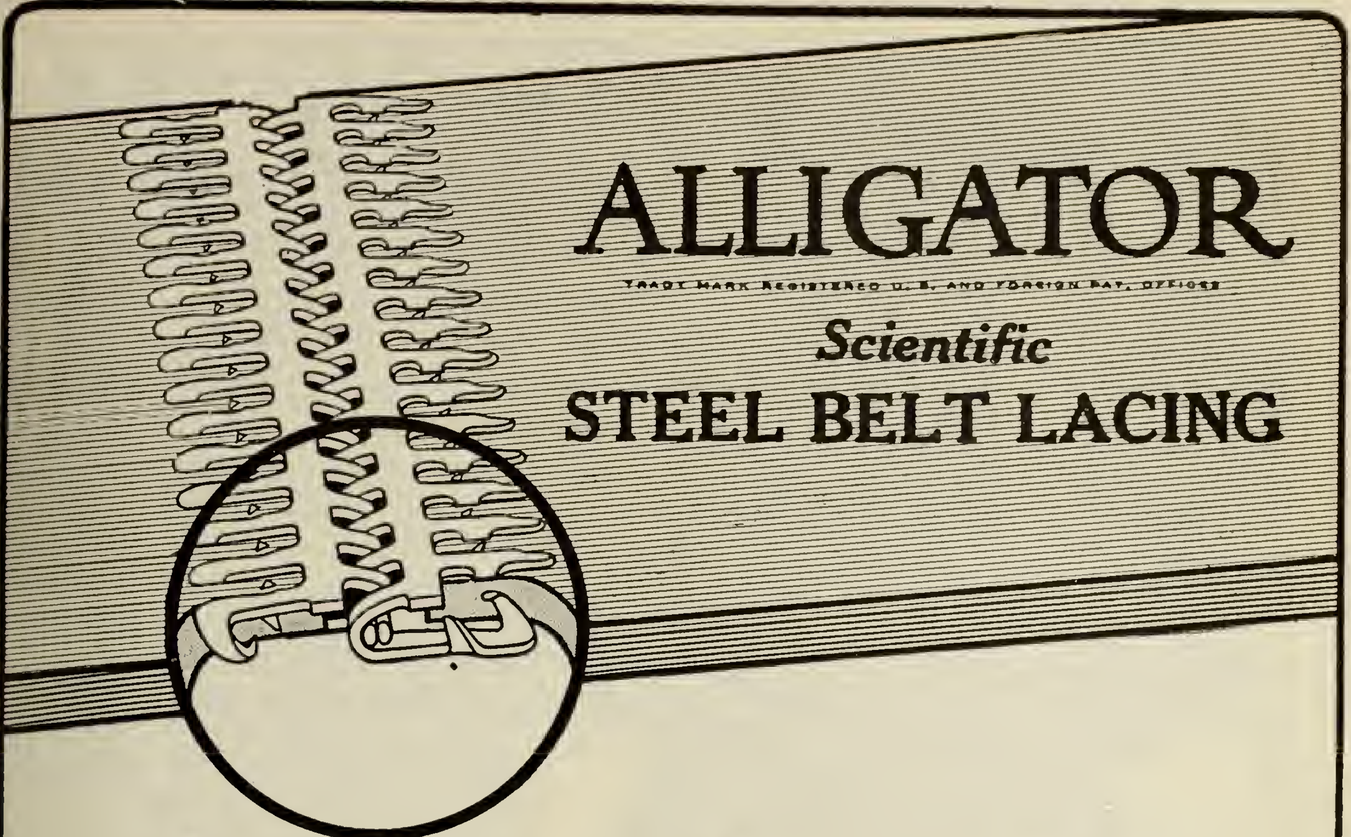
Stay Tight Permanently

No Upkeep Cost
No Replacement Cost
No Loss from Leaks

Because—THEY ARE BRONZE TO BRONZE AT THE JOINT

Your Jobber Sells Them

Manufactured by
DART UNION CO., LIMITED, TORONTO, ONT.


ALLIGATOR
TRADE MARK REGISTERED U. S. AND FOREIGN PAT. OFFICES
Scientific
STEEL BELT LACING

Setting New Standards in Belting Performances

BELTS give longer uninterrupted service when laced with Alligator Steel Belt Lacing for Alligator is the strongest and most durable of all belt lacings. It is scientifically and practically correct.

Every Alligator tooth is a vise, clinching around the belt fibers, holding them in equal permanent service.

Practically all authorities on belt transmission recommend Alligator. It is in use every day on millions of belts of every type and size and in every service. Sold at wholesale and retail the world over.

Flexible Steel Lacing Company
4667 **Lexington Street, Chicago**
In England at 135 Finsbury Pavement, London, E. C, 2

From the Standpoint of Science

Alligator teeth penetrate lengthwise of the belt leaving the long burden bearing fibers intact. Each tooth clinches down over its group of fibers, compressing them firmly so that there is no internal friction and wear at the belt end. Likewise the sectional steel hinge pin eliminates wear, the smooth oval faces rocking against each other.

Keep these vital features in mind when you buy belt lacing for the cost of any lacing is nothing as compared to the cost of the belt on which it serves.

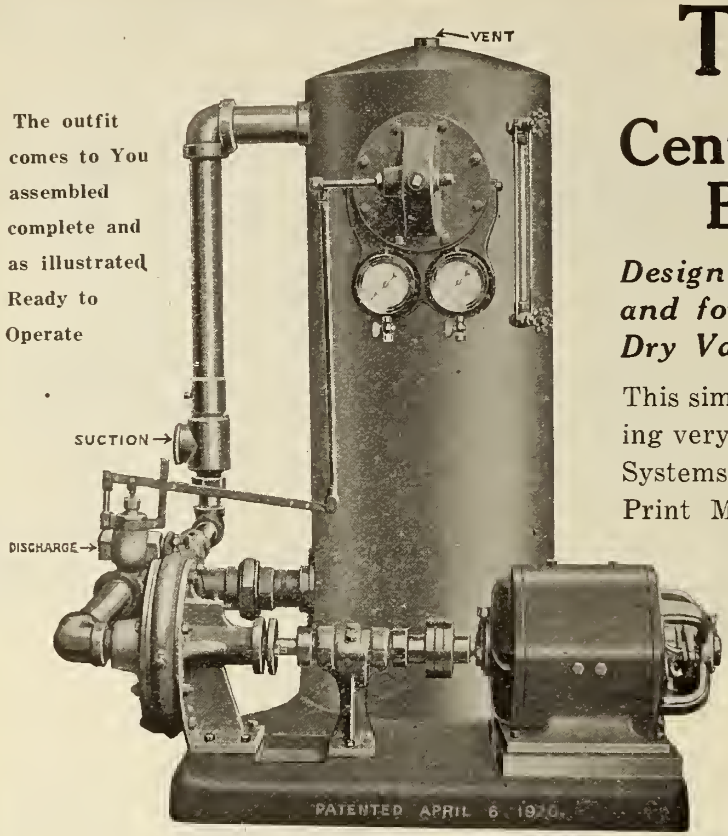
Just a Hammer to Apply It

"Never Lets Go"

The YOUNG

Centrifugal Vacuum and Boiler Feed Outfit

The outfit comes to You assembled complete and as illustrated Ready to Operate



Designed for Vacuum Heating Systems and for All Conditions Where a Wet or Dry Vacuum is Desired—Highly Efficient

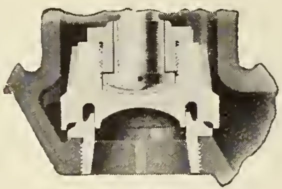
This simple, inexpensive and noiseless outfit is giving very satisfactory results with Vacuum Heating Systems, Dry Kilns, Paper Driers, Feed Driers, Print Mills, Cooking Apparatus, Vacuum Pans, etc., for the purpose of effecting a saving by returning the condensate for boiler feed.

Manufactured in Canada by

Young Pump Co. of Canada
96 Mary Street
HAMILTON, ONT.

EDWARD VALVES

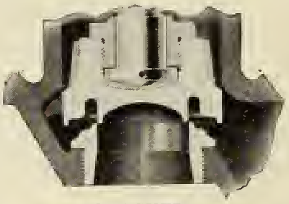
Note the Protection against Cutting Action



CLOSED

Unless positive means of prevention is provided, the cutting from wire drawing between the seat and disc of a valve will rapidly destroy the seating surfaces. This is especially true under high pressures and temperatures, where very small leaks will rapidly grow on account of the terrific erosive action, making the life of the valve very short and increasing the upkeep cost due to frequent repairs and renewals.

In the "cracked" position, the erosive action of the steam is greatest due to the fact that the steam is being wire drawn through a very small orifice and its velocity thus greatly increased. The illustrations show the positive protection which the Edward Protected Seat and Disc affords against this cutting action. Note that in the "cracked" position the seating surfaces are widely separated and protected from the direct flow of steam and that the velocity across the seating surfaces is greatly reduced.



CRACKED

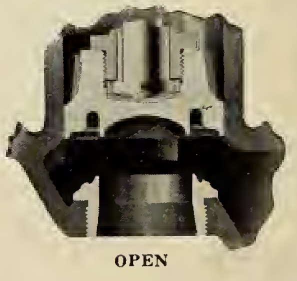
THE EDWARD PROTECTED SEAT and DISC

shown here, insures absolute protection of the most vital organ of the valve, the seating surface.

EDWARD Valves for High Pressures, Superheated Steam, Hydraulic Systems, Ammonia, Acid, Oil.

Superior Valves for Exacting Service.

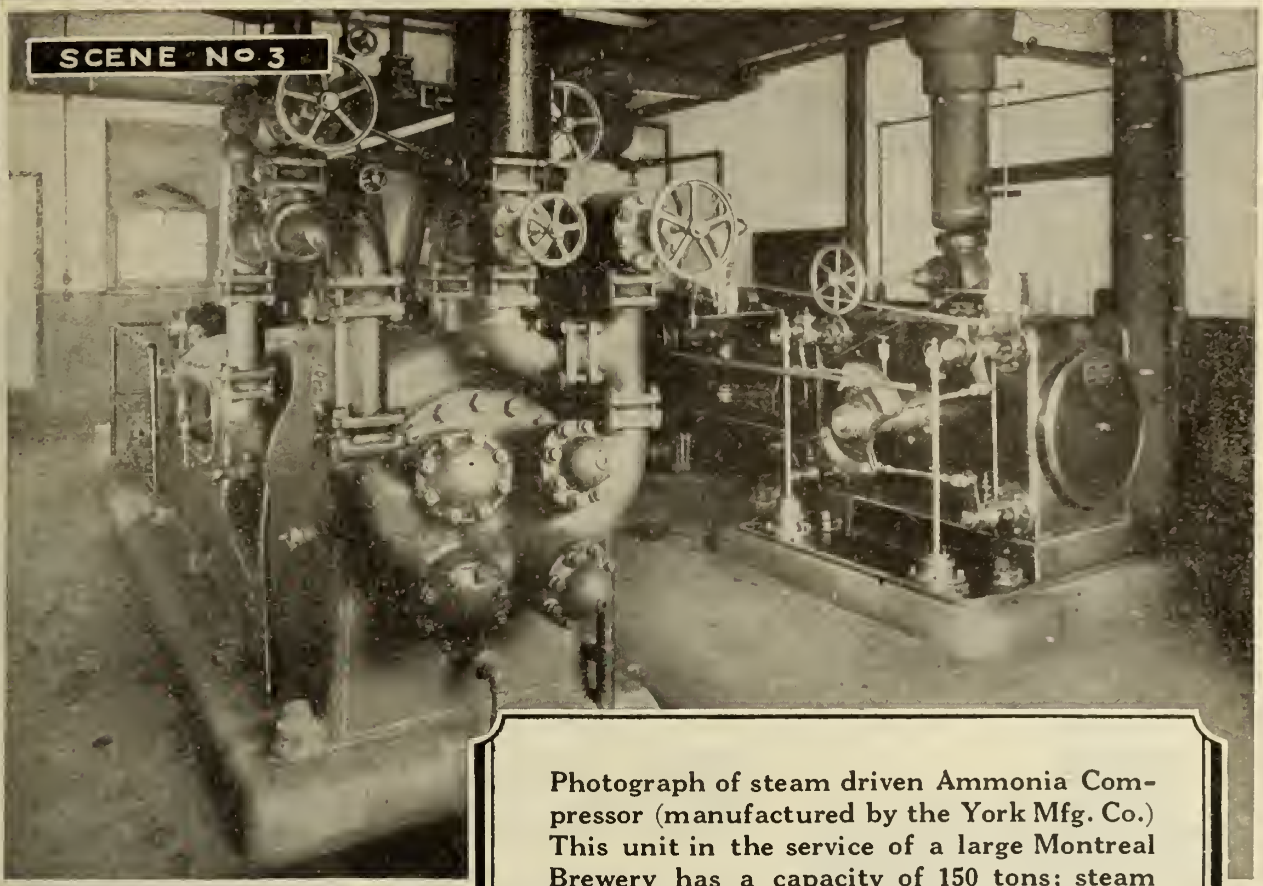
Send for Catalogue.



OPEN

The Edward Valve & Manufacturing Co.
General Office and Works: East Chicago, Indiana

Canadian Agents: LYTLE ENGINEERING CO., LIMITED, Montreal. VALVE ENGINEERING COMPANY, Toronto.



Photograph of steam driven Ammonia Compressor (manufactured by the York Mfg. Co.) This unit in the service of a large Montreal Brewery has a capacity of 150 tons; steam pressure 150 lbs.; speed 65 R.P.M.

Imperial Lubricants in use:—

Imperial Cylinder Oil.
Imperial Atlantic Red Oil.
Imperial Polar Machine Oil.

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

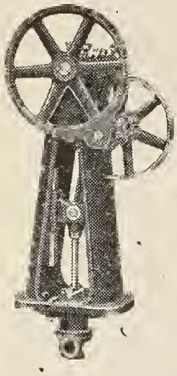
Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

Expensive machinery warrants the protection which Imperial Lubricants assure through correct lubrication of every bearing, journal and other moving part. Plant operation is made more profitable by the standardized use of the right grades of Imperial Lubricants on your different units. When you are confronted with a difficult lubrication job write our nearest branch office for the expert advice and service of our lubrication engineers.

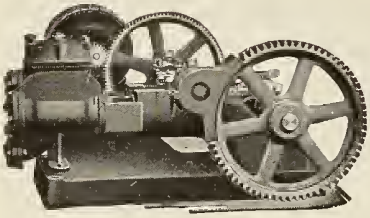
IMPERIAL OIL LIMITED

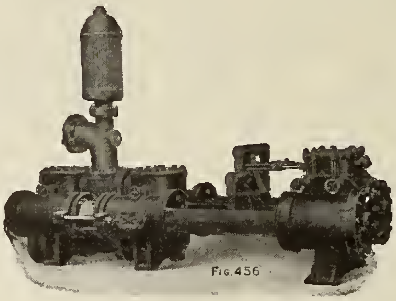


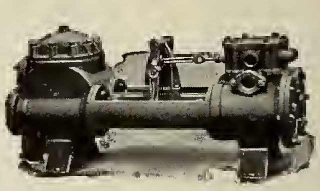
The John H. McGowan Co.

Builders of Pumping Machinery

CINCINNATI, OHIO, U.S.A.



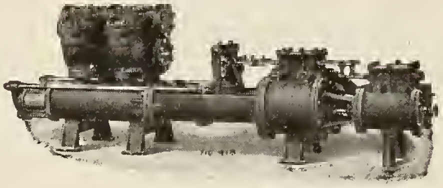


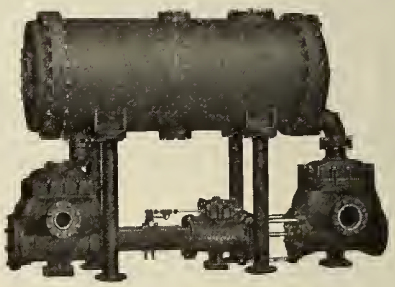


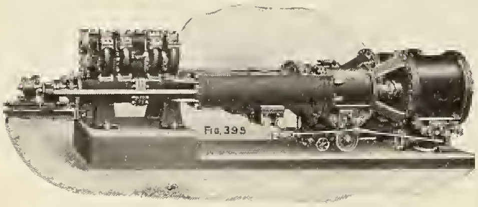
Mills Railways
Mines Power Plant

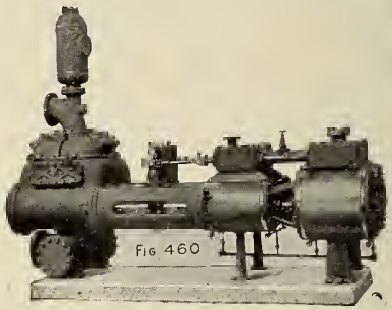
For all Industrial Plants

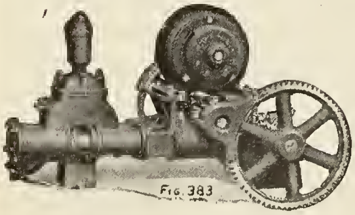
The purchase of a McGowan does not terminate our relations. The decision as to purchase might have been made on price alone — but when you are again in the market the excellence of our product and the quality of our Service is predominant in your mind.



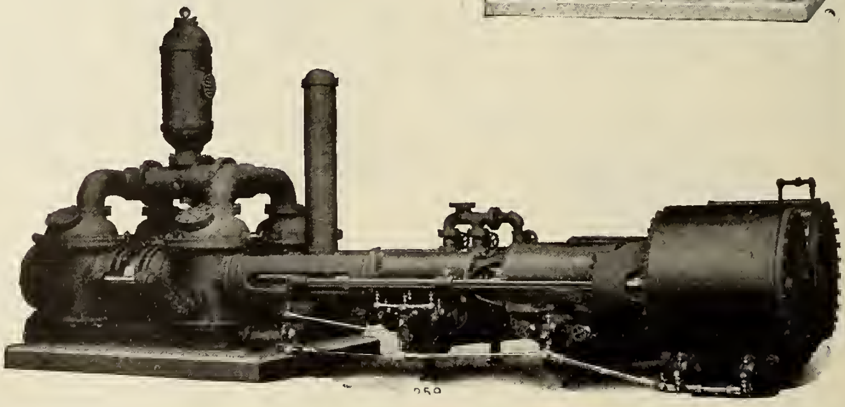








For All Conditions of Service



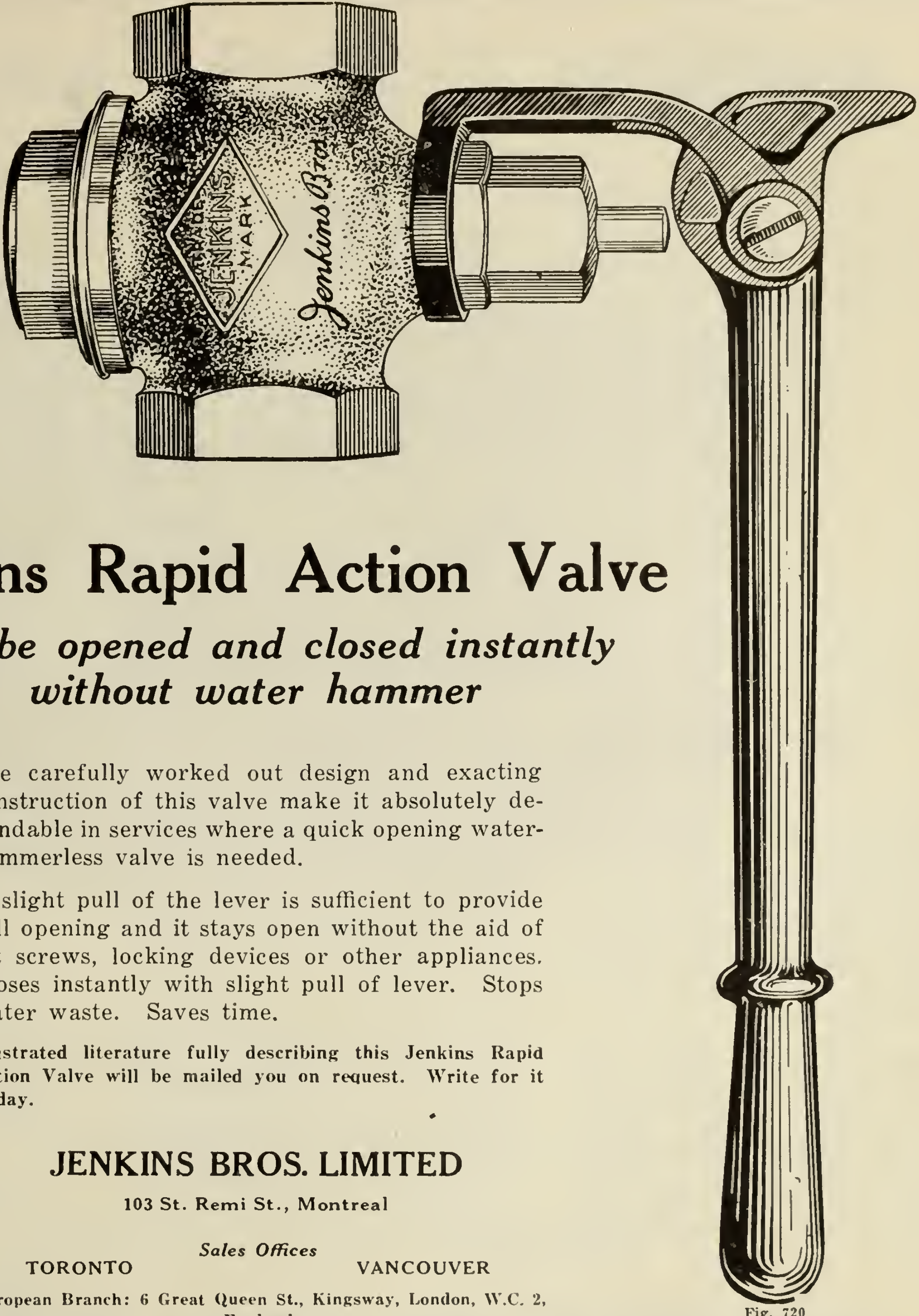


Fig. 720
JENKINS
Rapid Action Valve

Jenkins Rapid Action Valve

Can be opened and closed instantly without water hammer

The carefully worked out design and exacting construction of this valve make it absolutely dependable in services where a quick opening waterhammerless valve is needed.

A slight pull of the lever is sufficient to provide full opening and it stays open without the aid of set screws, locking devices or other appliances. Closes instantly with slight pull of lever. Stops water waste. Saves time.

Illustrated literature fully describing this Jenkins Rapid Action Valve will be mailed you on request. Write for it to-day.

JENKINS BROS. LIMITED

103 St. Remi St., Montreal

Sales Offices
TORONTO VANCOUVER

European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, England

Since 1864

"A Blessing to Society"

MORE than 85% of our population live in cities of 10,000 or more, and are mainly dependent upon the cold storage industry for their food supply. Impelled by public demand, the increase in storage space is enormous.

October 1, 1922, there were approximately 560,000,000 cubic feet in use in the nation—Chicago alone having more than 227,000,000 and New York following with 118,000,000 cubic feet. In such manner do we grow!

Thus, in line with the modern demand for perfection of details, the House of Jamison had devoted 17 years to the betterment of a complete line of specialized and standardized Insulated Doors, Windows and Ice Chutes.

You must recognize that "Your plant is only as good as your door"—a fact which explains the popular demand for Jamison Doors, recognized as unequalled in strength, sturdiness, simplicity, fitness, long life and ease of operation.

Write for Booklet

Every plant owner and plant builder will find some very pertinent facts in this Booklet. Write for it—marking your request, "Desk," Please.

> *"The cold storage house is a blessing to society. It permits the safe storage of food in times of flush production and holds it for public use during non-productive seasons; and the conduct of such establishments is safeguarded by law."*
>
> *Dr. Royal S. Copeland,*
>
> **Former Health Commissioner, New York, and Present United States Senator.**

Architects and Engineers

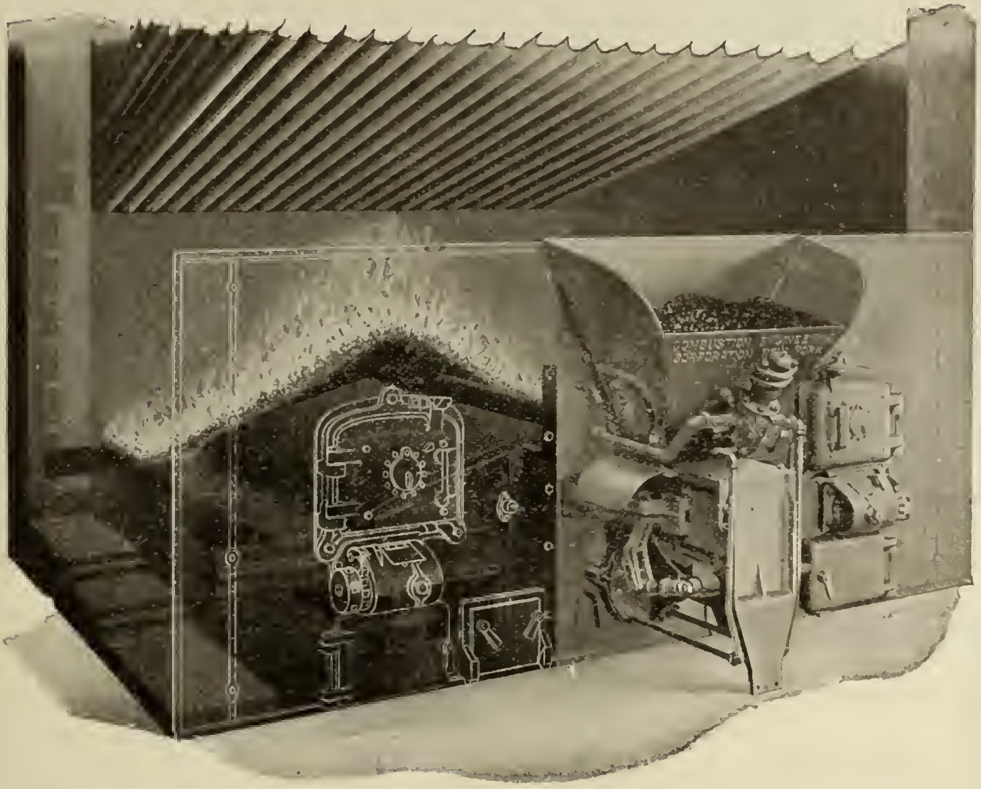
Jamison Cooler and Freezer Doors in standard sizes always ready for quick shipment. Refrigerator fronts for public buildings, institutions, hotels, hospitals, etc., built to specifications. We invite correspondence.

JAMISON COLD STORAGE DOOR CO.

Hagerstown - Md., U.S.A.

TYPE E STOKERS

Are establishing records for
successful operation



Burn Low Grade Coals
Easy to install
Economical in Operation
Capable of High Capacity
Simple to Operate

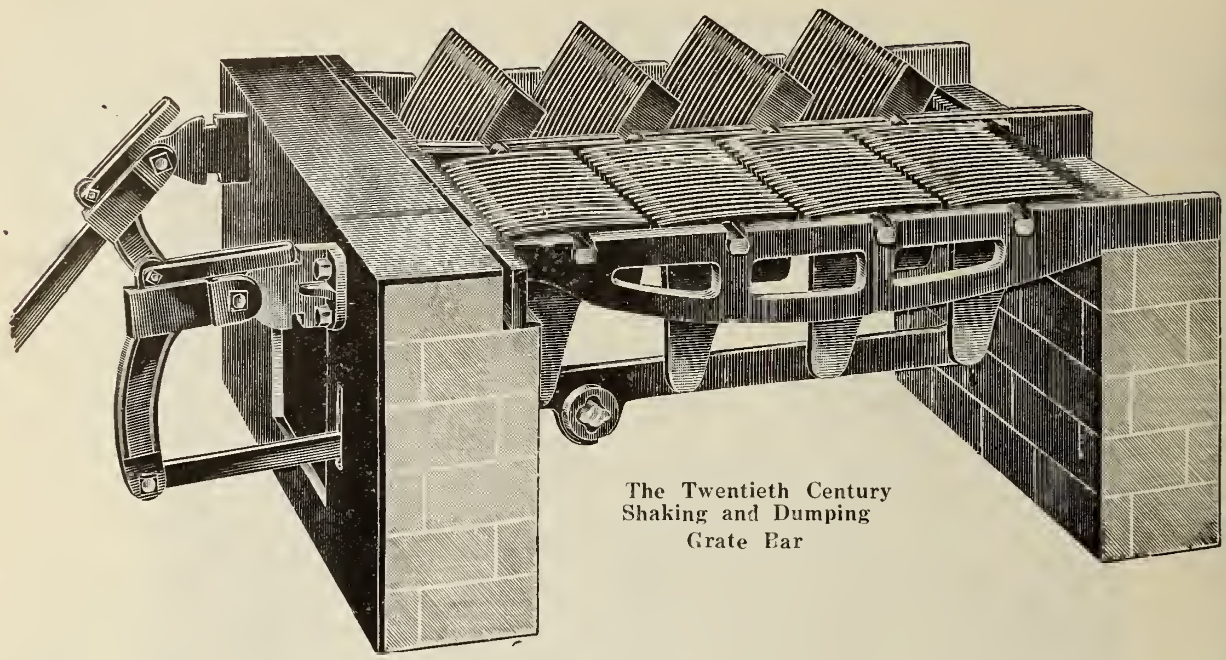
Let us give you detailed information

COMBUSTION ENGINEERING CORPORATION
LIMITED

A. J. T. Taylor, President John T. Farmer, Chief Engineer

MAIN OFFICE : TORONTO
VANCOUVER MONTREAL WINNIPEG

A Saving of 2½ to 5% Over Any Other Shaking and Dumping Grate Bar—or a minimum of 10% Over Any Stationary Grate



The Twentieth Century
Shaking and Dumping
Grate Bar

Grate Surface—Properly Proportioned

—that is, the proper proportioning of grate bar surface to the load or average demand—is one of the chief factors in bringing about maximum combustion efficiency. Without proper combustion, it follows, of course, that you are wasting fuel.

THE TWENTIETH CENTURY
Shaking and Dumping
GRATE BAR

ensures maximum combustion because it is specifically constructed for that purpose. We stand behind it, moreover, with our personal guarantee that it will save from 2½ to 5 per cent. more fuel than any other grate bar on the market.

Let us estimate on your requirements—no obligation whatever

OUR 35 YEARS' EXPERIENCE
In the Construction and Repair of Boilers and Grate Bars
AT YOUR SERVICE

Our long experience in the proper proportioning of grate bar surface and general boiler and furnace repair work means that we can take hold of any job, complete it quickly and do it right at a minimum cost.

We offer you personal, expert service in the construction and repair of boilers and grate bars.

Emergency repair work, night, day or week-ends, is our specialty.

BOILER REPAIR AND GRATE BAR CO.

84 Church Street - - Toronto

Detroit V-Type Stokers for Efficient and Economical Boiler Operation

Frankford Arsenal. U. S. Government War Department. Ten Stirling Boilers Fired by Detroit Natural Draft Stokers. 3000 Horsepower

You profit in many ways by the installation of Detroit Natural Draft Stokers.

First, You can use lower grades of fuel with Detroit Stokers than can be burned successfully by hand firing. Under favorable conditions these savings may run from a dollar to a dollar and a half a ton.

Second, You can save labor if you have a number of boilers. One man can tend a very much greater horse-power of stoker-fired boilers than hand-fired.

Third, You secure high over-all boiler efficiencies. Average hand-firing practice shows 55 to 60% boiler efficiency. The average boiler efficiency secured by users of Detroit V-Type Stoker is 70 to 75%.

The United States Government has found Detroit Natural Draft Stokers to be satisfactory, efficient and economical. Over 14,000 boiler H.P. are served by Detroit V-Type Stokers in Government institutions such as:

St. Elizabeth's Hospital, Washington, D. C.	3600 H. P.
Federal Reserve Bank, Cleveland, Ohio	1200 H. P.
Edgewood Arsenal, Edgewood, Maryland	4000 H. P.
U. S. Marine Barracks, Paris Island, S. C.	1000 H. P.
Camp Perry Proving Grounds, Camp Perry, Ohio	1800 H. P.
U. S. Naval Hospital, Brooklyn, N. Y.	1330 H. P.

For economy's sake you should install Detroit Stokers under your boilers. Remember there is a machine for every purpose — V-Type Overfeed for natural draft — Single Retort Underfeed for forced draft with boilers up to 250 H. P.—Multiple Retort Underfeed for large boilers.

Send for your copy of the Detroit V-Type Stoker Bulletin No. 338. It is yours for the asking

DETROIT STOKER COMPANY

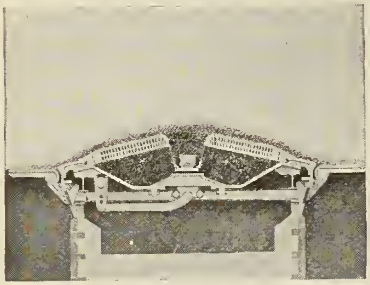
Underfeed Forced Draft and Overfeed Natural Draft Stokers

338 GENERAL MOTORS BUILDING DETROIT, MICHIGAN

SAVE FUEL "V" AND LABOR

DETROIT TYPE STOKER

It fulfills conditions met by no other stoker—



(Sectional View)

THE *"Lateral Retort"* Stoker should not be considered either as a substitute for, or an improvement on, the multiple retort type of stoker. It is rather a new type of multiple retort stoker—a type that makes multiple retort stoking possible in many plants that otherwise would be compelled to install an inferior type of stoker.

By embodying a multiple retort arrangement in a single stoker that follows the general design of simple side-cleaning stokers, a number of problems are solved in a remarkably simple way.

For instance, the necessity for basement ash pits is eliminated, since an excavation of 6 to 18 inches provides sufficient space for the two pits into which the ashes are discharged by the simple, side-dump plates. This greatly reduces installation cost and makes the *"Lateral Retort"* Stoker highly adaptable to old boilers in existing plants. Moreover, since the stoker is set very low, ample combustion space is insured when it is placed under low set boilers. Thus in many ways the *"Lateral Retort"* Stoker stands alone. It is the only side-cleaning stoker in which the coal is underfed throughout, giving the greater fuel economy and overload capacity of multiple retort stoking; and therefore it is the one moderate priced, economically installed stoker that in any way rivals the multiple retort type.

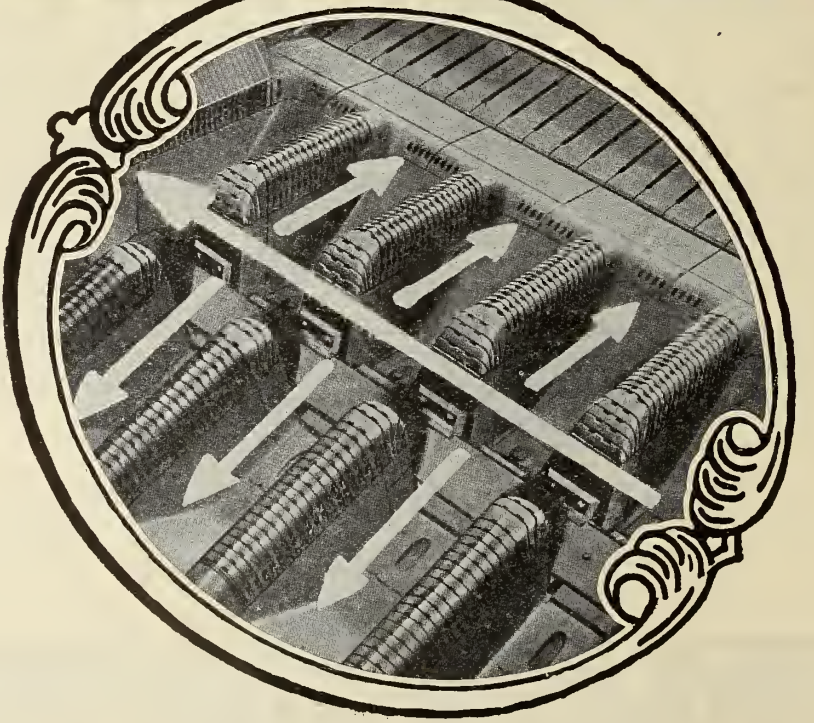
Conditions met by no other stoker. Are they your conditions? The catalog will help you decide.

The Under-Feed Stoker Co. of Canada, Limited
146 King Street, West, Toronto.

Sales agents for : Jones Stokers, Riley Stokers and Murphy Automatic Furnaces

Alta. & West. Sask.: Mr. J. Twomey, Camrose, Alberta.	Man. & East. Sask.: W. W. Hicks & Co., Winnipeg.	British Columbia: E. A. Earle, Ltd., Vancouver, B. C.	Quebec: The Cleaton Co., (Can.) Ltd., Montreal, Que.

RILEY JONES The UNDER-FEED STOKER COMPANY OF CANADA LTD. MURPHY

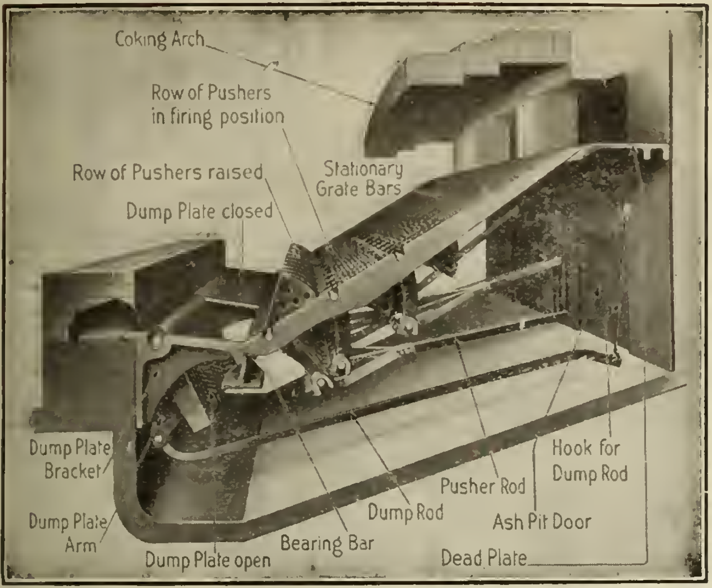


Multiple retort in everything but price.

The "Lateral Retort" Stoker

TRADE MARK

Big Savings with National Hand Fired Stoker



Get away from inefficient hand stoking—without going in for costly mechanical stokers—come in between with the National Hand Fired Stoker which any "green" furnace man can be quickly taught to understand. Pusher rods at front of furnace operate successive banks of Pusher Grates, keeping the fuel moving downward—finally to the Dump Grates. Ensures proper progressive combustion. Any type of fuel—even waste—can be used. No smoke. No fuel in combustion chamber. No ashes in flues. Increased boiler capacity can be demonstrated. Can be installed under your present boilers.

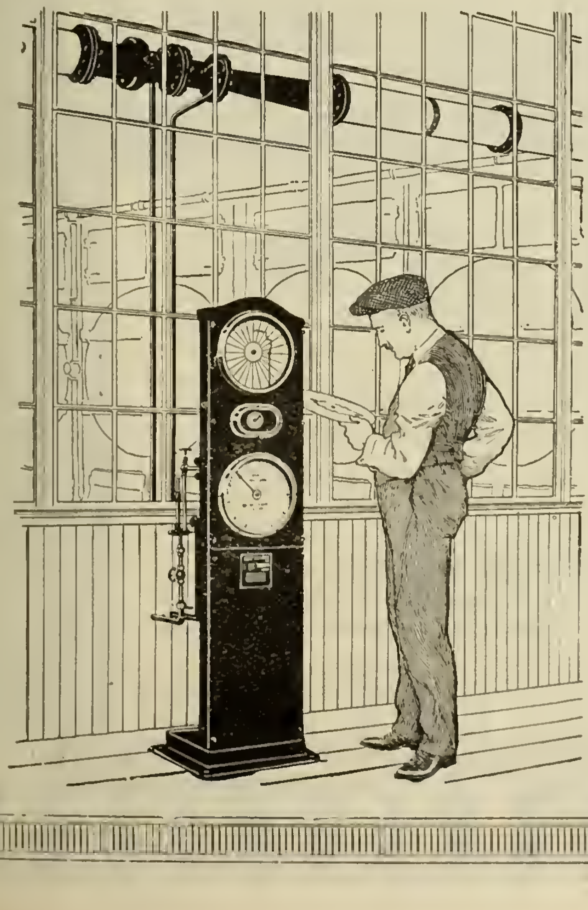
National Hand Fired Stokers are made here in St. Catharines and sold at a very moderate price

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

---



Constant Knowledge of Boiler Plant Results

The Chief Engineer who insists on maintained efficiency in his plant, must have proof of such a condition. For the story of his boiler plant, he has only to study the charts from the

VENTURI

Boiler Feed Meter

Over twenty years of service has proved the Venturi to be supreme for boiler feed measurement. It is accurate, durable and needs little attention; it gives the momentary rate, total flow and a 12 in. chart record of each 24 hour period. It has long been accepted as the standard meter for the boiler room.

Bulletins on request.

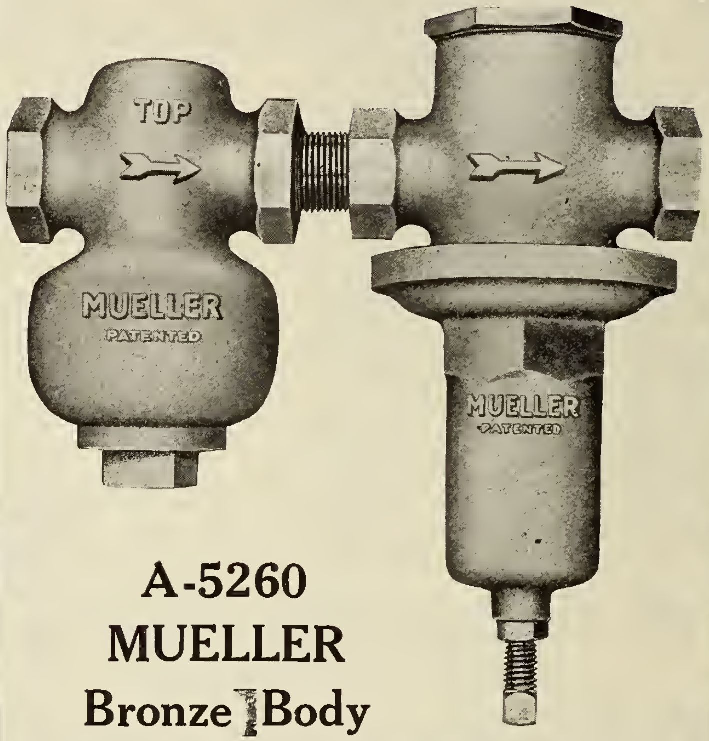
Builders Iron Foundry

Providence, R.I.

Canadian Representatives:

GENERAL SUPPLY CO. OF CANADA, Limited
Ottawa Montreal Winnipeg Vancouver

ALLEN GENERAL SUPPLIES, Limited
Toronto, Ontario



A-5260
MUELLER
Bronze Body
Reducing & Regulating Valve

Special sensitive, wear-resistant composition diaphragm to insure accuracy—full seat opening to pass a large volume of water—simple in construction to permit of easy access to working parts—made from MUELLER Bronze and therefore non-corrosive—these features combine to place this valve in a class by itself. And these are the points we bore in mind in designing this Regulator, since careful investigation proved them absolutely necessary to provide a satisfactory valve for the regulation of pressure on cold water lines.

This Valve will fill your requirements for cold water pressure regulation—let us know your problem.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Illinois, U. S. A. Branches, New York and San Francisco

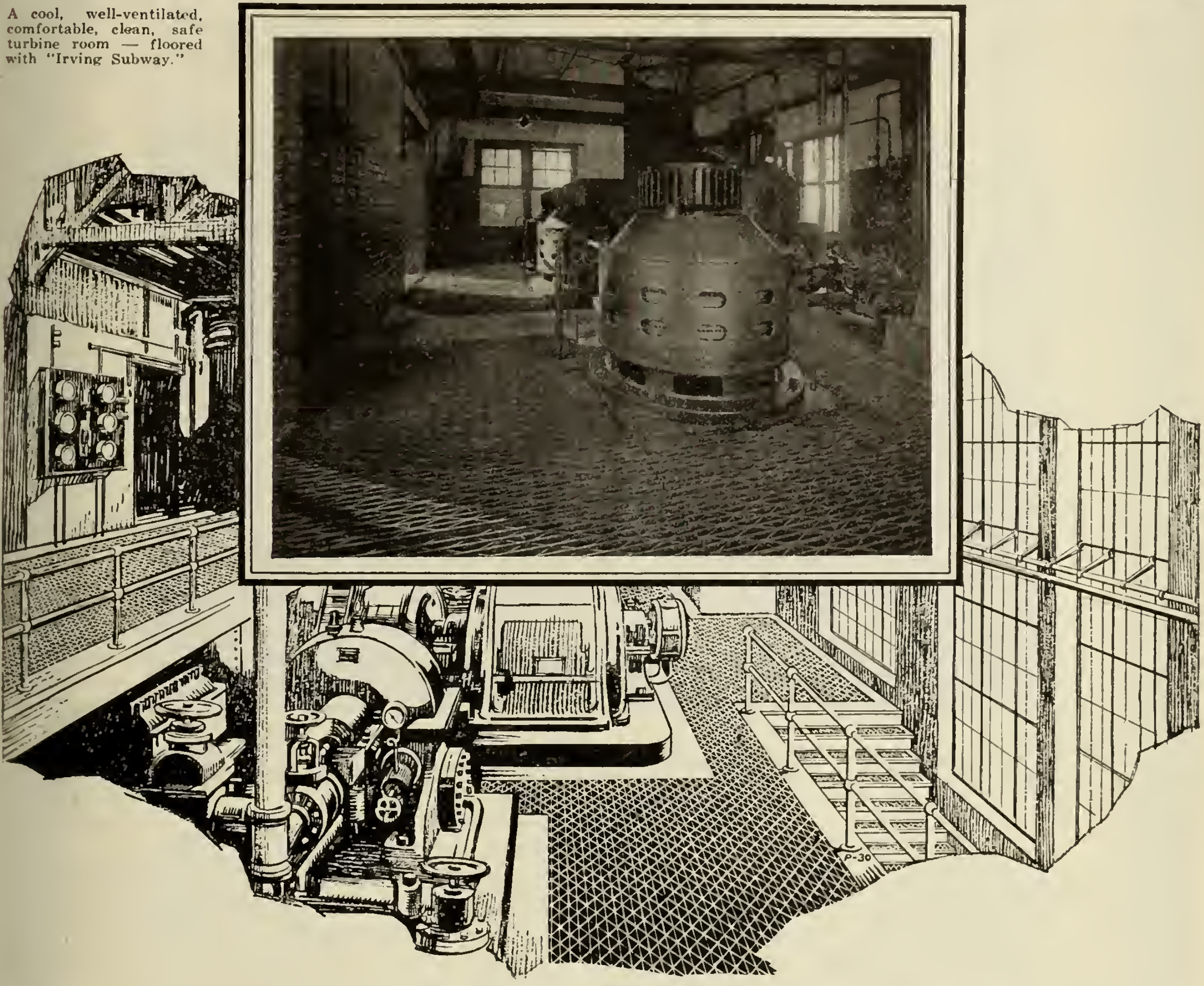
Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rods; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

TRADE MARK

IRVING SUBWAY

(PATENTED) REG. U.S. PAT. OFF.

THE FIREPROOF VENTILATING FLOORING


A cool, well-ventilated, comfortable, clean, safe turbine room — floored with "Irving Subway."

More and more, the character and quality of its floors are recognized as big factors in the efficiency of an industrial plant. And, more and more, the merits of "Irving Subway" are winning for it recognition as the ideal industrial flooring for the vast majority of industrial requirements. To every advantage of the best solid floor, it adds two exclusive advantages all its own—a permanently safe, non-slipping surface—and 80 per cent. open space for light and air.

"Irving Subway" is manufactured — not built — to rigid standards of quality and uniformity. Quantity production means low cost for high quality. The Irving plant — recently increased by the addition of two units — is the largest in the world producing open steel flooring. And Irving engineers have developed a new science — floor engineering — based upon a study of industrial floors as a factor in industrial efficiency. Let Irving engineers work with yours. Write for Catalog 3A50.

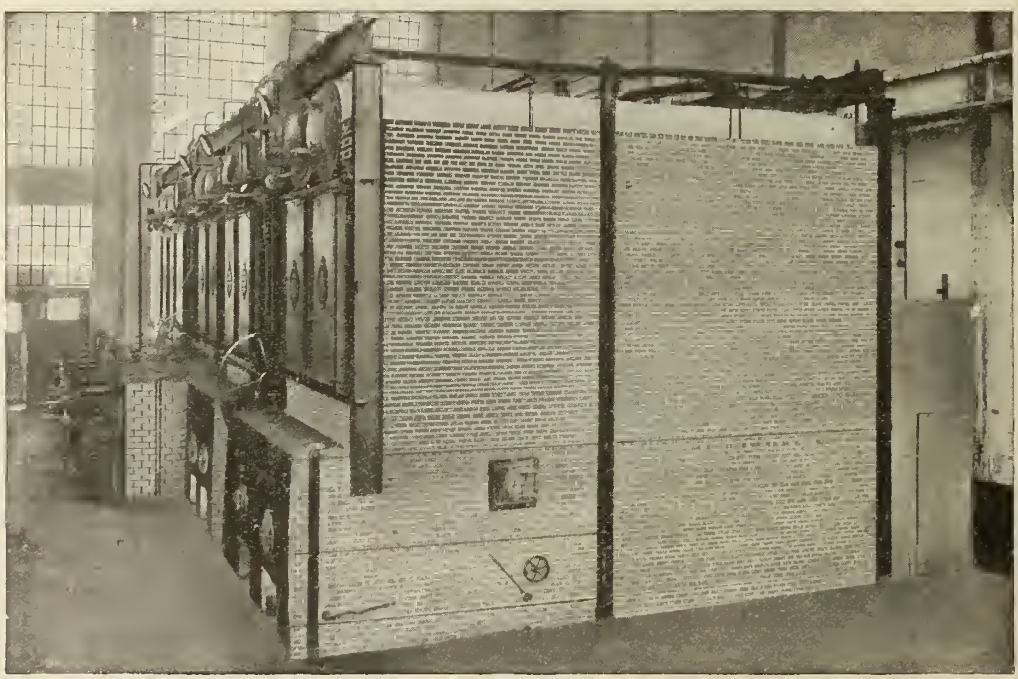
Canadian Agents:
Montreal, P.Q., 64 Decelles St. (St. Laurent). Winnipeg, Man., 141 Bannatyne Ave. Welland, Ont., Standard Steel Cons. Co.

IRVING IRON WORKS CO.

LONG ISLAND CITY, N.Y., U.S.A.

GOLDIE & McCULLOCH
Dependable Power Plant Equipment

Sectional Water Tube Boilers



Every Part Subjected to Steam Pressure is Made of Forged Steel

This important feature of the design and construction of G. & McC. Sectional Water Tube Boilers gives them a great advantage over all types of ordinary boilers. Other features include large steam and water drums and connecting nipples of increased size, thus providing greater combustion area and increased steaming capacity.

The installation shown consists of 5 Double Drum G. & McC. Co. Sectional Water Tube Boilers at the Power Plant of the Canadian Government Railways, St. Malo, Que.

Catalogs, Plans, Prices and Engineering advice for the asking.

THE GOLDIE & McCULLOCH CO.,
LIMITED.

Head Office and Works: GALT, ONTARIO, CANADA

Toronto Office: Suite 1101-2 Bank of Hamilton Bldg. **Western Branch:** 248 McDermott Ave., Winnipeg, Man. **British Columbia Agents:** Robert Hamilton & Co., Vancouver, B.C. **Quebec Agents:** Ross & Greig, 400 St. James St., Montreal, Que.

POWER HOUSE

ESTABLISHED 1907 *Toronto, April 20, 1923* A SEMI-MONTHLY NEWSPAPER

Profits Mechanical Stokers Pay Power Plants Daily

Smokeless Combustion From 1685 to 1923, Emphasizing the Dividends Stokers Return While Working Better Than Mere Man Ever Did With His Shovel

THE modern mechanical stoker is a substitute for the human stoker but its purpose is not merely to take the place of the man with the shovel but to effect a number of specific economies in the combustion of coal while doing the work better.

Among the economies, which are of such magnitude as to make the stoker an extremely profitable investment in power plants of any size, may be emphasized the following:

It operates without opening or shutting the furnace door.

It delivers just the small amount of fresh coal that may be properly added to the fire.

It makes additions of fresh fuel as the demand for steam dictates.

It prepares coal for addition to the fire.

It adds this prepared coal at just the right stage of preparation.

It separates, prior to burning, the volatile part from the coal and thus facilitates general combustion in the furnace.

We have had artificial combustion in the world from the earliest times for there is no period of history so remote that it can be cited as a time when men did not know how to build a fire. Somebody has in fact suggested that man might be defined as the cooking animal. Men know how to use fire; the beasts do not.

Combat Smoke Evil

Curiously enough however, only one of the decided advantages incident to the use of stokers has stood out as an actuating motive in their development through the ages and that is the desire to obtain smokeless combustion.

Complaints against the burning of coal are of very early origin indeed. Ten centuries ago in England smoke was supposed to be injurious to trade, health and complexion, and a host of other evils were attributed to its use.

In 1306 Edward 1 issued a proclamation forbidding the use of coal within a city or its neighborhood, and violators were punished by fine and the destruction of their furnaces. But as these penalties failed to end the "nuisance" a law was passed making the burning of coal a capital offense and permitting its use only in forges.

Cheaper power production is demanded to-day as never before, therefore it is very pertinent at this time to enquire into the efficiency, economy and operation of the mechanical stoker. The author of this article, in the capacity of engineer in charge of scores of installations has personally supervised the initial operation of stokers of different types and therefore it is reasonable to assume that the opinion he expresses of their value furnishes an adequate answer to the query.

When it is considered how lightly the violation of smoke regulations are regarded to-day it seems almost unbelievable that a man should have been executed at the command of King Edward for violating the royal edict.

The idea of feeding fuel to a fire so that the smoke and gases evolved passed through a bed of hot coals, is of very ancient origin for alongside the fireplace of the Athanor or constant furnace used by the alchemists in their laborious attempts to transmute base metals into gold, was a hollow chamber, containing charcoal and closed over by a tight lid. As the fire consumed the coal the charcoal descended and was replenished by it.

Exhibited in 1685

Delasme's base-burning furnace, exhibited by him at St. Germain in 1685, took the form of an inverted siphon, the shorter leg containing a grate and serving as the fire chamber, the longer leg acting as the chimney, the smoke forced through the incandescent fuel in this manner being more or less perfectly burned. The fire was kindled at the top and the chimney was heated by a lamp to create a draft.

In 1796 a William Thompson obtained a patent for consuming smoke by admitting a stream of air behind the bridge wall and four years later the Robertsons decided that it was necessary to admit air over the fire in order to burn the gases completely.

The next interesting development was made in 1816 by Gregsor who conceived the idea of using a multiplicity of bridge walls inside the furnace in order to baffle the gases and cause a more intimate mixture. The inventor later introduced air from the ashpit at the point where the two streams of gas joined. The combined gas flow was then made to pass through another bridge wall and out of the stack.

Patent Records Rich

Technical literature since 1850 is replete with descriptions of various forms of smokeless furnaces and the patent records, especially in the English patent office, are richer still in this particular field. This is undoubtedly due to the fact that it was in England attempts were first made to burn high volatile bituminous coals.

It is obviously difficult to trace all the factors contributing to the development of the stoker which is inseparably bound with the development of the boiler arch and the increase in knowledge of the generation and transmission of heat which naturally led to a better appreciation of the essentials of furnace design and combustion space for various fuels.

In Canada to-day no doubt can exist of the great success of the mechanical stoker of which there are a large number of makes on the market, differing in detail but practically confined to three well known types.

These are the overfeed, the underfeed and the chain grate stokers.

For units of less than 200 h.p. there has also been developed a variety of what might be termed the semi-automatic type, including the sprinkling or throwing types and those equipped with movable bars for shaking the fire bed and in some cases dumping the clinkers and ashes, operated by means of levers worked by the firemen.

Hand Stoking Costly

The great objection to hand stoking, even supposing the fireman is a master of the art is the necessity of continually opening the fire doors and keeping them open while fuel is being fed to the furnace.

The doors have to be opened up to lift the fire from the bars and prevent the formation of clinkers and after the lifting has been done the fuel has to be raked over the top to preserve its even thickness.

Naturally every time these operations are performed cold air rushes into the furnace with an accompanying loss of heat and fuel.

This cleaning of fires is one of the hardest things that a fireman has to contend with and is at best a long process attended with inconvenience and loss. and often, in a hard-pushed plant, with a considerable drop in stream pressure.

A further drawback to handfiring is the necessary limitation in the length of the grates, for a man cannot handle a fire which is more than 5½ ft. long, especially when cleaning time comes.

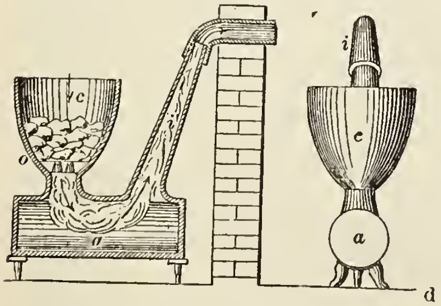
Ends Disadvantages

With mechanical stokers all these disadvantages are removed and a means is provided by which coal can be fed at any required rate, and with the help of forced draft, burned at high rates per square foot of grate surface per hour with much higher efficiency than is possible under any hand conditions.

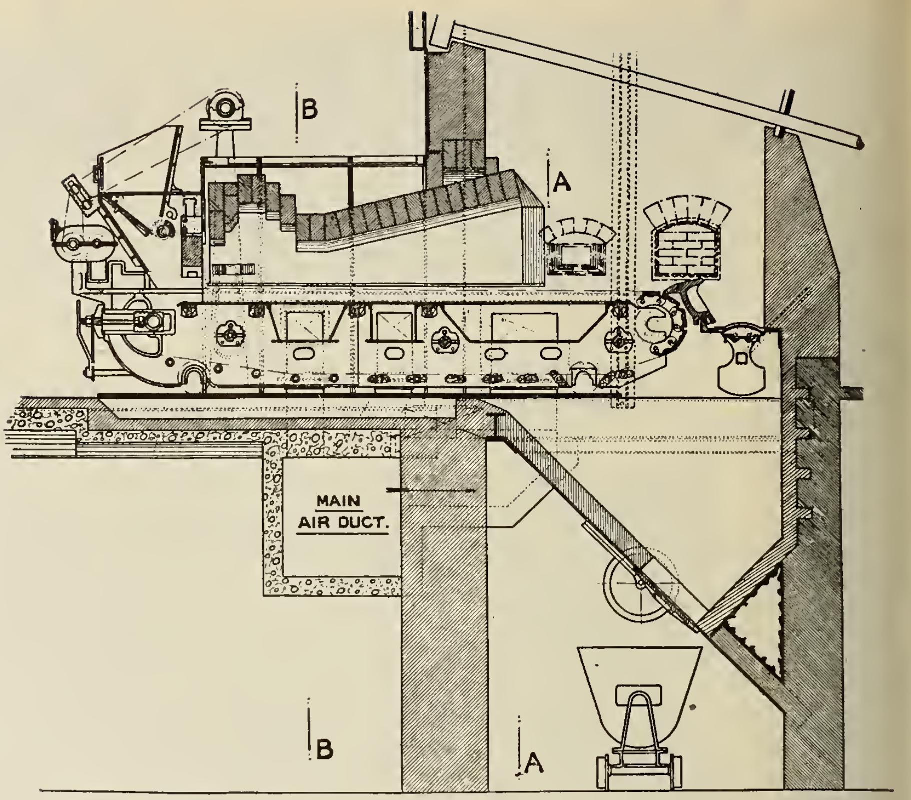
The question of whether to use mechanical stokers of the semi-automatic type can be settled at once by the size of the boiler installation and the characteristics of the load and the type of mechanical stoker selected should be governed by the kind of fuel available and the rating to be developed by the boiler.

Overfeed Stoker Type

Stokers of the overfeed type are of two general classes, the side feed double-inclined or V-type, and the front-feed or single-inclined stoker. The early development of these stokers was along natural-draft lines, because that was the draft available and because it was possible to readily burn all the coal required to meet load conditions.



Base Burning Furnace 1685.



Longitudinal Section Compartment—Type Balanced Draught Chain Grate Stoker.

The double-inclined side-feed stoker was the first to make its appearance on the American continent, Thomas Murphy fathering this particular line of development, commencing about 1875. His first attempt, which was hand-operated, was placed in the firebox of a marine boiler and had inclined grates, every second grate being movable. It was provided with a revolving toothed cylinder or clinker grinder extending from front to rear along the bottom of the V, for the removal of clinker and ash.

Grate Sizes Vary

These stokers to-day are made in various sizes, both as to width and depth, varying from a stoker with a grate surface 4 ft. wide and 3 ft. deep to one having a grate 12 ft. wide and 9 ft. deep.

In the large stokers 1 sq. ft. of projected grate is provided for each 6¼ rated horsepower of the boiler, and in the smaller stokers 1 sq. ft. for about each 5 rated horsepower. Where the stokers are set with a Dutch oven they extend in front of the boiler about the depth of the grate surface of the stoker, this being varied to suit local conditions and the details of the boiler. The overall width of the stoker is roughly the width of the boiler setting.

The head room required will vary with the width of the stoker. The boiler should be set sufficiently high so that the front header or the sill of the tube-door opening clears the top of the arch about 3 in. Where vertical water-tube boilers are used, it is advisable to place a combustion space between the rear of the stoker and the tube surface of the boiler. This can be made of somewhat greater cross-section than that of the stoker. The distance from the rear end of the grate surface to the tube surface should be 6 or 7 ft.

Find Engine Best

Stokers of this class are usually driven by a small steam engine operating the reciprocating bar through a chain of gearing. Where for any reason it is desirable to do so, a motor, either a.c. or d.c., can be used in place of the engine. An engine is preferable to a motor, however, as the exhaust steam which it supplies is useful under the clinker grinder.

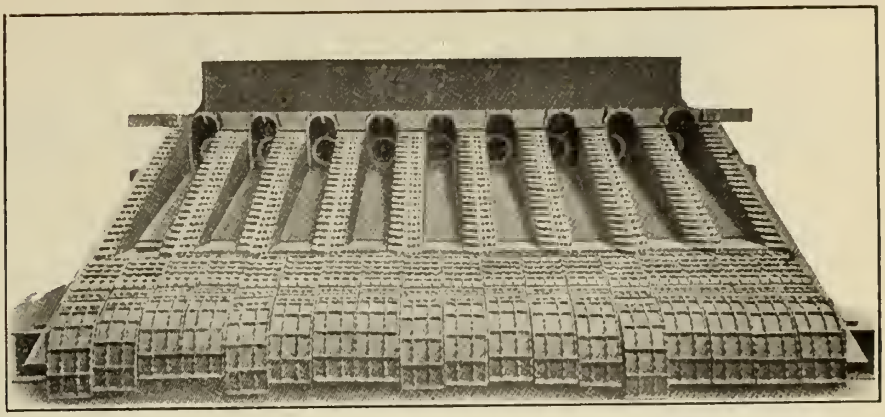
As far as recent developments show, the most convenient and effective means of chilling clinker so that it can be readily handled is by means of low-pressure steam discharged under both the clinker grinder and the lower ends of the grates.

It is desirable that the fuel be fed as uniformly as possible to the stoker. The fuel bed is about 8 to 10 in. thick at the upper end of the grates, thinning down gradually toward the clinker grinder. Minor fluctuations in load should be taken care of by minor variations in the draft over the fire. Where the load changes into a decidedly higher or lower range, the coal feed should be increased or diminished to meet this range, the draft over the fire being regulated to take care of the immediate needs of the boiler.

Draft Loss Varies

The draft loss through the fuel bed will vary with the amount and kind of coal being burned, the high-volatile coals requiring less draft than the lower-volatile coals. The amount of draft required is also affected by the amount and kind of ash which the coal carries.

Where the proper draft is provided, stokers of this class will take care of various loads readily up to 125 or 150 per cent. of boiler rating, although the draft conditions and the grate area are the governing factors in the matter of ratings. Where there is a shortage of draft it is possible to compensate for this in part by increasing the amount of "rousting" or hand manipulation of the fuel bed.

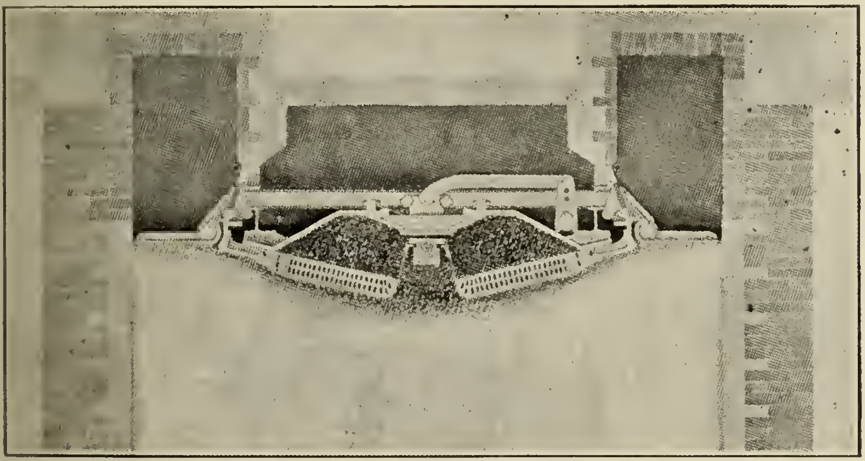


Nine-Retort Self-Dumping Underfeed Stoker.

Add Forced Draft

Where it is desired to obtain more capacity than can be obtained with the natural draft available, it is sometimes possible to do this by adding forced draft. Where forced draft is applied to a stoker of this class, it is advisable to see that all the necessary items for its proper installation are taken care of.

The air should be admitted to the space beneath the grates, either at the front or the rear, in a line parallel with the clinker grinder; two inlets being used, placed symmetrically with reference to the center line of the stoker. Instances have been found where a blower has been placed through each side sheet, discharging air directly against the grates, and troubles have quickly resulted from such practice. Under natural-draft conditions the amount of air reaching the furnace through the openings in the arch plates increases as the capacity increases, and provision should be made so that this same condition holds good under forced-draft conditions.



Multiple Retort Underfeed Side Cleaning Stoker.

Prominent Manufacturers

Among prominent manufacturers of this type of stoker are: The Underfeed Stoker Co., of Canada, "Murphy," York Bldg., Toronto, Ont.; Detroit Stoker Co., "Detroit," 7340 Woodward Ave., Detroit. Mich.; Canada Stoker Co., "Sprinkler," 2 Gould St., Toronto, Ont.; Automatic Furnace Co., Dayton, O.; Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.

Underfeed Stoker Type

Underfeed stokers are so designed that coal is fed from beneath the burning fuel. This is accomplished by feeding through retorts with adjustments so that the fuel bed is replenished throughout the length of the retort.

The main feed from the coal hopper is accomplished with rams of fixed displacement so that the amount of fuel fed per hour is accurately controlled by regulating the speed at which the rams are operated.

The first development of this type was the single-retort underfeed stoker. This consists essentially of a horizontal retort, into which fuel is fed from the hopper and distributed throughout the length of the retort. Tuyeres are placed around the edge of the retort and through these air is supplied to the fuel under pressure from a fan. Dead plates or dump plates are placed on each side of the retort, from which the ash and refuse are removed.

For wider furnaces, intermediate inclined movable grates or tuyeres are placed between the retorts and the dump plate. These serve the purpose of providing more grate surface and also of depositing the ash and refuse on the dump plate.

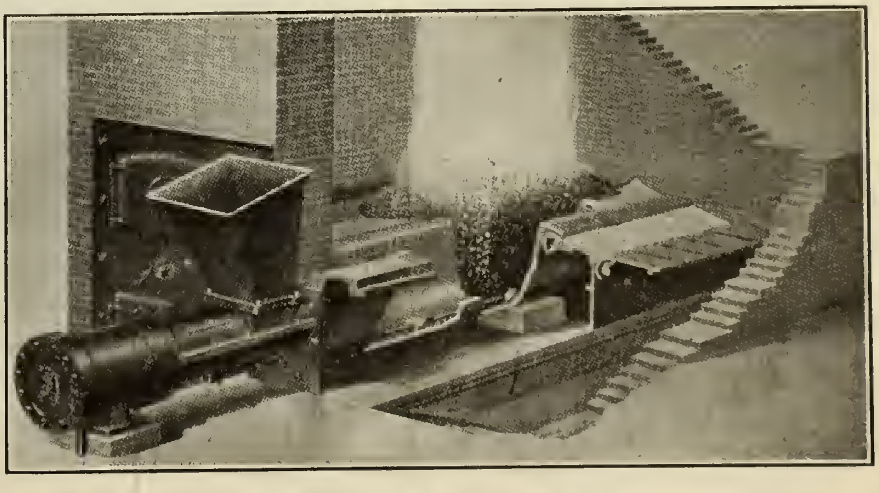
Single-retort underfeed stokers do not require large ashpits and ash tunnels below the boiler-room floor. They are cleaned of ash and refuse by dumping into shallow ashpits which are depressed slightly below the floor line, and withdrawing the ash and refuse through doors in the boiler front at floor level or by withdrawing the ash from the dead plates in the boiler front.

Eliminate Excavation

These stokers are also particularly adaptable to installations in which more than two boilers are placed in a battery, since side doors are not necessary to their operation. Boiler plants may then secure the advantages of the underfeed type of stoker without the expense of excavation and without being limited as regards arrangement of boilers.

Multiple-Retort Stokers

The multiple-retort stoker is a devel-



A Side-Dump Type of Underfeed Stoker.

Chronological History of Stokers, 1819-1923

Traveling and Chain-Grate Stokers.

This Chronological History shows that traveling-grate stokers were introduced earlier than any other type.

1819—Brunton developed a traveling grate which is said to have been the first mechanical stoker brought out in England; it was a circular grate traveling on a vertical spindle.

1834 In the Badmer stoker the grate traveled from the front to the back of the furnace; it was probably the first of its type built.

1841—Jukes may be said to have been the original inventor of the traveling chain grate.

1871—R. F. Weller was the first to manufacture a traveling-grate stoker in America.

1893—Being impressed with the mountains of fine coal that were being dumped along the sides of the mines as a waste product, E. B. Coxe brought out a chain-grate stoker especially designed to burn the small sizes of anthracite, and probably was the first one to use forced draft under a chain-grate stoker. This stoker has been greatly improved upon very considerably and is now manufactured by the Combustion Engineering Corporation. Mr. Coxe can be considered the father of the chain-grate stoker. His two 1893 patents covered not only the design, but also the process of the forced draft and the zoning of the air in multiple air boxes.

1898—The Green Engineering Co. put the Green Chain Grate stoker on the market originally to burn the Illinois and Middle-West coals, but it is today also burning lignite coals successfully. The company has also developed a forced-draft chain grate.

1898-1904—During this period the Playford chain-grate stoker was brought out by the Rosedale Foundry & Machine Company.

1904-1906—Patents were taken out by the Babcock & Wilcox Co. on chain grates, and they put on the market a chain-grate stoker for use with their own boiler only. Their latest development is a forced-draft chain-grate stoker for general use.

1910—About this time the Westinghouse Electric & Manufacturing Co. brought out their chain-grate stoker.

1910—In this year The Illinois Stoker Co. first brought out the Illinois chain grate for natural draft, and later their forced-draft chain grate.

1911—Girtanner, of the Laclede-Christy Clay Products Co., filed applications for patents, which were subsequently granted, and this company is now manufacturing the Laclede-Christy chain grate.

1919—Harrington brought out his forced-draft stoker for burning anthracite, coke breeze, and Western coals, zoning his air in multiple air boxes.

1919—L. R. Stowe brought out a new type of stoker, consisting of alternating traveling grates and stationary tuyeres inclined toward the bridge-wall at an angle of 20 deg. This stoker is manufactured and marketed by the Laclede-Christy Clay Products Company.

Underfeed Single-Retort Stokers.

1838—Jukes patented a stoker in which the coal was thrown into the hopper and dropped down in front of the ram. By means of a hand screw the coal was fed in under the center of the grates beneath the burning fuel above it.

1844—Frisbie brought out and patented a stoker in which the fuel was fed from under the grates through a center opening.

1889—Evan William Jones invented and brought out the first underfeed stoker that proved successful, and he can be considered the originator of the underfeed principle, as he carried it forward to a success.

The paper mills in Oregon at that time were using green wood for fuel, difficult though it was to burn, owing to the moisture it contained. Jones, who at that time was president of the Union Iron Works at Portland, Oregon, was engaged to find some means to dry this fuel economically. The result of his study of the subject was a device for feeding sticks of green wood, in cordwood lengths, under a bed of burning fuel. The heat from the fire above dried the wood below, and as successive lengths of wood were fed under, the dry wood was advanced upward into the fire zone.

The success of this stoker led Jones to apply the same principle to burning coal. The grates were replaced by a retort, having dead plates on each side, from which ashes and refuse were cleaned. Tuyeres were placed along the edge of the retort, through which air was supplied to the fuel under pressure from a fan. This is the stoker manufactured by the Under-Feed Stoker Company.

1898—In this year W. R. Wood took out a patent on a stoker with a screw feed in place of the steam ram employed by Jones. This was known then as the American stoker. From 1901 to 1906 and 1907, Wood took out other patents on rocking bars in place of dead plates, and on side dumps. Later on he adopted the steam ram in place of the screw feed, and the final development of his original patents is the Type E stoker, manufactured by the Combustion Engineering Corporation.

1916—The Roach Stoker Co. entered the market with a patented stoker of similar design to the Type E, both of them using the steam cylinder for pushing in the fuel, as in the early Jones stokers.

1916—In this year the Moloch Stoker Co. brought out a device which was similar in design to the Standard Jones stoker, but instead of using dead plates, a clinker grinder was placed between the retorts.

1917—The Under-Feed Stoker Co. converted its standard stoker into a side-dump type, still maintaining the original principles of the former, however.

1917—The Detroit Stoker Co. brought out a stoker on the principle of the Jones, using a mechanical drive in place of the steam cylinder and substituting side dumps for the stationary dead plates.

Underfeed Multiple-Retort Stokers

1876—The Smith stoker was probably the first underfeed stoker to be used commercially and advertised. It, however, soon went out of use.

1903—E. E. Taylor, seeing the opportunity and the field for stokers of greater capacity, conceived the idea of the multiple-retort stoker. The first stokers of this type were manufactured by the American Windlass Co., of Providence, R. I., which company later reorganized under the name of the American Engineering Co.

Taylor's first patent was taken out late in 1904 and his stoker embodied the fundamental principle of a continuous fuel bed supported by legs of coal in multiple underfeed retorts. The patent claims also cover an inclined fuel bed, with the delivery of ash to the rear of the stoker, and the method of air distribution employed. Taylor was the first to use the crank drive.

1911—R. Sanford Riley made application for his patent, and subsequently started manufacturing and marketing the stoker that bears his name, the distinctive features being the moving sides of retorts and tuyeres.

1912—The multiple-retort stoker brought out by the Westinghouse Electric and Manufacturing Co. in this year was similar in design to the Taylor stoker, the difference being mainly in the angle of the ram, the bottom of the retorts, and the design of the tuyeres. Their stoker is driven mechanically.

1916—The Under-Feed Stoker Company brought out a multiple-retort steam-driven Jones A. C. stoker using the general design and principles of their standard single-retort stoker and avoiding all moving parts in the furnace.

1919—Detroit Stoker Company brought out a multiple-retort stoker in this year, which is similar inside the furnace to the Jones A-C, except that the retorts are laid flat instead of being at a slight angle; the rams, however, are driven by a specially designed mechanical drive instead of by a steam cylinder.

1919—The Frederick stoker is very similar in design to the Westinghouse, Taylor, and Riley stokers, and is now manufactured by the Combustion Engineering Corporation.

Underfeed Lateral-Retort Stokers

1918—H. E. Kleffel was granted a patent embodying the idea of a lateral retort.

1919—Blackburn and Armstrong stoker consists of a central retort placed longitudinally through the center of the furnace and feeding coal to lateral retorts branching out at right angles. The design is novel, and the stoker is manufactured by the Under-Feed Stoker Company.

Overfeed Inclined-Grate Stokers

1867—Vicars stoker is still manufactured in an improved form in England, but the points that are most interesting about it are that not only were inclined grates used, but the coal was fed by a plunger or ram, this being practically the first stoker in which that was done.

1878—Thomas Murphy brought out in this year his inclined-grate stoker of the inverted or V-shaped type. The grate bars have a reciprocating motion, and the ash is gradually worked down from the center of a clinker grinder. Mr. Murphy was undoubtedly the first to employ a clinker grinder with mechanical stokers, using in some cases one breaker and in others two breakers working together. These stokers are manufactured by the Murphy Iron Works, of Detroit, which is probably the oldest stoker concern in the country still manufacturing stokers having the same basic principle as those they first built.

1885—William R. Roney. Roney brought out the front inclined-grate stoker and was the first one to make a distinct success with this type in this country. It is manufactured and sold by the Westinghouse Electric & Manufacturing Company.

1890—Wilkinson Stoker is a front inclined stoker, but varies from some of the others in that steam jets are used to draw air through hollow grate bars. It was designed originally for burning small sizes of anthracite.

1897—Detroit Stoker Company took out patents on the Detroit V-type stoker, similar in design to the Murphy stoker, the clinker crusher being composed of rotating disk.

1904—The Wetzel stoker is a front-inclined overfeed stoker that operates on natural draft and has movable and stationary grate bars.

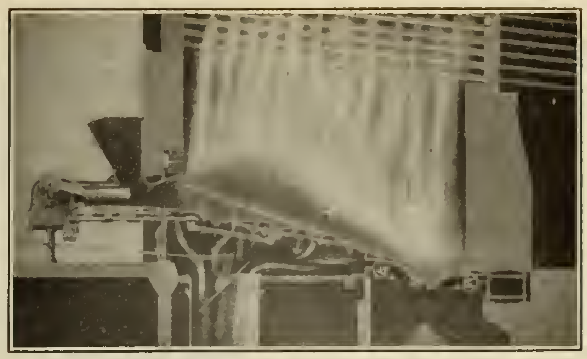
opment of the single-retort and consists of a number of single retorts placed close together and inclined with the ash discharge at the rear. As the coal is burned the ash is formed on top of the fuel bed and is floated to the rear and deposited on dump plates or into crusher pits from which it is readily removed. The continuous ash discharge consists of rotary toothed crushers placed at the rear of the stoker and set low so that a large, deep pit is formed for receiving the ash and burning out the last of the combustible material.

The secondary coal feed, that is, the feed from the retort to the fuel bed, is obtained in various ways. The Taylor stoker uses additional rams similar to the coal-feeding ram, which are placed in the bottom of the retort. The retort inclination is such that the rams are reciprocated horizontally. The Westinghouse and the Frederick stokers have a lesser inclination, and the secondary coal feeding is accomplished by large wedge-shaped castings placed at the bottom of the retort. These are reciprocated on an inclination corresponding to the slope of the bottom of the retort.

Have Similar Retorts

The Jones and Detroit stokers have similarly shaped retorts, and the secondary coal feed is obtained by small wedge-shaped pushers which are reciprocated horizontally in the bottom of the retort. The Riley stokers accomplish the secondary feeding by reciprocating the retort sides and the tuyeres. They also vary in the angle at which the tuyeres are placed—from horizontal in the case of the Detroit to 25 deg. in the Taylor stoker.

Tuyeres are placed between the retorts. and serve to convert the static head of air into velocity and direct the flow of air through the fuel bed. The tuyere designs naturally are different in each stoker.



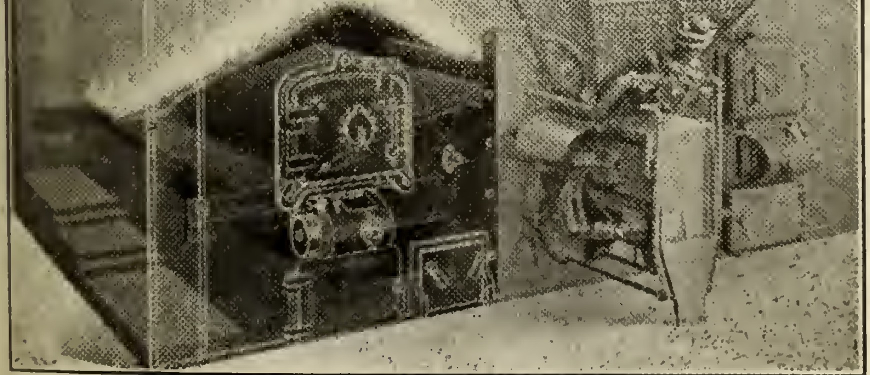
Multiple Retort Underfeed Type.

All designs are for forced draft and cannot be operated at any appreciable capacity with natural draft. The air for combustion is circulated beneath the furnace parts and thereby cools these parts before being discharged through the fuel bed.

In the operation of front and side-feed types of inclined overfeed stokers it is claimed that 150 per cent. of boiler rating can be obtained with 0.3 in. to 0.5 in. draft loss through the fuel bed, and that when forced draft is applied, it should be done with proper regard to air circulation and the maintenance of suction above the fire.

The operation of underfeed stokers is essentially as follows. The incandescent burning fuel is on top and is replenished throughout the entire retort length from beneath. As the coal emerges from the retort it is coked and spreads over the tuyeres, forming a homogeneous fuel bed across the entire furnace width. As the fuel approaches the surface the volatile matter is completely distilled off and the fuel completely coked. The surface consists of a layer of incandescent burning coke.

The air for combustion is introduced near the point where the fuel emerges from the retort. As the volatile gases are liberated they are thoroughly mixed with air. As the mixture passes up through the fuel bed, higher-temperature zones are reached and complete combusion of the volatile gases takes place when they pass through the white-hot coke at the surface.



Underfeed Single Retort Type of Stoker.

Smokeless Combustion

Smokeless combustion is obtained without the use of special mixing of ignition arches or special brickwork construction. As the fuel bed is replenished from beneath the surface, the burning incandescent coke which is on top is slowly moved toward the dump plates. As the ash is formed it is floated on the surface and is eventually deposited on the dump plates.

The control of the fuel bed is obtained by adjustments of the secondary coal-feeding arrangement. For good operation it is essential that the fuel bed be so controlled that the replenishing coal emerges from the retort through its entire length; the lesser amount being fed from the rear end of the retort.

With low-grade coals more fuel must be discharged from the rear end of the retort than with high-grade fuels. In general, the greater the quantity of ash in the coal, the longer should be the stroke of the secondary fuel-feeding mechanism.

With the underfeed stoker properly adjusted, fresh fuel will be fed up throughout the full length of the retort. Green fuel moving upward with respect to the tuyeres tends to keep them buried, and consequently the ironwork is in the comparatively cool zone of the fuel bed. For this reason maintenance is low on underfeed stokers.

Among prominent manufacturers of this type of stoker are: Underfeed Stoker Co. of Canada, "Jones Lateral Retort," "Jones A. C.," and "Sanford Riley," York Bldg., Toronto, Ont., Maclean Underfeed Stoker Co., "Maclean" 95-97 King St. W., Toronto; Taylor Stoker Co: "Taylor," 416 Philips Place, Montreal, Que.; Combustion Engineering Corporation, "Type E", "Type K" and "New Frederick" 1107 Bank of Hamilton Bldg., Toronto, Ont.; Detroit Stoker Co., "Detroit," 7340 Woodward Ave., Detroit, Mich., Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Chain Grate Stoker Type

The chain grate type of stoker was first developed to burn high-volatile free-burning, high-ash, clinkering coals.

The development of this type has been gradual but definite, and has involved the successful burning of many coals having far different characteristics. All successes, however, have been dependent upon the application of the principles of progressive combustion.

Coal burning in any practical process involves some losses: a total conversion of the heat in coal into heat in steam is impossible. Costs of operation must also be considered. These facts determine that every combustion process must finally operate with a common-sense balance between the three important factors in steam-generation economy namely, maintenance, efficiency, and capacity.

Maintenance and Efficiency

Maintenance and reliability are closely related. The chain grate, with two-thirds of the grate surface out of the furnace and with a simple driving mechanism, was low in maintenance costs. In the earlier designs, however, some of the parts were exposed both to heat and wear. Parts necessarily exposed to wear or strain often did not have sufficient resistance.

The chain, which is the fuel-carrying part, is now subjected to but slight heating as a result of adequate ventilation. Stoker frames are not subject to wear and are not exposed to heat. When exposed to heat or wear, replaceable parts are provided.

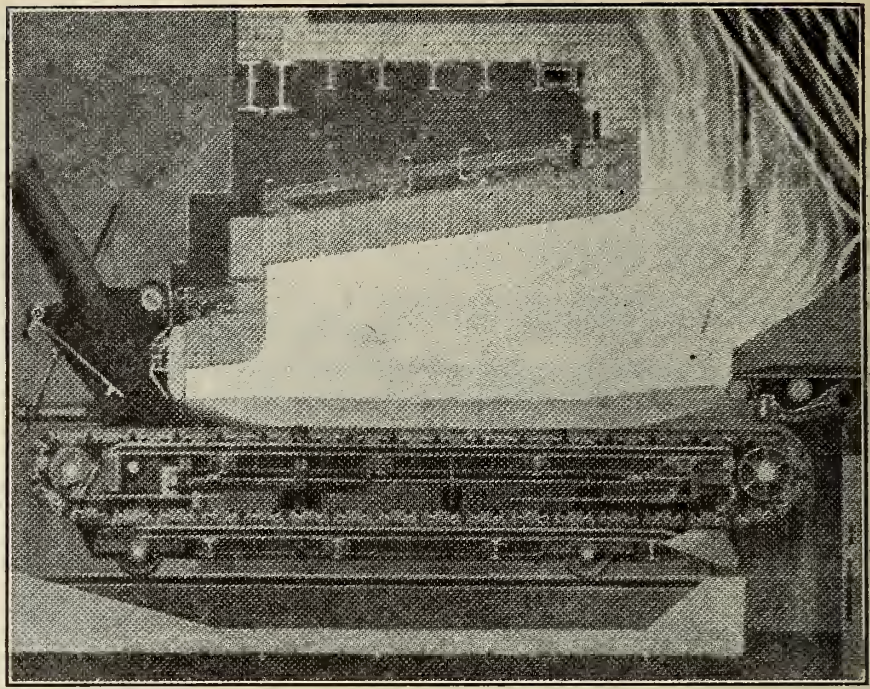
Improvements in Design

A grate surface moving through a furnace presents the problem of air seals along the sides of the stoker and at the rear. The reduction of air leakages at these places has contributed materially to modern economy.

Ledge plates or seals along the sides of the stoker have reached a high stage of development, resulting in the modern adjustable ledge plates for making a proper rubbing seal with the stoker chain, and including means for adjustment to keep this seal intact.

Meet Fuel Changes

The development in certain types of this stoker, of the ledge-plate flange adjustable against the side of the upper chain made it possible to raise and lower the stoker to vary the discharge opening under the water back in order to meet broad changes in fuel conditions. The improved results thus obtained indicated the desirability of a water back adjustable as to the height, and several designs were developed. These were for the most part difficult to construct or to maintain. From such designs the modern fuel retarder was developed. This is an adjustable member in connection with a fixed water back and bridge wall.



Another Type of Chain Grate Stoker.

The forced-blast chain-grate stoker is particularly adapted to the use of free-burning coals that require agitation of the fuel bed to break the crusting or caking action so often encountered with the slower-burning coking coals.

Obtain Good Results

With free-burning coals, which usually run high in sulphur and have ash with a low fusing point, results are being obtained, with uninterrupted operation, that equal the results obtained with other types of stokers using the low-volatile high-carbon coals.

With the underfeed type of stoker ability to control the draft over the fire is an important economical factor, obviating infiltration of cold air and maintaining good furnace temperatures. This in combination with the rate at which coal can be burned, ensures excellent efficiencies at maximum ratings. Latest designs allow of complete control over the width of the fire, which ensures a minimum of combustible in the refuse and the absence of sifting obviates waste.

Extreme width or depth of furnace are no impediments to modern underfeed design. Actual operations with all types of domestic and foreign coals has proven the success of this type of stoker.

Maintenance costs, with reasonable care in operation, should not, it is claimed, exceed 2c per ton of coal burned.

When burning buckwheat or coke breeze, fires 3 to 6 in. in thickness are carried on the grate and sufficient blast is carried in the first and second blast compartments to cause a gentle boiling or dancing of the fuel bed. Care must be taken, however, to regulate the thickness of fire and the blast so that excess carbon monoxide is not produced and continued combustion carried through the boiler to the chimney.

The forced-blast chain grate may be operated at continuous high overload capacities for days at a time with only slight variations in steam output of the boiler. This operation is made possible by the uniform thickness of the fuel bed, the uniform blast pressures carried, and the uninterrupted disposal of ash and refuse from the grate. A stoker, such as the "B & W" compartment type may be operated efficiently under natural draft when burning as little as 10 lb. per hour. Forced-draft combustion ratings reach 55 to 60 lb. of coal per sq. ft. of grate per hour.

Simple to Operate

Similarly to high duty underfeed stokers the forced-blast chain grate is simple to operate and flexible in handling varying load conditions. If properly handled it can be brought from banked fires to full load in time to meet any ordinary power-plant requirements. A cold boiler can be put on the line in 45 min. from the time of lighting the fires. The boilers can be operating at 150 per cent. of rating in 5 min. from the time it goes on the line, or it can be operating at 200 per cent. of rating in 7 min.

Automatic control has been successfully applied to both natural and forced-draft chain grates. With natural-draft chain grates the usual control is by means of a steam-pressure or steam-flow regulator controlling the boiler damper and the speed of the stoker engine or motor. With forced-draft chain grates several control systems are in successful service. The electrical control is applicable on motor-driven installations. The steam-flow regulator, controlling the air supply to the stoker and the speed of the grate, is giving successful results.

The steam-pressure regulator controlling the air supply to the stoker and speed of the grate is also giving excellent service. In case constant furnace draft is desired, the balanced control can also be applied, as in other types of stoker installations.

Natural vs. Forced Draft

Whether natural or forced-draft chain grates should be installed depends upon the conditions in the individual plant. The station load, banking periods, boiler absorption with or without economizers, as well as the limits of the draft available, are all involved.

Among prominent manufacturers of this type of stoker are: Babcock & Wilcox Co., "B. & W.", College St., St. Henry, Montreal, Que.; Illinois Stoker Co., Alton, Ill.; Combustion Engineering Corporation, "Coxe," 1107 Bank of Hamilton Bldg., Toronto; Green Engineering Co., East Chicago, Ind.; Laclede-Christy Company, St. Louis, Mo.

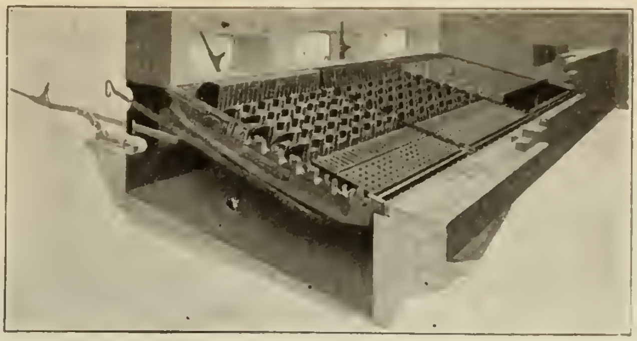
Semi-Automatic Types

The type of stoker that may be termed semi-automatic, in that it is intended for hand operation of the grates themselves, is designed to get away from the disadvantages attendant on hand firing and cleaning, and at the same time be adaptable for smaller units.

It is easily attached to any boiler, the only work to be done on the boiler fronts being the drilling of a few holes to support the lever brackets, which are set at the front of the boiler.

The grate is inclined to the back of the boiler, and the coal which is fed onto the front bars, is there coked, the volatile gases passing over the incandescent fuel bed, where final combustion takes place.

The coked coal is gradually worked down the inclined surface by the operation of the stoker bar handles, which are situated at the boiler front.



Hand Operated Stoker Type.

The operation of the handle turns the stoker's bars up into the fire about six inches, breaking up the clinkers and ash, and pushing it forward to the cleaning plate, while the coked fuel is also advanced along the inclined bars. There is thus a free passage for air through the fuel bed constantly maintained.

The cleaning plate at the lower end of the grate is counterbalanced, and a single pull on the lever is sufficient to dump the ash and clinker into the ashpit, without the loss of any unburned coal, and with absolutely no waste of time, therefore no drop in pressure.

Notable improvements have been made in chain grate stoker practice as regards air-tightness, cooling, size of combustion space, etc. A greater boiler capacity can be obtained by increasing grate size or by more intense natural or forced draft (0.50 to 0.60 in. for a combustion rate of 40 to 45 lb. per sq. ft. of grate per hour), but high and sudden overloads are best met by forced-draft chain grates burning 55 to 60 lb. of bituminous coal per sq. ft. per hour, with air at 2 in. pressure distributed through compartments between the runs of chain. It is claimed for such equipments that 200 per cent. of the rating can be reached in 10 min. from a short-banked fire, or in 52 min. from a cold grate.

Among prominent manufacturers of this type of equipment are: Waterous Engine Works, "Files," Brantford, Ont.; Engineering Machine Works of Canada, "National," St. Catharines, Ont.; McClave-Brooks Co., Scranton, Pa.; Combustion Engineering Corporation, 1107 Bank of Hamilton Bldg., Toronto; Cokal Stoker Corporation, "Cokal," 341 East Ohio St., Chicago, Ill.

Traveling Grate Stoker.

BELTING EFFICIENCY

Tests made of leather belting by the Leather Belting Exchange, Philadelphia, show that, with a reasonable shop tension, a transmission belt with its flesh side in contact with the pulleys will average only about 50 to 60 per cent. as much power as when the grain side is in touch with them.

On the other hand, at higher tension the flesh side will do much better, averaging from 50 to 100 per cent. more power than the grain side, the results depending, of course, on the belt and the conditions of service.

For the experiments, five 4-inch, 30-foot, single belts of different make, weighing from sixteen to eighteen ounces, were used. The conditions were standardized, and the belts were all thoroughly "run in" before the tests were made.

The following test, conducted at the same time, strikingly illustrates the low efficiency of a new belt. When first put on the pulley, the belt transmitted 12 H. P. at a slip of 1.2 per cent. After turning for five hours it transmitted 19 H. P. with the same percentage of slip; after thirteen hours it transmitted 24 H. P.; while after twenty hours it transmitted 31 H. P. with a slip of 1.6 per cent. According to the horse-power tables, its schedule transmission should have been 26 H. P.

To reverse the direction of rotation of a shunt motor, reverse the armature leads or shift the brushes backward past the polepieces an amount equal to that which they were originally forward of the polepieces; where the winding is such that the neutral brush position is opposite a pole piece, the brushes will be shifted backward a distance equal to the pole pitch plus twice the lead.

Lubrication by forced circulation is the best method known, where the oil is delivered into the bearings under pressure in a copious stream, collected and returned after being filtered and cooled. Pressure and large passages insure an ample supply, and the comparatively cool oil conveys heat from the bearing in proportion to its weight, specific heat and temperature rise.

Service Engineering at the Mount Royal Hotel

One Third of Total Cost or Approximately $2,000,000 Expended on Service Engineering Features of "The House of Ten Thousand Lights"

*BY WALTER J. ARMSTRONG

THE Mount Royal Hotel, including permanent equipment, cost in the neighbourhood of $6,000,000.00 of which, approximately one-third, or $2,000,000.00 was expended on service engineering features. The building has a content of 9,363,000 cu. ft., with a total floor area of 766,000 sq. ft. or approximately 18 acres on fourteen floors. This includes basements and part of mezzanine floors. There are 2,500 rooms in the building, both small and large.

Of these 2,500 rooms approximately 2,300 had to be heated, and this required 60,000 sq. ft. of direct radiation, divided into over 2,500 separate units. The direct heating of the larger spaces is supplemented with indirect heating or supply ventilation, and approximately 12,000 sq. ft. of indirect radiation is provided for heating the air for these purposes. The temperature of the more important rooms and of air for ventilation is automatically controlled.

Steam is used for heating the building, heating air for ventilation, and heating water for all purposes, also for cooking and warming in the various kitchens, and for drying and ironing in the laundry. Piping used for these purposes, together with that required in the boiler and engine rooms, is over 20 miles in length, varying in sizes from ½ in. to 20 in. in diameter, and having a total weight of approximately 150 tons.

10 Separate Systems

There are 10 separate supply ventilation or indirect heating systems, supplying 200,000 cu. ft. of air per minute—and 15 separate exhaust ventilating systems, exhausting 300,000 cu. ft. of air per minute—all of the mechanical type, utilizing 25 motor driven fans. The reason for providing so many separate systems was partly due to the large area of the building, and partly due to the fact that many of the rooms are not in use continuously or simultaneously.

The air in the various rooms is changed from 4 to 20 times per hour, the amounts supplied or exhausted being fixed so that the flow of air is into rooms where odors are likely to occur. Air supply is taken from the top of the building to ensure maximum purity, and in the case of the more important systems the air is washed and humidified, and during certain portions of the year also cooled. This air is distributed through sheet metal ducts, having a total weight of 200 tons.

Walter J. Armstrong

Engineer in charge of design and installation, Ross & MacDonald.

In connection with the plumbing, two problems appeared to be of more importance than the others. These were:—

1st. To ensure the continuity of water supply.

2nd. The solution of the drainage problem.

Own Water Supply

The Water Works Department finally agreed to permit connection with their 140 lbs. pressure main on Peel Street and their 40 lbs. pressure main on Burnside Place, but we were not satisfied with these alone, due to failure of water supply in Montreal in the past, and we therefore felt that the hotel should have a water supply of its own—and thus a 10 in. diameter well was sunk to a depth of 900 feet, and from tests made at this depth a supply of approximately 7 000 gallons per hour of an excellent quality water was obtained.

This not only practically assures water supply at all times but also showed a very handsome return on the expenditure. This water is pumped into a tank on the mezzanine floor by means of compressed air, from which it is drawn for cooling purposes in connection with the refrigeration plant, after which it is pumped into two 20,000 gallon storage tanks at the top of the building, and again used through the various plumbing fixtures.

As the elevation of the city sewer is only a little below the elevation of the basement floor, it was impossible to place a drain under this floor connecting with the sewer and obtain the usual slope asked for by the city, and it would have been disastrous to connect fixtures and apparatus in the basement direct to such a drain. It was also impossible to raise the building out of the ground 1 in. on account of the 130 foot city by-law, neither was there sufficient room on the basement ceiling for so many and large branches of the drainage system. We were finally permitted by the various parties interested, reluctantly by some, to place the main drain under the basement floor, provided no fixtures or apparatus on this floor were directly connected to it. Separate and independent drainage systems were provided connecting to three electric driven duplex ejectors, which pump all basement drainage into the main drain.

Water Softening Plant

The water consumption was estimated to be 350,000 gallons per day, with a maximum demand of 60,000 gallons per hour, while the hot water maximum demand was estimated at 20,000 gallons per hour. Records taken by the operating company show that these quantities are approximately correct. All of this water before being used is filtered. In addition to this, a plant is provided for softening water for particular uses.

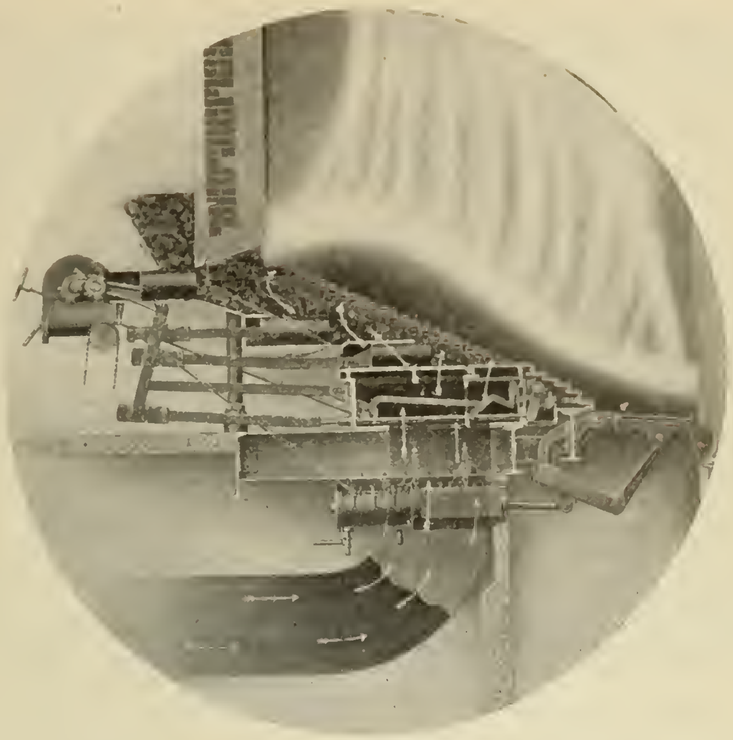
135 hose lines are installed for fire protection purposes, in addition to which in workshops, storerooms, and similar places, automatic sprinklers are provided. Piping in connection with the plumbing and allied systems is over 30 miles in length, varying in sizes from ½ in. to 20 in. diameter, and having a total weight of about 500 tons, made up of cast iron, wrought iron and brass piping. The latter, that is the brass piping, which was used throughout for hot and drinking water lines, weighs about 40 tons. There are 3,320 plumbing fixtures, exclusive of those in kitchens and laundries, and 9,700 bathroom accessories.

The controlling factor in arriving at the passenger elevator requirements was the carrying of passengers between the lobby floor and the ball and banquet rooms located at the top of the building. At a most conservative estimate, the six passenger elevators provided in the central group will carry 1.000 persons one way between these two terminals in twenty minutes—or if only four of these elevators are utilized for this purpose, they will handle the same number of passenger in 30 minutes.

The next most exacting elevator demand is that for room service and three

---

*Engineer in charge of design and installation, Ross & Macdonald. A paper read at the Rotary Club luncheon in the Windsor Hotel, Montreal, on April 10.



Sectional view of stoker showing series of coal feeding plungers.

(3) elevators have been provided for this purpose alone.

Total of 16 Elevators

There is a total of 16 elevators and dumbwaiters in the building, all of which are equipped with the latest type of safety devices, and all passenger elevators with threshold illuminators, flashlight signal systems, and indicators. An indicator is also provided on the lobby floor, which shows the elevator starter the promptness or otherwise with which calls on the various floors are answered.

If I were asked to suggest a name for this, the largest hotel in the British Empire, I would immediately reply, "The House of Ten Thousand Lights." As a matter of fact, there are over 10 000 lighting outlet boxes, having connected thereto approximately 15 000 lamps.

In addition to the lighting, the electrical work includes:—

Wiring for 150 motors, ranging in sizes from one-eighth to sixty horsepower; wiring system for electrical cooking and baking having a connected load of 200 h.p.; signal systems of various types to speed up the service for the convenience of guests, such as carriage calls; electric time clocks and time stamps, also fire alarm system.

70 miles of conduits, ranging in sizes from ½ in. to 4 in. in diameter, are provided for electric wires. The wires have a total length of over 300 miles, which is approximately the distance between Montreal and Toronto.

Over 1 200 Telephones

As there are over 1 200 telephones, no small portion of these amounts of conduits and wires was provided for talking purposes. I suppose if President Frank was asked to suggest a name, he would call it—"The House of One Thousand Voices."

To me, the most interesting part of the electrical work is the provision made for continuity of service. Electrical energy for all purposes may either be generated by the building plant, or purchased from a local power company, and the main switchboard is so arranged that any portion desired of the electrical load may at any time, be either taken from the Power Company's lines or from the Building Generating Plant. By this arrangement it is possible at all times of the year to make the amount of exhaust steam available just equal to the amount required for heating purposes. Provision is also made for an emergency service from the Power Company.

If electrical energy should fail at any time, many parts of the building would be in total darkness; the elevators would cease to operate, as would all electrically operated apparatus, such as pumps and equipment in the kitchens and laundries. Thus you can readily realize how serious even a short interruption would be. With the equipment provided any interruption is a remote possibility.

If a hotel manager were asked, "What is the largest problem in hotel management?' I have no doubt he would say—"The satisfactory feeding of the guests." In the Mount Royal no effort has been spared to simplify this problem. Five separate kitchens have been provided four of which are more or less auxiliary to the main kitchen. Some idea of the problems may be realized from the fact that equipment is provided to serve from day to day, without confusion or unusual effort from 6 000 to 7,000 meals, and many more from time to time, as the occasion demands. This figure does not include afternoon teas.

In the employees' cafeteria, equipment is furnished to serve 1,200 meals per day. Approximately 400 separate pieces of permanent kitchen and service equipment are installed. This includes equipment for all bread, pastry, ice cream and candy making, as well as that for the usual cooking and serving, and practically each piece requires either water, waste, steam, gas, electrical or brine connection and many pieces require a number of such connections.

Only so-called "raw foods" are purchased. Large storage rooms and refrigerators are provided and maintained at the proper temperatures by mechanical refrigeration to preserve large stock of raw foods, and numerous smaller refrigerators for "ready to cook" or "ready to serve" foods.

At one time during construction it was practically decided to omit, at least for the time being, the laundry, but after considerable investigation it was learned that no laundry company in Montreal, in fact, if my memory serves, no two companies, were in a position to handle the linen from the hotel. The equipment as provided is of ample capacity not only to handle the hotel laundry, but also for handling linen, and so forth, for guests. This laundry has a capacity of from 7 to 10 tons, or 18,000 pieces per eight hour day; the 18,000 pieces include the average run of hotel and guests' linen. Equipment such as washers, extractors, tumblers, flat work, ironers and the like, are individually motor driven and in the case of washers, extractors and tumblers, are automatically controlled.

A smaller laundry for the use of the maids is provided on the top floor.

Refrigeration Needs

Although modern heating, ventilating and plumbing systems, electricity and elevators, make a hotel like the Mount Royal possible, the present day refrigeration plant contributes in no small way to the enjoyment and health of the guests and to economy in service. The duty of the plant in the Mount Royal is to maintain in 94 separate refrigerators temperatures varying from 10 deg. to 45 deg. Fahr., to make 30 gallons of frozen desserts per hour, to manufacture 10 tons of ice per day, and to cool 450 gallons of water per hour for drinking purposes. Brine at approximately 0 deg. Fahr., is used for freezing ices and for cooling refrigerators in which are stored foods which must be frozen and kept frozen. Brine at from 10 deg. to 15 deg. Fahr. is circulated through all other refrigerators. There are two (2) ice freezing tanks containing a total of 240 100-lb cans. This size of can being selected for ease in handling.

A separate small autematic plant is provided for cooling refrigerators in the banquet room kitchen located on the top floor.

In this day of high priced labor it has been found that it is more economical as well as being more positive and reducing delays to a minimum to send messages, complaints, orders, bills, and even small parcels such as keys, through pneumatic tubes rather than by messengers. Thus an extensive system has been installed connecting the various operating departments. Tubes are also provided between restaurant cashiers and the front office. If a guest of the house after charging his dinner to his house account rushes from the restaurant to catch a train, paying his bill on the way, he will find that the front office has a record of the meal only finished a few minutes before.

Scales are provided so that every pound of supplies received, whether they be coal (which is purchased by the ton), or food supplies (which are purchased by the pound), may be weighed before being received.

Shops for repairing furniture, linen and silver, as well as all sorts of mechanical and electrical apparatus, are equipped with modern power driven labor saving devices.

Electrically driven printing machines also form a part of the necessary equipment.

Efficiency at Maximum

Although architects and owners do not always see such matters from this point of view, nevertheless it pleases me to think of the boiler and engine room equipment as being the heart, and the pipes, wires, etc., emanating therefrom as being the arteries and veins of the building, and only as these essentials of the building's anatomy are healthy, efficient and lasting, so may the goal for which the project was promoted be fully realized.

Space do not permit saying very much concerning the boiler and engine room equipment. I do wish to state, however, that in selecting the boilers and stokers, the coal and ash handling equipment, engines, generators, pumps, and the like, the effort was made to obtain a plant of maximum lasting qualities and efficiency in operation, interest and maintenance charges, together with available space conditions being taken into consideration. Tests of the boiler plant made to date show a steam generation of 10 lbs. per 1 lb. of coal, which fulfills the efficiency endeavor.

As much as possible of the equipment is made automatic, and by this I mean stokers, draught fans, damper regulators, feed pumps, etc., respond automatically to the load demand. In this way the plant is operating a maximum efficiency for any condition of load. Efficiency instruments, meters and gauges are supplied, so that the operators may quickly tell whether the automatic features are responding to variations in loads as they should, and in the case of the boilers, the work done by any one may easily be compared with that of the others. Quantities of hot and cold water, steam and electric current used in the various departments are recorded daily. The heat remaining in the steam after passing through engines and pumps is utilized for heating the building, air for ventilation or water for various purposes, and the condensation from such systems is again returned to the boilers; thus practically all of the heat of the steam is utilized.

The elimination of noise and vibration caused by engines and compressors has always been a difficult problem in hotels. Thus it may be of interest to you to know that the foundations for engines and compressors in the Mount Royal Hotel are carried down to solid rock over 20 feet below the level of the engine room floor the foundations are encased with cork. These precautions may at first thought seem unnecessarily elaborate, but the satisfactory results obtained appear to justify the expenditure.

Personals

Cama, Norton & Co., 11 Elphinstone Circle, Bombay, India, would appreciate receiving catalogues from Canadian firms exporting electrical machinery, devices and appliances for plants.

Dunn's Leather Packings, Ltd., is another new industry for Hamliton, Ont. The company has recently been incorporated with a capital of $40,000, to manufacture washers, packings, valve leathers, and leather specialties. J. M. Dunn is the manager.

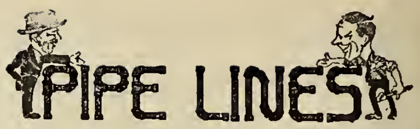
Disher Steel Construction Co., 95 King Street East, Toronto, have been incorporated with a capital of $500,000. C. E. Disher is the president of the new concern, and was formerly junior partner of the firm Hepburn & Disher, Ltd., 71 Van Horne Street.

E. L. Cousens, consulting engineer of the Toronto Harbor Commission, has been appointed one of the consulting engineers for the Port of New York, in addition to his present duties in Toronto. Mr. Cousens is one of twenty such engineers appointed. The cost of the complete New York project will total between $50,000,000 and $75,000,000.

J. Amos Johnston has been appointed sales manager in the Ottawa district, for the Eugene F. Phillips Electrical Works, Ltd., Brockville, Ont. Mr. Johnston was formerly manager of the Public Utilities Commission for the city, and prior to that district inspector for the Hydro-Electric Power Commission of Ontario.

Eric D. Todd, the newly-appointed municipal engineer of South Vancouver. B. C., who assumed his duties April 1, was employed as engineer in charge of road construction and maintenance in the electoral districts of South Vancouver, North Vancouver, Richmond and Dewdney by the provincial government since 1917.

Born in Edinburgh, Scotland, Mr. Todd received his technical education at the Lewis institute of Technology, Chicago, Ill.



UNCOVERED IN ANY OLD SPOT

In condensing it is usual to use about 28 times as much injection water as the steam to be condensed; the temperature of the hot water should not be above 120 degrees.

* * *

They say a man always finds that which he earnestly and persistently seeks. Then look for 80 per cent. efficiency in your boiler plant.

* * *

If it is suspected that an engine piston is leaking steam, place the engine on the crank-end dead center, and after removing the cylinder head, on the head end, admit steam back of the piston. Any leak can be readily detected.

* * *

A modern boiler room is a brain proposition, not a muscle job. You've got to double your brain power, Mr. Engineer, to stay in this man's game.

* * *

After removing loose dirt with a stiff brush, files can be cleaned of grease by boiling them for about 40 minutes in a solution of ¼ lb. of saleratus to a quart of water. The files should then be thoroughly washed in clean water and after being dried should be submerged in a solution of ¼ lb. of sulphuric acid to a quart of water. After remaining in this solution for about 12 hours, should again be thoroughly washed, quickly dried and given a light coating of kerosene to prevent rusting.

* * *

A boiler flue is so named because it is the place where the gases fly faster when the temperature soars.

* * *

End play of a crankshaft may be caused by the crankpin brasses being out of line and bearing alternately on opposite ends of the crankpin, or to the shaft being out of line, causing a wobbling motion of the flywheel or, in a single crank engine, by lost motion in the crankshaft bearings.

* * *

It's better to wear a boiler tube out with a tube cleaner than to have it burn out from scale.

* * *

Surface condensers are allowed from 1½ to 2½ sq. ft. of tube surface per indicated horsepower, or better, 1 sq. ft. of tube surface for every 8 to 12 lbs. of steam to be condensed per hour.

* * *

There's a thimble full of air in every quart of make-up water. If you don't get it out, the oxygen will most surely pit your boiler.

* * *

Failure of a direct current generator to build up its voltage may be the result of lost residual magnetism, an open field circuit, reversed field connections, wrong brush position, poor brush contact or a short circuit.

Editorial Comment

CAMPBELL BRADSHAW, Editor

Time for Study

IN THE average power plant the more simple the equipment can be made, the greater the opportunity for the engineer to maintain it in an efficient condition.

When the firing is performed by automatic stokers and the draft regulated automatically, there is a far greater likelihood of the operating force maintaining the best conditions, than in a plant where this work is done by hand.

The investment must be considered from several angles. There are tangible returns annually from the elimination of labor; the economy possible from the use of a lower grade of fuel; and the saving due to better combustion and general efficiency which sometimes alone offsets the initial cost by the possibility of installing a smaller boiler plant, due, of course, to the mechanical stoker being capable of carrying heavy over-ratings for short periods.

Indeed even in the small plant considerable fuel economy can often be effected by the installation of one of the many hand operated stokers or dumping or moving grates.

Such an investment pays further dividends in the shape of a more contented fireman and a better kept boiler room, for it must be remembered that men forced to undergo physical fatigue to keep up steam cannot be expected to give their undivided attention to efficient operation.

Their chief interest naturally centers in maintaining the required pressure with the minimum of exertion.

When operations are practically automatic, the same load cannot only be carried with less than one third of the boiler capacity with labor at a minimum but the functions of the operating force have become more mental than physical.

This satisfactory result merits more attention in Canada than is generally given it, for if engineers and firemen are expected to give careful study to efficient operation they must have time for such study without encroaching on the hours necessary for their other duties.

And so it is important to remember that the automatic regulation of the boiler room so as to promote the highest degree of mental vigor is a very real factor in efficiency and economy.

* * * *

Brains at a Discount

BRAINS that are merely cultivated, or cultured as brains, are at a decided discount in the world's markets.

Brains, highly disciplined to serious thought, manicured and polished, shine in obscurity. There is no demand for them unless of the rank of genius.

A writer in a current magazine expresses it this way:

"When educated men were scarce, disciplined brains could be sold at a good price on a virgin market. Then the news went out that higher education meant good pay and the past three decades have so glutted the market with disciplined brains, that we are now confronted with the incongruity of an engineer in greasy overalls rightly commanding better pay than a professor in white collar, whose learning involved an outlay of $5,000."

Yes, fortunately, to-day the demand is for workers with brains trained to act through the senses. The psychological vocations find a market only when specialized and then they are graded until only the very best of them can compete with the "engineer in greasy overalls."

The concert pianist, the violin virtuoso, the lawyer, physician, or teacher who found economic comfort three decades ago in the broader field, has now been relegated in Canada to the rural community for even a local fame.

But the man whose trained brain was trained by experience, and if also in a university so much the better, to find expression through the senses, has come into his own.

The academics of a former generation are the high school graduates of this. The statesmen of a former century would be the demagogues of to-day, save for the geniuses.

A precarious existence is the reward of mere brain culture, which is now classed only with the impracticables. But skill such as that expressed in the production of power, fortunately rules the world.

* * * *

Blind Prejudice

PREJUDICE—a judgment or opinion formed hastily without due examination of the facts or reasons essential to an impartial consideration of the value of the power plant equipment in question.

It is unfortunate that once in a while we run across a man who is sadly afflicted with one or more prejudice—unfortunate because there are so many real opportunities going to waste for want of the man who will accept the word and experience of his successful fellow.

The engineer who not so long ago ordered a stoker installation "thrown out" of his boiler room although the identical equipment was installed in a similar plant a few weeks later and has since given perfect satisfaction, wouldn't think of wearing eyeglasses that blurred his vision any more than he would tie a ball to his feet when he was going to run a foot-race—yet day by day he continues to grope about blindly in a dark abyss of prejudice wondering why he doesn't get anywhere.

* * * *

Write Your Editor

SHARING of knowledge so that it may be applied whenever wanted, is characteristic of human progress and typical of engineering co-operation. Everyone of us should be interested in engineers who are doing things, for to read about what they are doing helps us to do better what we are doing.

The man who works out a new idea, puts that idea into practice and then tells the results so that they can be passed along to readers of Power House helps himself and helps his fellows. Everybody to-day is interested in just one thing—success. The story of your success helps the other fellow and the other fellow's story helps you.

While it is not always easy to send in ideas that are of wide interest, the present tendency in the engineering world is to co-operate freely in supplying information—so take a hand, get the writing habit and tell the go-between—your editor—what you are doing and how you are doing it for when you help Power House to help power plant efficiency, you are really helping it to help you.

Power Plant Economy Paramount in Britain

E. R. Hanson Declares Fuel Costs Have Trebled Since Pre-war Days, Forcing Engineers to Seek New Methods of Cutting Costs of Power Production

By KENNETH MacTAGGART

WHILE much is being written of the necessity of power plant economies in fuel and methods of operation in Canada to-day, the demand for efficiency in coal burning is nowhere more insistent at the present time than in Great Britain where coal has soared to three times the pre-war price.

This was the outstanding feature of conditions observed by E. R. Hanson, secretary-treasurer of Mutual Coal Mines of Canada, during an eight weeks' trip abroad.

Factories utilizing steam for power purposes in the British Isles are entirely dependent upon coal because of the lack of oil or other substitutes used on this side of the Atlantic, Mr. Hanson declares. Pulverized fuel is practically an unknown quantity.

Only Fire In Forge

This condition has resulted in a great increase in the use of electricity. In one large mine visited in the Glasgow district the boiler room has been superseded by a large transformer and the engine room housed electric motors. The only fire to be seen on the property being in the blacksmith's forge.

So great is the demand for coal that urgent steps are being taken to reclaim the mines flooded in the Glasgow district by striking miners and several new pits have been sunk lately equipped with the most modern types of mining machinery.

This unprecedented demand for fuel has in part been caused by the action of France in the Ruhr district causing utter stagnation in coal production there, a condition which has taxed the available supply of substantially the only raw product that Britain produces for export.

Cut Cost of Power

Manufacturers are greatly embarrassed by this drain on the nation's natural resources and every means is being taken to reduce overhead in the production of power.

This "famine," coupled with the fact that industrial progress in Britain is at a standstill as far as quantity production is concerned, has so greatly increased the cost of operation that large numbers of firms have found it necessary to close their plants, forcing thousands of men out of work.

On the Clyde, shipbuilding has been so greatly hit by this industrial depression that there is absolutely no demand for labor. The majority of the mechanics have been without work for months and the few who are working are receiving the meagre wages of the common laborer in many cases.

Despite this inactivity, the evidences of poverty which one would naturally expect to see on every hand are lacking. In fact, the condition of the working man and his family are far advanced as compared with twelve years ago when Mr. Hanson last visited the Old Country.

Men are better dressed to-day; children are receiving a better education and all in all it would appear that living conditions have risen to a much higher standard in the last decade.

The paradox this surface "prosperity" implies is, however, directly attributable to the system of "doles," as it is called, on which, unfortunately, so many families are dependent. This method of granting relief to persons unable to obtain employment has been the target of the press and the political opponents of the government alike on the ground that it tends to encourage laziness by officially sanctioning "loafing."

Whether you are operating a boiler plant or running a bank, it is up to you to decide whether the crowd shall come to you under the "big top" or in the side show. The answer is the degree of concentration plus enthusiasm that you put into what you are doing. Even if you don't like to hand fire a boiler, do it for all you are worth. Make every shovelful contribute something to your experience, something to your ability, but close the switches to the spur lines and keep on the main track.

On the contrary, however, the men are eager to return to work, accepting positions in many cases which pay less than the amount they had been receiving in "doles."

When the condition of the industrial world in Europe is taken into consideration, it is self-evident that these inequalities must temporarily exist although there can be no doubt of the fact that they will right themselves at an early date.

Seek Better Jobs

In the meantime, however, until the wheels of industry have regained their former impetus, the average workman must obtain a better means of deriving a livelihood, and to do this without delay he is reviewing other spheres for his activities in which the prospects of employment seem to warrant emigration.

Mr. Hanson believes that such families should be encouraged to come to the Dominion as they would provide the best type of population obtainable to develop the agricultural resources of the country.

Large English landowners are finding themselves in such a position, due to the heavy taxes which the government has found it necessary to levy, that they are being forced to liquidate their holdings. This is producing a large amount of liquid capital which, because of the possessors' reluctance or inability to reinvest in Britain, must ultimately find its way abroad, preferably the colonies.

Cites Canada's Wealth

Where in the world to-day, Mr. Hanson asks, can this money be put to better use than in Canada with its unlimited farming tracts, its undeveloped mining resources and the many manufacturing industries which offer innumerable opportunities for safe investment.

Whatever the final outcome may be, however, the large industrials are in a very optimistic frame of mind, viewing the situation with anything but alarm and daily observing a gradual upward trend in the business world.

The owner of one of the largest coast trading and shipping firms declared, the day Mr. Hanson sailed on his return trip, that business prospects were brightening on every hand. Such expressions reflect the cheery belief expressed by everyone in Britain's infallible ability to overcome all obstacles in her triumphant return to leadership in the industrial circles of the world.

Book Reviews

Steam Power. By C. F. Hirshfeld and T. C. Ulbricht. Second edition. John Wiley & Sons, New York; Capman & Hall, London. Cloth, 5 x 8 in., 174 pp., illus., diagrams, $3.25.

In preparing this textbook the authors have attempted to collect in a comparatively small book such parts of the field of steam power as should be familiar to engineers whose work does not require that they be conversant with the more complicated thermodynamic principles considered in advanced treatises.

They have therefore eliminated mathematical treatment as far as possible and confined themselves to giving a correct viewpoint with regard to the use of heat in the power plant, to supplying what is required to solve common power-plant problems and to describing the more common types of apparatus.

Cutting Steam Costs in Hand Fired Boiler Plants

30 Per Cent. Saving in Fuel Costs Effected by a Few Simple Changes in the Furnaces and in the Control of the Operation of the Boilers

* BY A. R. MUMFORD

DURING the course of the investigation of a hand-fired return-tubular boiler plant, it was found hat the average cost of fuel to produce ,000 lb. of steam was $0.5287. Tests onducted after some simple changes had een made in the furnaces, and in the ontrol of the boilers, showed the preious high cost of fuel per 1,000 lb. of team could be reduced to the reasonable igure of $0.3540, or the equivalent of ver 30 per cent. saving in fuel cost.

The boilers were the ordinary returnubular type, 18 feet long and 56 inches n diameter, set 27 inches above grates, feet deep and 5 feet wide. The bridgeall rose to within 5 inches of the shell f the boiler. The space behind the ridgewall had been filled in so that the loor of this space was only 20 inches elow the shell of the boiler.

This form of setting is believed to be ommon, and results in smoky and inomplete combustion when bituminous al is used for fuel.

Combustion Space Small

The combustion space, in the original nstallation, was small, and the gases ere exposed to the cooling action of he boiler during all of their passage hrough the setting, and, what is peraps more important, were not subjectd to any thorough mixing action. These onditions made it possible to burn tuminous coal without producing more moke than was permitted under the local egulations governing the emission of moke. For this reason, pea-size anthraite was burned during the greater part f the day, and the plant was able to ırn bituminous coal only at night when he demand for steam was somewhat ss than during the day and when the moke could not be seen.

The presence of black smoke in the ases issuing from a stack indicates hat the gaseous products formed durg the combustion of the coal are not ompletely burned. In order to burn ases completely it is necessary to mix hem with a certain proportion of air hile the gases are so hot that the reulting mixture will be above its igniion temperature.

There are limits to the amount of air hat can be mixed with a certain amount f any combustible gas to form an inlammable mixture, and increasing or ecreasing the amount of air above or elow these limits renders the mixture on-inflammable, so that it may be imossible to ignite it.

The rate of combustion of the inflamable mixture will vary with the proportions of gas and air, it is desirable to mix the gases rapidly with air in such proportions that they may burn quickly in the furnace and combustion chamber. Thus the problem to be solved, before the use of anthracite could be discontinued and bituminous coal used at all times without violating the regulations governing the emission of smoke, was to completely burn the gases formed during the combustion of bituminous coal before they left the setting.

Mixing Device Missing

The principal difficulties presented by the original setting were the small volume of the combustion chamber, which shortened the time allowed for the combustion of the gases; and the absence of any mixing device in the path of the gases which would have caused mixing of the combustible gases and air by changing the direction of flow of the gas stream and by changing its velocity at some point or points in its path.

The first obstacle to overcome was the small volume allowed for the combustion of the gases. On account of mechanical difficulties involving excessive cost, it was not feasible to alter the relative position of the grates. The combustion chamber beyond the bridgewall, however, had been built up from a concrete floor with filling and a layer of loosely-laid brick, and by removing this filling the distance of the floor from the shell of the boiler was increased from 20 to 30 inches.

It does not make a bit of difference whether you are an engineer or diplomat, there are times when the full power of your understanding will be called into play, times when no matter how fair you try to be, you will be thought unfair. How well you are able to work out that kind of a situation will reflect just how good a general you are at heart. The degree to which your own men understand you, will determine just how loyal they will be to the things for which you stand.

This increase in combustion-chamber volume permitted the gases to move at a slower speed for a given rate of combustion and excess of air, and therefore allowed them more time to burn completely. The second obstacle presented to complete combustion was the absence of any mixing device in the path of the gases. This was easily overcome by the installation of two semi-obstructing arches, one over the bridgewall and one in the combustion chamber. The vertical distance between the shell of the boiler and the top of the bridgewall was only 5 inches in the original installation, and this distance had to be increased to 10 inches before an arch could be placed over the bridgewall. This arch over the bridgewall closed off the former opening around the shell of the boiler, and reduced the area available for gas passage from 5.6 square feet to 1.7 square feet.

Arch Was Extended

The arch was extended for three feet from the front edge of the bridgewall in the direction of gas flow, to provide hot fire-brick surface for the ignition of any combustible gas-air mixture not previously ignited. The reduction in area caused a temporary increase in velocity, which resulted in a turbulent flow, so that mixing was greatly assisted. The increase in velocity and the mixing action were accomplished at the expense of the available draft, and this is the determining factor that governs the extent to which such obstructions may be employed.

Just beyond the bridgewall the area available for gas passage is 12 square feet, an increase of 10.3 square feet over that available above the bridgewall.

This increase in area considerably reduces the velocity of the mixture of gases which have come through the restricted area and so gives them a longer time to burn. The deflection arch in the combustion chamber was of single-span construction, extending from the floor to the boiler, and leaving only a semi-circular opening 4.15 square feet in area next to the floor of the combustion chamber.

This deflection arch caused the gas stream to turn towards the floor of the combustion chamber, and further assisted in mixing by causing a second contraction, increase in velocity, and expansion of the gas stream. These changes in furnace arrangement in connection with the introduction of an improved method of firing permitted the substitution of bituminous coal for anthracite at a reduction of approximately $3.00 per ton in delivered price.

Found Firing Irregular

It was found during the course of tests, made before the furnaces and method of firing were modified, that the operation of the boilers was left entirely to the firemen, as long as steam pressure was maintained above 100 pounds and below the blowing off point of approximately 110 pounds. This method resulted in irregular firing and increased fuel losses because the firemen added fuel or worked the fires only when the steam pressure was decreasing. The dampers on all of the boilers under fire were always wide open, and if the steam pressure rose toward the blow-off point the firemen reduced the rate of combustion by closing the ash-pit doors, and if the steam pressure continued to rise the rate of combustion was further reduced by opening the fire doors.

---

*Assistant fuel engineer, Bureau of Mines.

Closing the ash-pit doors to reduce the rate of combustion has long been recognized as very poor practice, and results in overheated grate bars, increased clinker formation, and increased flue gas losses.

Opening the fire doors to reduce further the rate of combustion, not only results in the same evils that result from the closing of the ash-pit doors, but in addition cools the boiler unequally and puts a local stress on the boiler which, especially with fire-tube boilers, increases the wear and repairs necessary on boiler and brick work. The use of this method of controlling the rate of combustion is brought about by irregular intervals between firings, varying quantities fired at each firing, and inaccessible dampers.

Open Ash-pit Doors

The evils resulting from the closing of the ash-pit doors are caused by the increase in the draft throughout the boiler. When the ash-pit doors are open the draft available at the damper of each boiler is used to draw air into the ash-pit and through the grates and fuel bed, thereby burning the coal; to move the products of combustion through the boilers; and to draw air into the setting through any openings in the fire doors or cracks in the brickwork or boiler casing.

This influx of air through cracks in the brickwork or boiler casing is objectionable, and should be prevented by keeping the brickwork and casing air tight. When the ash-pit doors are closed the amount of air entering under the grates is greatly decreased, thereby decreasing the rate of combustion and the quantity of the products of combustion flowing through the boiler.

On the other hand, closing the ash-pit door increases the draft throughout the setting and thereby increases the infiltration of cold air into the setting through cracks in the brickwork or openings in the furnace doors, and thus cools the products of combustion and increases the flue-gas losses. When the amount of air passing up through the grates and fuel bed is reduced, the grate bars and the ash resting on them become overheated by conduction of heat from the fuel bed. This overheating melts the ash, forming clinker, and causes the grate bars to burn.

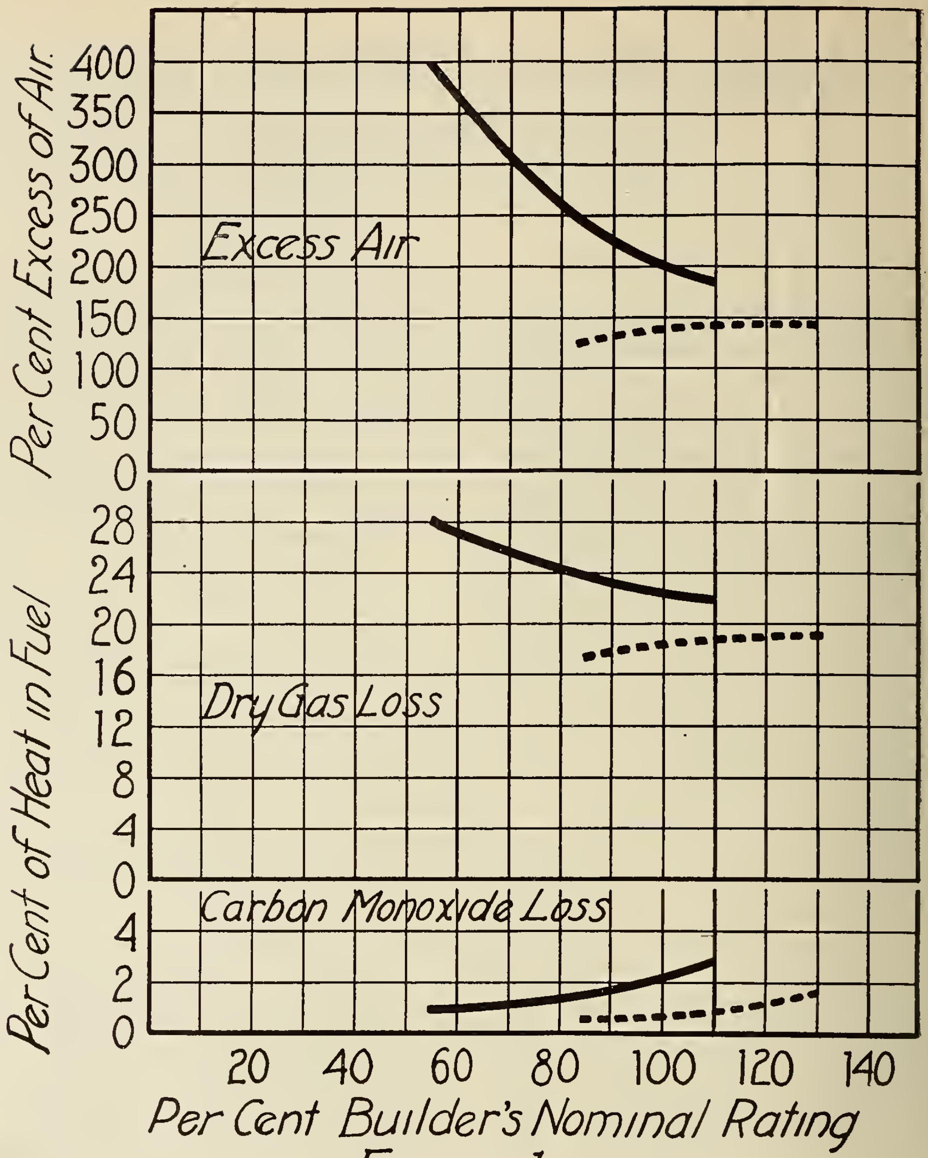


Figure 1.

Illustrate Gas Losses

In Figure 1 the flue-gas losses and excess air are plotted against boiler rating for two methods of boiler control. The solid curves show the variation in gas losses and excess air when the boiler was controlled by the ash-pit doors, and the dotted curves show the variation in gas losses and excess air when the boiler was controlled by the damper.

The difference in heat loss due to the presence of carbon monoxide in the flue gases, shown in the bottom set of curves, is not wholly due to the method of control of the boilers, but to a combination of the method of control, the furnace modifications, and the method of firing. The effect of the increased mixing action is perhaps most important in the reduction of this loss due to carbon monoxide.

The trend of both curves is similar, but the solid curve is higher at all ratings, and the loss increases far more rapidly as the rating increases under the original conditions than it does under the modified conditions.

Method of Control

The difference in heat loss due to the temperature and composition of the dry flue gases, shown in the middle section of the chart, is due almost entirely to the method of control of the boilers. The curves are similar in only one respect, and that is, they tend to become parallel to the base line as the rating increases. The solid curve, showing the dry-gas loss when the boiler was controlled by the ash-pit doors, rises rapidly with a decrease in rating; whereas the dotted curve, showing the dry-gas loss when the boiler was controlled by the damper, is more nearly level, and descends, as the rating decreases. The probable reason for the separation of the curves at higher ratings is in the improvements made in the method of firing which was more regular under the improved conditions, and consequently reduced the fluctuations in the proportion of air to combustible gas.

The curves showing the variation in the per cent. excess of air for the two methods of control are similar to the corresponding curves of dry-gas loss. The solid curve rises very rapidly as the rating decreases, whereas the dotted curve descends as the rating decreases.

In general, with ash-pit door control practically the same draft at the breeching is available at all rates of combus-

TABLE 1—TIME SPENT BY FIREMAN IN VARIOUS OPERATIONS.

Test No.	Rate of Working Boiler Per Cent.	Time Spent on Firing Minutes	Time Spent on Cleaning Minutes	Time Spent on Levelling Minutes	Time Spent on Barring Minutes	Total Time Spent During 12-hr. Test Minutes	Time spent on boiler per 1000 lb. of steam produced Minutes.	Kind of Fuel Used
1	71	23.34	35.92	0	0	59.26	2.38	Anthracite
2	79	33.08	42.25	0	0	75.33	2.75	do
3	63	24.00	40.75	0	0	64.75	2.94	do
4	107	31.75	20.58	0	17.75	70.08	1.88	Bituminous
5	81	26.08	16.67	0	15.67	58.42	2.08	do
8	125	25.50	12.67	24.51	17.75	80.43	1.87	do
9	99	22.00	6.20	27.43	12.68	68.31	1.97	do
10	85	18.05	6.33	28.23 3.50*	1.93	58.04	1.97	do

*Hooking.

tion, but that part of the available draft utilized for actual combustion decreases with the rate of working the boiler. The excess of draft over that utilized for combustion draws air into the furnace and setting above the grates, thus increasing the excess of air and dry-gas losses as shown. With damper control the available draft is reduced by shutting the damper so that the draft available to the boiler is enough for the desired rate of combustion only, and no excess exists to increase the stack losses.

Amount of Work

Perhaps the best criterion which can be used to judge the practicability of a firing method, from the standpoint of the fireman, is the amount of work he must do to produce a given amount of steam. If a new method requires more actual work on the part of a fireman, it is very likely that the method will be opposed, but if the fireman can be convinced that the new method requires no more work, and perhaps less work, it will be more readily acceptable.

In order to determine whether a fireman had to perform more actual work per 1,000 lb. of steam produced when he fired according to an improved method than when he fired without any attempt at regularity and without care, a record was kept on each test of the time spent on the various operations for each of the tests made.

Table gives a summary of the total time spent by the fireman on each of the various operations concerned with the fires.

The average work in minutes required of a fireman per 1,000 lb. of steam produced with anthracite is 2.69 minutes; with bituminous coal, under former plant operation, 1.98 minutes; and with bituminous coal, with the new firing method, 1.94 minutes.

To produce steam with anthracite requires more work than with bituminous coal, because the anthracite contains more ash and has a lower heating value per pound than bituminous coal. The higher ash content of anthracite necessitates more frequent cleaning, and on account of the lower heating value a larger quantity must be fired to produce 1,000 lb. of steam.

New Firing Method

The new method of firing requires approximately the same actual work per 1,000 lb. of steam produced as did the former method with bituminous coal as fuel. However, the new method also requires supervision until the firemen become accustomed to firing small amounts regularly, and to keeping their fires in good condition at all times.

This supervision is the price to be paid for more complete combustion without objectionable smoke, and is equivalent to a saving of $0.0685 or 16 per cent. in the cost of fuel per 1,000 lb. of steam. The time spent on levelling the fires is at least as much as that spent on firing, because this work is essential to good efficiency. It is the levelling of a fire which insures even combustion, for in this operation holes in the fire bed are covered and the coke bed is loosened so that combustion takes place more evenly. The observations of the smoke produced showed that barring a fire generally produced objectionable smoke, whereas levelling a fire from the top with a rake did not produce objectionable smoke. Even with a rake, however, smoke can be produced if the fireman is allowed to force the rake too deeply into the fuel bed.

A safe method of operation as regards smoke abatement is to use the rake for breaking and levelling the top of the fire without disturbing that portion resting on the grates. The grates themselves should be kept free from ash obstruction by running a flat hook over them at intervals of four hours. This hooking of the fires does not disturb the fuel bed to any great extent, but does keep the air passages in the grate bars open.

The improved firing method utilized the alternate system of firing. Thus only one-half of the grate surface is charged with green fuel at any one time, and the remaining half is left covered with a bed of freely burning incandescent coke from the preceding firing. In this way the fluctuation in furnace temperature is reduced and a temperature high enough to ignite the mixture of combustible gases and air, in the furnace, is maintained.

The procedure followed was to charge with fuel that portion of the fire reached through one of the fire doors and to break and level the other half as part of the same operation.

In order to determine the performance of the plant both before and after the modifications in the setting and control were introduced, a series of tests at different rates of evaporation per hour were made. Six tests, three with anthracite and three with bituminous coal, were made under the original conditions. After the conditions had been modified three more tests were run with bituminous coal, to determine the actual improvement in efficiency.

Table 2 represents the heat balances of the whole series of tests. Tests 1, 2 and 3, represent plant operation with anthracite; Tests 4, 5 and 6 represent plant operation with bituminous coal; and Tests 8, 9 and 10 represent modified operation with bituminous coal.

The principal features of the results obtained with anthracite are shown by the variation in efficiency, dry-gas loss, and ash-pit refuse loss, with rating. The efficiency and dry-gas losses decrease as the rating increases, while the loss in the ash-pit refuse tends to increase with the rating. The large ash-pit losses are due to the high ash content in the original coal which necessitated frequent cleaning of fires. It was found that steam could not be supplied in sufficient quantities if the fires were permitted to burn more than four hours without cleaning, so that the high ash-pit loss was part of the cost chargeable to smoke abatement under the original operating conditions.

The decrease in dry-gas losses with increase in rating further discredits control of boilers by ash-pit doors instead of by dampers, for the decreasing loss indicates that the available draft was more completely utilized for combustion as the rate of burning coal increased.

Under the original operating conditions with bituminous coal the efficiency

TABLE 2—PERFORMANCE FIGURES BEFORE AND AFTER.

	Before Modification						After Modification		
Number of trial	1	2	3	4	5	6	8	9	10
Kind of coal	Anthracite			Bituminous			Bituminous		
Per cent. of builder's rating %	71	79	63	107	81	56	125	99	85
Heat Balance per lb. Coal—As Rec'd.									
Heat absorbed by water %	57.9	55.7	58.9	66.0	61.0	59.0	66.5	65.7	69.0
Heat carried away by dry gases %	81.9	18.4	20.1	22.1	24.0	27.7	19.0	18.5	17.4
Heat carried away by CO in dry gases %	0.0	0.0	0.0	2.8	1.0	1.3	1.4	0.7	0.7
Heat c'rried away by steam in flue g'ses	2.3	2.3	2.3	3.7	3.6	3.5	3.5	3.5	3.5
Heat lost in ash pit refuse %	14.4	16.2	14.7	2.4	4.8	2.6	3.1	5.3	4.1
Heat unaccounted for %	6.5	7.4	4.0	3.0	5.6	5.9	6.5	6.3	5.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Evaporation per lb. coal. lb.	6.61	6.36	6.73	8.70	8.05	7.78	8.82	8.71	9.15
Coal per 1000 lb. steam, lb.	151.3	157.2	148.6	114.9	124.2	128.5	113.4	114.8	109.3
Cost of coal per 1000 lb. steam $	.6943	.7215	.6820	.3775	.4081	.4222	.3726	.3772	.3591

increased with the increase of rating as shown in Tests 4, 5 and 6. This increase in efficiency with increase in rating is accompanied by a reduction in dry-gas losses, and a reduction in the losses unaccounted for. The CO loss increases, as would be expected, as the rate of burning coal increases. The decrease in dry-gas loss with increase in rating is again due to the more efficient utilization of the available draft at higher ratings.

Under the modified operating conditions with bituminous coal the efficiency increases with a decrease in rating. The increase in efficiency is accompanied by a decrease in dry-gas losses, and a decrease in loss due to carbon monoxide in the flue gases.

The decrease in dry-gas losses with decrease in rating, just the reverse of the trend of the dry-gas losses under the original conditions, is brought about by the decrease in pressure difference between the inside and the outside of the setting as the damper is closed. This decrease in pressure difference decreases the influx of cold air through leaks in the setting, and consequently results in less dilution and cooling of the products of combustion, and therefore less waste of heat.

A Desirable Condition

The fact that the efficiency increases with a decrease in rating under the modified operating conditions is an especially desirable condition because of the low average rate of working the boilers in the plant under consideration. The average rate of working the boilers was estimated to be 75 per cent. of builder's nominal rating. Thus the gain in efficiency due to modifying the conditions was 13.2 per cent. over the original conditions with anthracite coal, and approximately 9 per cent. over the original conditions with bituminous coal.

Thus from each 176 heat units in the anthracite coal, 100 heat units were given to the steam; and from each 176 heat units in the bituminous coal, 104 heat units were given to the steam before the modifications, and 123 heat units were given to the steam after the modifications.

The cost of coal per 1,000 lb. of steam under the original operating conditions at the average rate of boiler working was $0.7050 with anthracite and $0.4225 with bituminous coal. After modifying the conditions the cost of bituminous coal per 1,000 lb. of steam was $0.3540. These figures were obtained from the costs of coal obtained from the delivery records for an eleven-month period. During that period 2,653 long tons of bituminous coal were delivered at a total cost of $19,535.16, and 1,957 long tons of pea-size anthracite at a total cost of $20.121.31.

When the capacity of an injector decreases slowly week by week, it indicates that the combining tubes are becoming coated with scale. Soaking the tubes or injector in a strong soda solution will help loosen the scale.

What's Wrong With Stokers?

Not Much When Engineers Firmly Declare Any Type to be an Improvement Over Hand Firing

CANADIAN engineers can well remember when a one-armed man could count all the successful makers of stokers on his fingers, and bearing this in mind the recent developments in design and the expansion of the field are remarkable.

This development has followed the usual course of conflicting opinion between maker and user, the manufacturer often regarding the engineer, with his suggestions for improvements, as in the class of the old lady who moved spring and fall for 20 years hoping to find a dwelling with a southern exposure on all four sides, and the engineer in turn believing the maker was only interested in selling large rectangular blocks of cast iron at a very excessive price per pound.

User Often Wrong

Of the two, however, the user in the past was more frequently wrong not only because there were more of him but because he demanded an impossible standard of performance from a fixed mechanism handling a very variable material.

To-day however, it is very evident that times and results have changed, for the engineer joins with the manufacturer in praising the economies in fuel and labor and the efficiency in combustion possible with modern stoker installation.

"Speaking on behalf of stokers, I can't see how you can begin to compare them with the hand-fed type," says W. Clark, chief engineer, Toronto Carpet Co.

Mr. Clark thinks there are three outstanding points in favor of them. First—the saving of labor; Second—higher evaporation; Third—greater efficiency in the plant.

The Toronto plant contains four stokers, each of 421 h.p. Each stoker is supplied by natural draft.

Can Be No Doubt

"As to the superiority of mechanical stoking over hand firing, there can be no doubt. When local conditions are considered, and the most suitable stoker installed to meet those conditions, there is nothing better. With proper stoker selection and proper operation, hand firing hasn't a show against mechanical stokers. Having operated, installed and tested stokers, I am of the firm opinion that they can't be beaten." This is the opinion expressed by R. McLaren, chief engineer, Massey-Harris Co.

John H. Stananought, chief engineer, Canadian Dyers' Association, expresses his opinion that "stokers of the type installed in our plant are very economical. They are labor saving, smokeless and can cope with variable loads. I might say that the engine is automatically controlled by a regulator, and the steam pressure never varies beyond 3 lbs. Comparing them with hand firing I must say that it is a marked improvement and beneficial both to manufacturer and firemen." The equipment in this plant is as follows:—Two 400 h.p. vertical water tube boilers with stokers, 3 retorts under each boiler. Each stoker supplied by forced draft.

Ends Useless Toil

"In comparison with hand firing, I consider any type of standard make of stokers an improvement, both as regards fuel economy, smoke abatement and the absence of the arduous duties incidental to hand firing. We are at present operating stokers, installed under 4—150 h. p. return tubular boilers. The type of stoker we have installed is very well suited to a plant of moderate size, and in operation is an imitation of the expert hand fireman, without the detrimental effects of hand firing, arising through the frequent opening of the furnace doors. We are reasonably sure of the superiority of the stoker over hand firing, because we can get a practical demonstration by reverting to hand firing at any time." The practical opinion of H. Potter, chief engineer, Hinde and Dauch Paper Co.

Trade Catalogs

Recording gages for pressure and vacuum, Bristol Company, Waterbury, Conn. Catalogue No. 1006 contains 84 pages of text and illustrations. Besides the different types of instruments shown, there is a variety of charts listed which adapt the gages to practically every application where pressure of liquids, gases, steam or air are required to be measured.

Thomas A. Gerner, of Newmarket, has been appointed superintendent of the gas works in Waterloo. Gas in Waterloo is unusually expensive and the new superintendent will immediately reorganize the department and effect economies, which, it is hoped, will result in a considerable reduction in the price of gas.

To build a new fire with a minimum of smoke when bituminous, high-volatile coal is used, put a thin layer of green coal on the grate and cover with shavings and wood soaked in crude oil. Ignite adding as little green fuel as possible, the aim being to begin the fire by burning the top of the layer, thus making the volatile gases and vapors pass through the hottest zone. Keep the fire door open as much as possible to prevent smoke.

Why Feed Water Heating Saved $30,000 a Year!

Whether Heat Utilized is Waste or Not—It's Good Business, for the Hotter the Water is When it Enters the Boiler the Sooner It Will Boil

* By ROBERT McLAREN

THAT it is good business from the standpoint of economy to heat the boiler feed water with waste heat, hardly anybody will deny. That it is good business to heat the feed water even when the heat employed in the process is not waste heat, not every engineer is aware.

But it is good business and good engineering practice for the reason that the circulation of the water in the boiler is more rapid when it is boiling than when it is not and the hotter the water is when it enters the boiler the sooner it will reach boiling point.

Heating of the feed water may be accomplished in heaters of the Hoppes type in which live steam is in contact with the water, both water and steam being at boiler pressure. This would be a live steam feed water heater.

Or it may be done in heaters in which exhaust steam is used, the heater being between the feed pump and the boiler and the water being at boiler pressure.

Exhaust Steam Heater

Or the heating may be done in a heater in which the water and exhaust steam are in direct contact. The heater in this case would be between the pump and the boiler, the water would not be at boiler pressure, but either at atmospheric pressure during the summer or at the pressure carried on the heating system during the cold season. The pump would draw water from the heater instead of pumping it through the heater.

With the closed heater no attempt may be made to remove the oil from the exhaust steam in which case the condensate produced in the heater will have to be wasted unless the engine happens to be a turbine (in which case the steam will be oil free and the condensate may be used for boiler feed) and the only ill effect of the oil in the steam will be a more or less lowering of the efficiency of the heater through coating the heating surfaces with oil.

Oil Separator Necessary

With the open heater an oil separator is necessary to remove the oil from the exhaust steam. This will be done more or less thoroughly although there are separators that will remove the oil with sufficient thoroughness to permit the use of the exhaust steam and condensate for textile manufacturing and, of course, that should be good enough for boiler feed purposes.

The kind of cylinder oil used will have an effect on the thoroughness with which the separator will do its work. A straight mineral oil is more easily removed from exhaust steam than a compounded oil but if the steam is wet compounding is necessary as a straight mineral oil will not form an emulsion with the moisture in the steam while a compounded oil will and lubrication of the cylinder wall is thereby effected.

Filtered Oil Usage

Compounding also makes the oil more easily atomized but this result can be obtained by using filtered oil. The fuel saving possible by heating the feed water amounts to about 1 per cent. for each 11° rise in the temperature of the feed water. This applies to any heater in which waste heat is used.

In the open heater there is another saving, and that is the condensate produced in the heater. Roughly, to make 7 lbs. of hot boiler feed water the closed heater requires 7 lbs. of cold water and 1 1/6 lbs. of steam, the latter being thrown away unless the engine is a turbine, in which case it may be saved as already explained, whereas the open heater requires 6 lbs. of cold water and 1 lb. of exhaust steam, assuming that the water is heated from 50° to 210° in both cases. From this it is evident that with the open heater 1/7 of the boiler feed is distilled water which requires no boiler compound.

The following table shows what the open heater does in heating water from various temperatures to 210° F.

Horsepower Ratio

A boiler horsepower is assumed to be the evaporation of 30 lbs. of water. It will be noticed columns 2 and 3, pounds of steam required + pounds of city water required = 30.

Water entering Heater at	Pounds of Exhaust Steam Condensed	Pounds of City Water Required	Saving of Water By the Use of Open Heater
32° F.	4.67	25.33	15.9%
35	4.60	25.40	15.7
40	4.49	25.51	15.0
45	4.37	25.63	14.6
50	4.26	25.74	14.2
55	4.15	25.85	13.8
60	4.03	25.97	13.4
65	3.91	26.09	13.0
70	3.80	26.20	12.7
75	3.68	26.32	12.3
80	3.56	26.44	11.9
85	3.44	26.56	11.5
90	3.31	26.69	11.0
95	3.19	26.81	10.6
100	3.07	26.93	10.2
110	2.81	27.19	9.4
120	2.56	27.44	8.5
130	2.29	27.71	7.6
140	2.02	27.98	6.7
150	1.75	28.25	5.8
160	1.47	28.53	4.9
170	1.19	28.81	4.0
180	0.93	29.07	3.1
190	0.63	29.37	2.1
200	0.32	29.68	1.1
210	0.00	30.00	0.0

The open heater has another advantage in that if it is properly ventilated it will heat the water to within 1 or 2 degrees of the temperature of the exhaust steam while the closed heater will not heat it to within 15° of the exhaust steam temperature and even that performance requires a more liberal ratio of heating surface to horsepower rating than most heater builders are willing to allow.

Boiler Compound Cut

At a temperature of 200° and over it is well known that the carbonates are precipitated, further reducing the amount of boiler compound required. Any case of oil in boilers of which I am aware where an open heater was used, was not due to failure of the oil separator to remove the oil from the steam but due to failure to remove the separated oil from the trap, and should not be regarded as a deficiency of the heater or separator.

As an illustration, the following will probably suffice:

In a plant of which I once took charge the safety idea was carried to such a length that all the condensation from the heating system was run into the sewer. There was also a closed heater that heated the water to about 145°, the condensate from which, of course, also ran to the sewer. As the floor area of the plant was about 28 acres, you will readily understand that it was not a small one. By means of a vacuum pump condensation was removed from dry kilns at least 500 feet from the engine room and dumped into the sewer, at the engine room door. During the day all the exhaust steam was turned into the heating system but the supply was insufficient, on very cold days 30% or more of the heating being done with live steam.

At night and during week ends and holidays, of course, all the heating was done with live steam, but everything went to the sewer. I had an open heater installed and the water was heated as high as 220°, depending on the back pressure carried for the heating system. I also had the heating system overhauled and the boiler settings improved, the changes resulting in annual saving of more than $30,000.

---

*Chief Engineer, Massey-Harris Co.

Safety First in Boiler Rooms

Practical Methods of Adjusting the Blow Off Pressure of Three Types of Safety Valves

BY GEORGE A. BROWN*

IN ANY discussion of appliances necessary in a boiler room, it is natural that one of the first to come to mind should be the safety valve, the purpose of which is to relieve the boiler of excess pressure and prevent the steam rising above a certain point.

When the boiler is generating steam faster than it can be used it is plain that a large quantity of steam is being built up in the steam space and the result is a steadily increasing pressure. If this condition were to continue the boiler would eventually explode from a pressure it could not withstand, and so it is the function of the safety valve to eliminate such danger.

There are three types of safety valves—the dead weight, the weight on a lever, and the spring loaded. The weight or spring is so adjusted in the different types that when the steam reaches the desired pressure the seat raises and allows the surplus steam pressure to escape.

The dead weight form of safety valve and the weight-on-lever type have been almost superseded by the spring-loaded type, as the boiler laws of various countries indicate that this type of safety valve is almost fool-proof.

Difficult to Overload

Dead-weight safety valves are difficult to overload as the weights are so large that it requires a considerable added weight to raise the blowing-off pressure.

As an example, let us decide what load would have to be put on a 3-in. valve to allow it to blow off at 90 pounds per square inch by multiplying the area of the valve in sq. inches by the pressure.

For example:

Weight required = 3 x 3 x .7854 x 90 = 636.17 pounds.

What weight is required for the same valve to blow off at 75 pounds per sq. inch?

Weight required = 3 x 3 x .7854 x 75 = 529.14 pounds.

It, therefore, can easily be seen that it requires considerable added weight to raise the pressure, as the 90-pound pressure takes 107 pounds more to hold down the valve than it does to hold down 75 pounds pressure.

The weight-and-lever safety valve, more commonly called the ball-and-lever type, is often found in old plants. Experience shows that the position to place the ball on the lever is usually found by trial in preference to calculations. The majority of safety valve levers are notched, and below the notch a number is to be found corresponding to the pressure per sq. inch at which the valve will blow off when the weight or ball is placed in that notch.

Since it is possible that the notches are not correctly located or that the weight of the ball is not for that particular lever, it is good practice to determine the position of the weight on the lever by actual trial.

If you get the steam pressure up to the point you want the safety valve to blow off at, slide the weight along the lever until the valve just commences to blow off, then lock or fasten the weight so that it cannot be accidentally moved. If, however, you prefer to set the weight and lever safety valve by calculation, the following formula applies:

$$P=\frac{W\times D}{A\times d} \text{ or } W=\frac{A\times P\times d}{D}$$

$$\text{or } D=\frac{A\times P\times d}{W}$$

P=Pressure per sq. inch on valve, which will balance ball.

W=Weight of ball in pounds.

D=Distance of ball from fulcrum in inches.

d=distance of valve stem from fulcrum in inches.

A=Area of valve in sq. inches.

The engineer in middle life should have a more reliable mental process than the young man. If he acquires facts and methods of calculation less rapidly, he usually grasps them more firmly. Besides he has a wealth of practical experience that helps him to understand and a maturity of judgment which aids him in deciding the particular needs of his plant. Age is no drawback, it is an asset.

I have purposely omitted the weight of the valve seat and stem, also the weight of the lever at its centre of gravity because they make so little difference in the solution of the problem as to be almost negligible.

To Make My Point Clear

What pressure will a safety valve blow off at with an area of 7.069 inches with the valve stem 2.5 in. from fulcrum?

The valve and stem weighs 1.5 pounds, the lever weighs at its centre of gravity 6 pounds. The length to centre of gravity, 9 inches, weight of ball, 48 pounds, placed 30 inches from the fulcrum.

A Practical Example

The correct way to do this is to multiply the weight of the ball, valve, stem, and lever, each by the distance of its centre of gravity from the fulcrum, and add the result. Multiply the area of the valve by the distance of its centre from the fulcrum, dividing the result into the sum of the products. The answer then will be the pressure the valve will blow off at.

Weight of ball 48 lbs. × 30 inch from the fulcrum.

Weight of valve and stem 1.5 lbs. × 2.5 inches from fulcrum.

Weight of lever at C. gravity 6 lbs. × 9 inches from fulcrum.

We then have:

48 × 30 = 1440.
1.5 × 2.5 = 3.75
6 × 9 = 54

Sum of products = 1497.75

Area of valve 7.069 × 2.5, distance of stem from fulcrum 7.069 × 2.5 = 17.6725; this divided into the above product gives the pressure to make the valve blow.

17.66725)1497.7500(84.74
1413800
839500
707000
1325000
1237075
87925.

Now we will seek to solve the same problem by the first formula:

$$P=\frac{W\times D}{A\times d}=P=\frac{48\times 30}{7.069\times 2.5}=\frac{1440}{17.6725}$$

$$\frac{1440}{17.6725}=81.48 \text{ lbs.}$$

pressure the safety valve blows off at, or a difference of but 3 lbs.

In the spring loaded safety valve the valve seat is held down by a spring and the blow off pressure may be changed by altering the tension on the spring. The general rule, if it is necessary to change the blow off pressure, is that the spring tension may be changed within 10 pound limits. That is to say, if you had a 100 pound spring and wished to change it to 120 lbs., you would have to get a 120-pound spring from the manufacturer, but if you only wanted to change it to 105 pounds, then you could screw down the spring tension to make it blow off at 105 pounds.

Rules Must Vary

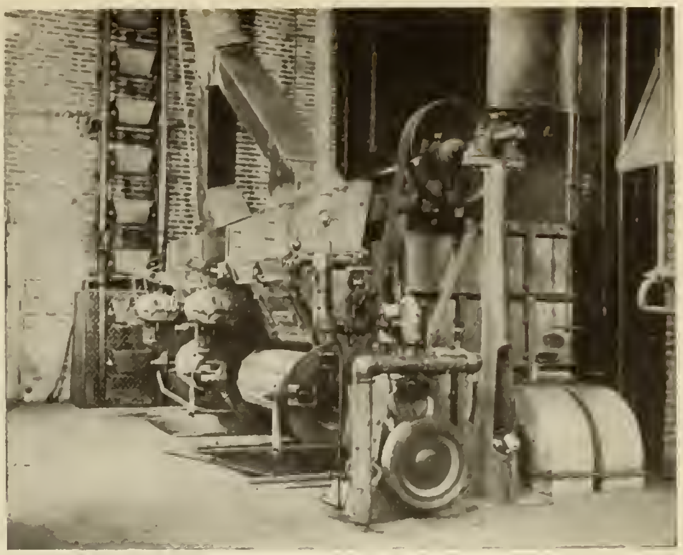
It is doubtful if the spring loaded safety valve can be computed by any special rule, because a spring will yield according to the shape, size, and material it is made of, as well as its diameter, pitch and number of coils. It is only necessary to consider the varied materials springs are made of to realize what a problem it would be to determine a standard rule for computing every type of spring loaded safety valve.

Spring loaded safety valves are practically foolproof because after they have been set for the desired pressure they can be locked so that the boiler attendant cannot make them hold down more pressure than the amount required, whereas with the dead weight and the ball and lever safety valve it is a simple matter to put on more weight to raise the pressure from which they are set at.

---

*Engineer, The House of Industry, Toronto.

Babcock & Wilcox Compartment Type Chain Grate Stokers



Showing Stokers Installed by the Berliner Gramophone Co., Montreal

Balanced Draft When it is required to burn low grade fuels at maximum efficiency these stokers are operated on Balanced Draft. In considering the question of Balanced Draft it has to be remembered that the heating value and general characteristics of fuels vary within very wide limits. Further, the amount of heat imparted to a boiler depends on the number of heat units liberated per square foot of area in a given time.

The primary object of Balanced Draft is to consume a larger quantity of low grade fuel per square foot of grate area than is possible when working under natural draft conditions. The necessity for this increased consumption will vary in intensity according to the characteristics and heating value of the fuel to be consumed, and a naturally free burning coal will not require so much draft as one containing a low percentage of volatile matter. Whilst, therefore, Balanced Draft is not necessary for efficiently burning an average quality coal, it is often essential for the efficient combustion of very low grade fuels or of fuels containing a low percentage of volatile matter.

Natural Draft This stoker is so constructed that although Balanced Draft can be applied when the class of fuel makes this necessary, it still has all the advantages of the standard Chain Grate in that it operates economically on Natural Draft when using average coal.

Write for Particulars

BABCOCK & WILCOX LIMITED

Toronto Office
Bank of Hamilton Building

St. Henry - MONTREAL

Odd Questions and Their Answers

Queries are invited on the every-day problems of engineers in all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped a fellow engineer and a pleasure for us to pass on the data.

VALVE ADJUSTMENT

Will you please answer the following question in Power House. By what method, in a busy shop, where time is a paramount factor, can the slide valve and Meyer cut-off valve be set and adjusted in an Ingersoll-Rand Type C2 compressor?—J. N.

Answer:—The main valve should be set to open on dead centre or a little late; as late as ¾ in. on the stroke would be an advantage rather than otherwise. Under no circumstances should the main valve be given "lead." This is a mistake that any engineer familiar only with steam engines is pretty sure to make. The compression in the air cylinder makes it not only unnecessary but absolutely harmful to have compression in the steam cylinder, because in that case you get a double load on the bearings just at the end of the stroke which is very liable to cause a knock. The machine will therefore run smoothest if the steam admission is a little late.

The machine should be turned in the direction of rotation past the dead centre until the crosshead has moved say, ½ in., then the main valve should be just opening. Then turn the machine over to the other end and see that the other end of the valve opens at the same point on the other stroke. This is all that is required in connection with the main valve. Then turn the machine in the direction of rotation to half stroke and set the cut-off indicator half stroke and see that the valve is just closing. Then turn the machine over until the crosshead is halfway on the other stroke and see that the other cut-off valve is just closing. If the cut-off is unequal the nut lock can be taken off one of the crosshead nuts and the cut-off adjusted.—H. V. Haight, Chief Engineer, Canadian Ingersoll-Rand Co.

* * * *

KILN-DRYING APPARATUS

I recently had an inquiry concerning the steaming of a dry kiln in a tile factory, as to size of boiler and the best method of installation. My intentions are to steam an open trough, 30 x 18 inches, and 6 inches deep, on each side of the room, with coils. Room is 30 x 44 x 8½ ft., and at present it is heated with hot water plant, which will be left in for that purpose. The steam must rise from troughs into said room to keep it damp. I will appreciate any information you can give me on this subject.

S. C. S.

Answer:—It would require an intimate knowledge of the work to be performed and the conditions prevailing to enable us to advise you as to details of the installation of an apparatus for drying.

The equipment of a dry room or kiln with apparatus for drying presents so many angles that it is quite impossible, in a discussion of ordinary length, to treat the subject intelligently. Each installation, as a rule, requires separate and distinct consideration.

Generally, much better success can be had with a fan system (hot blast) than with a system of any other type. There must be sufficient heat introduced to warm the drier and its contents to the temperature required and sufficient air passed through it to carry away the moisture. It is essential that the amount of moisture to be evaporated in a given time should be known.

The size of the room, 30 x 44 x 8½ ft., is important only as regards volume of air. There is only one good method of moving air by volume and that is by using a fan. The heating surface required can be made up of coils, indirect radiator sections or special heater sections, such as the vento.

* * * *

NOISY BALL CHECK

Could you tell me why a new ball check on the feed pipe of a boiler should be very noisy when the pump is in action?—A. W.

Answer:—The humming of a ball check valve, or chattering of an ordinary flat or mitre seat check valve, is usually experienced when the rate of feed is such that the valve is lifted very slightly from its seat, and kept in a sort of balance by the incoming feed and the pressure from the boiler.

A condition arises when this feed forcing itself past the narrow opening of the valve, causes a vibration which communicates itself to the pipe with a humming or chattering sound.

As a rule a change of speed of the pump will effectually stop this noise, which can be very unpleasant. It has been our experience with ball valves that it is more difficult to keep them from banging than from chattering.

* * * *

TURBINE VIBRATION

What are the principal causes of turbine vibration and what is a simple test for operation?

Answer:—Misalignment and unbalance are frequently the causes of the few cases of vibration reported. Misalignment involves either the turbine and generator or the rotating and stationary elements. In the first instance the misalignment is marked by the heating of the bearings, whipping, extreme working or moving of the shafts and vibration which is extreme under heavy loads although perhaps not noticeable under a light load or no load at all.

If misalignment of the rotating and stationary element exists there is usually rubbing and considerable mechanical noise to indicate it.

Unbalance is the easiest trouble to locate as it produces a steady vibration corresponding to the speed of the machine. It is better at some speeds than at others but at normal speed it remains much the same while the machine is operating.

Other causes of vibration are loosening, warping or failure of parts of the rotor or stator, eccentric or loose coupling, spring shaft, settling of the foundation, floor, piping, or other parts connected with the turbine; strains caused by exhaust piping or steam piping, excessive variation of vacuum, the restriction of oil or cooling water or improper action of the valve gear.

The ordinary test for first class operation is to balance a coin on the bearing bolts. If this will stand satisfactory on edge, the operation is considered good.

* * * *

BOILER FOAMING

What is the difference, if any, between the foaming and priming of a boiler?

Answer:—Priming is simply a boiling over of the water in the boiler, which if it is carried along with the steam to the units in operation sometimes causes considerable damage. Foaming is a frothing of water in the boiler, it is purely a surface effect without any water being lifted from the boiler, it is caused by dirt or greasy water in the boiler.

* * * *

CHIMNEY DRAFT

What produces chimney draft and what does the amount of draft depend on?

Answer:—The draft produced by a chimney is caused by the difference in weight of the gases inside the chimney and the weight of the outside air. The chimney gases have a higher temperature and are lighter, and the lighter

1800 of These *Dunham Radiator Traps* Used on One Big Vacuum Heating Job

NO UPKEEP COSTS IN 12 YEARS!

This same sort of service is available for every kind of industrial plant and office building. It affords the real economy of **lasting service** and an actual **saving of fuel** through improved radiator operation. These make the Dunham Trap the logical selection for replacement of less efficient types and for new installations.

Plant owners, executives, and engineers are invited to write for detailed information about Dunham Heating Service and Heating Specialties.

C. A. Dunham Co., Ltd.
TORONTO, ONTARIO
Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary
London, Eng.: 18 St. Thomas St., S.E.1.

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE
(MADE IN CANADA)

Dunham is the original thermostatic disc trap. It is simply constructed, effective, dependable. It has made the low pressure steam heating system practical.

gases rise and the cold air flows in to take their place.

If cold air is heated as it enters a chimney, there will be a continuous current of cold air flowing to replace the heated air that is discharged. Since the draft in a chimney is produced by the difference of weight between the column of heated gases inside of the chimney and the air outside, the draft will be greater with a higher temperature inside or with a tall chimney.

The draft pressure is proportional to the temperature inside (measured from absolute zero), and the velocity is in proportion to the square root of the height of the chimney.

* * * *

RESETTING ECCENTRIC

If the eccentric of an engine has slipped on the shaft and it is imperative to have the engine running as soon as possible without placing the crank on a dead center, how can the eccentric be reset?

Answer:—First, turn the eccentric around on the shaft in the direction of rotation until the admission valve opening is correct for the beginning of a stroke of the piston from that end of the cylinder from which a stroke has been partly completed.

This position of the eccentric can be approximately determined by alternately setting the eccentric forward and opening the throttle valve enough to observe whether steam escapes from an indicator connection or cylinder pet cock in the same end of the cylinder but without moving the piston. Then make a light mark on the shaft to correspond with a mark made on the side of the eccentric, and estimate the angle through which the crank would have to be turned backward to bring the crank on dead center, and set the eccentric the same angle forward of the position previously determined.

U.C.C. of E. Notes

The objects of Toronto Council No. 27, Universal Craftsmen's Council of Engineers, are to educate and elevate engineers whose fraternal affiliations are satisfactory; to bring them into closer contact individually and to comfort and relieve their necessities.

Councils consist of active, associate and honorary members who are Master Masons in good standing.

Active members shall be operating, supervising, or erecting engineers; consulting, mechanical, or electrical engineers, and inspectors or examiners of engineering apparatus, who have been practical engineers.

Associate members shall be men who are directly connected with the engineering profession but who are not qualified for active membership.

On April 23rd Canada Council No. 27 will celebrate its anniversary and a good time is assured to all. Visitors are expected from Fidelity No. 6 of Buffalo, N. Y.; Toronto No. 52 of Toronto; Hamilton No. 60 of Hamilton.

Grand Worthy Chief James M. Patton of Buffalo, P. G. W. C., W. J. Ranton of Rochester, N. Y., and P. G. W. C. Henry C. Senn of Buffalo, N. Y., will aid in the celebration on this occasion.

Mayor C. Alfred Maguire, an honorary member of No. 27, is also expected to answer the roll call on the anniversary night.

Br. A. M. Auchterlonie and his entertainment committee are making great preparations for the anniversary.

Two more applications for membership were received by No. 27 at the last meeting.

Chas. L. Holmes, the smiling Worthy Chief of No. 27, says he would like to see the membership of the Council reach 200 by the end of the year. This and more can be done if every member does his share.

Walter J. Hudson, Rec. Secy.
443 Manning Ave.

An occasional squirt of oil on a bearing is the worst form of lubrication—a feast and famine process, wasteful and inefficient.

Automatic Combustion Control

Recent Developments Allow Entire Plant to be Operated as a Unit to Meet Load

*By F. E. OSWALD

KNOWING of the advancements made during the past few years in the art of burning fuel efficiently, it is hard to believe that only recently the importance of proper automatic combustion control has been recognized as necessary to efficient boiler operation.

The attitude taken toward automatic regulation by the majority of engineers can certainly be appreciated because it is a known fact that until recently it was impossible to obtain a control system that would really operate successfully.

There are possibly more so-called "damper regulators" hanging on the walls of boiler rooms and not working, than any other kind of power plant appliance. An engineer has every reason in the world to be skeptical towards equipment of this kind because possibly at some time he purchased a regulator and found it to be unsatisfactory.

Perfect Control Systems

Times have changed, however, and within the past few years, there has been some real development work done on combustion control systems.

Undoubtedly the most important function of a control system is to save fuel. It is a fact that some regulators are an actual detriment rather than an asset to a boiler plant, so it is of utmost importance to know what to look for when buying one.

In the first place, a regulator should have a gradual movement. That is, the fuel and air supply should at all times be in proportion to the boiler steam pressure or load. A control having just two positions—wide open and tight shut—will possibly hold the steam pressure within a five pound range but it will be at the cost of economical operation.

Secondly, it should be simple in construction with a minimum number of wearing parts. A good regulator should be in as good operating condition after ten years of use as when installed.

Gave Ideal View

Several years ago an engineer of national repute voiced his opinion on what he believed would be an ideal combustion control system. His idea was to have a central or master control actuate auxiliary or secondary controls at various places in the plant, each of the auxiliaries to move in unison with the master. At each auxiliary control there should be a means for adjusting the relation of the movement between the master and auxiliary. In this way an auxiliary control could be placed on each boiler so that individual regulation could be obtained. With this method, therefore, the entire plant would be regulated as a unit to meet the plant load and still there would be a provision for adjusting each boiler so that it would operate at its most efficient rating.

The system outlined above has been worked out and can now be obtained. Almost any combination of methods of control can be had because the better systems manufactured to-day are flexible in application and are sold by companies specializing in this branch of engineering.

Other features to look for when buying a control system are:—

Is the regulator simple in construction or does it have a number of compensating devices and wearings parts?

Will the company selling the equipment give an unquestionable guarantee of satisfaction or money back if you desire to have one?

---

*Sales Manager, Carrick Engineering Co.

C.A.S.E. Notes

The Toronto branch of the C. A. S. E. are issuing a souvenir in commemoration of the 34th annual convention to be held at the Central Technical School, Toronto on June 25, 26, 27, 28.

The souvenir will contain a complete program of the convention and a directory of the branches, secretaries, executives and certificate regulations.

It will be mailed on or before June 9 to all members of the association and to a list of prominent engineers. Copies will also be distributed at the convention to visiting engineers.

* * * *

At a meeting of the executive of Toronto No. 1, C. A. S. E., at the residence of George Fowler, 428 Delaware Ave., Toronto, on April 9th, attended by R. McLaren, president; G. A. Brown, secretary; Ed. Golightly, financial secretary; Geo. J. Soucy, treasurer; J. Quinlan, conductor; G. D. Bly, auditor, and Geo. Fowler, trustee, legislative matters were discussed.

In view of the fact, however, that refreshments and a musical program were in store, the business of the evening was expedited, all present agreeing that Mr. and Mrs. Fowler were splendid hosts.

* * * *

The regular meeting of London No. 30 C. A. S. E., was held Friday evening, April 6, and was well attended.

Grand Conductor, Bro. R. E. Arnup, of Woodstock, was present but Grand Secretary Bro. T. G. Eliss, of Hamilton, who also had been expected, was forced to cancel his visit through unforeseen causes. Bro. Arnup gave an interesting address, and Bros. Lyme and Moll also spoke.

London No. 30 tendered their confidence and support to Bro. G. F. Galloway, who is now Grand President, as a result of the resignation of Grand President Bro. Wright. The London members are sure the association is on the way to greater success.

Jos. H. Ward,
Rec. Secretary,
90 Rectory St.,
London.

* * * *

Kitchener Lodge No. 9 of the C. A. S. E. meets every 2nd and 4th Friday in the month in Moose Hall, corner King and Ontario Sts.

Our regular business meeting was held April 13th, and we had a very good attendance. We held an at-home recently, which also was very successful both in attendance and financially.

Mrs. C. Ott, Miss Merrett and Mr. Rodge Gofton each gave a recitation, also some members of the Waterloo boys' band furnished a few musical selections.

Music for dancing later was provided by Mr. Carl Ott on the Xylophone, accompanied by Mr. Carl Zinkan on the piano.

Bro. Frith of the General Hospital mechanical staff (Toronto) who is a member of No. 9, spent a few days in Kitchener last week and called on a good many brother engineers who were all pleased to see Bro. Frith.

Bro. C. Emmrich, engineer at the Button works, met with an accident recently, and has been laid up for a week with a sprained knee, but we are pleased to see he is now back on duty again.

C. Ott,
202 Breithaupt St.,
Kitchener, Ont.

Announcements

Auto Gear Co., 1175 Bathurst Street, Toronto, have been re-organized and will operate under the name of Toronto Gear Co. at the same address. Henry Winger is the president of the company; W. E. Lear, vice-pres.; E. J. Winger, sec.-treasurer.

The Combustion Engineering Corporation, Ltd., and the Uehling Instrument Company have entered into an agreement whereby Uehling interests in Canada and Newfoundland will be handled exclusively by the Combustion Engineering Corporation, Ltd., with principal offices located in Toronto, Montreal, Winnipeg and Vancouver. The Uehling line includes such equipment as CO_2 recorders draft recorders, combined barometer and vacuum recorders, absolute pressure indicators, etc.

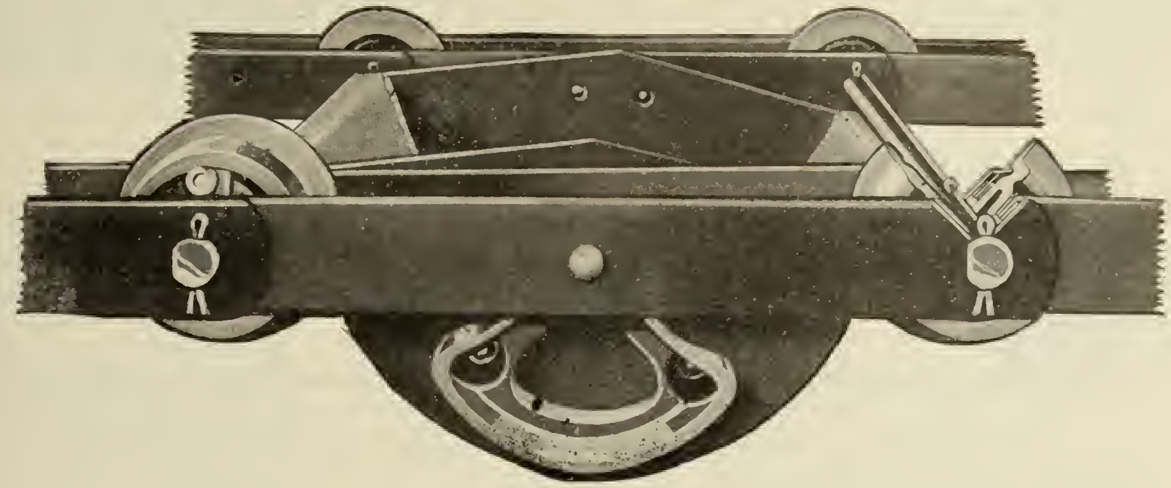
The Montreal committee of the American Society of Mechanical Engineers is doing intensive work in preparation for the spring meeting to be held in Montreal, May 28-31.

Monday, May 28, will be given over to

"MEAD-MORRISON"

Steel Bucket Conveyors

Convey and elevate in Canada a greater tonnage than all other makes combined



Especially adapted for handling Coal, Ashes, Raw Sugar, Cement, Refined Sugar, Crushed Stone, Hot Clinker, Phosphate Rock and other bulk materials.

WELDED STEEL BUCKETS—STEEL LINKS
DEPENDABLE SERVICE

Agents :

B.C. Equipment Co., Limited, Vancouver.
Powell Equipment Co., Limited, Winnipeg.
Harvard Turnbull & Co., Toronto.
O'Hanlan Ferguson Supply Co., Edmonton.
Ferguson Supply Co., Calgary.

Made in Canada by

CANADIAN MEAD-MORRISON CO
LIMITED
CANADA CEMENT BUILDING
MONTREAL
WORKS: WELLAND ONT.

MAGNOLIA
ANTI-FRICTION METAL

is always uniform in composition and depend[illegible] quickly to rough or scored shafting, makes smooth highly polished contact surfaces and "sets" particles of grit where they cannot cut the journal or appreciably increase friction.

Magnolia Metal melts and pours well, is easily peened and scraped in and is perfectly adapted to a very wide range of speeds and pressures. With the lowest frictional coefficient of any known bearing metal, it runs cool with less lubricant and is excellent protection against hot boxes and melting out where lubrication is neglected.

Sold in ingots and cored bars, the latter to eliminate shrinkage, and pattern and casting costs on small bearings.

Write for test data.

Magnolia Metal Company
113 Bank St. - New York

Chicago
Fisher Bldg.
San Francisco
Pacific Bldg.
Montreal
37 Shannon St.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK

Cut Your
Replacement Costs

Replacements of furnace linings, boiler settings, etc., is a costly operation nowadays. Why not avoid this trouble and expense by welding your Fire Brick into a solid one-piece structure with

STERNSON No. 30

the only Canadian Made High Temperature Cement that will give your furnace protection where it needs it most—at the joints. Sets harder than the bricks, withstands up to 3,000 deg. F. Try it out on a repair job.

"Let a Technical Firm do a Technical Job"

G. F. STERNE & SONS, LIMITED
Chemical Manufacturers, Consulting Chemical Engineers
BRANTFORD - - CANADA

a meeting of the council and a business meeting of the society, and in the evening there will be a joint meeting of the councils of The Engineering Institute of Canada and The American Society of Mechanical Engineers. Technical sessions will be held Tuesday morning. Wednesday and Thursday afternoons will be devoted to visits to points of engineering and historical interest in and near Montreal. On Thursday evening there will be a "smoking concert" tendered by the Montreal branch of The Engineering Institute of Canada. A dinner-dance will be held Wednesday evening.

Wayne Oil Tank & Pump Co., have removed their Toronto sales office from 119 Adelaide West, to 165 Dufferin Street. The latter premises were formerly occupied by the Mason & Risch Co., piano manufacturers, the building comprising about 50,000 feet square floor space.

Dodge Manufacturing Co. of Canada are now sales representatives for Chapman ball-bearings, now being made by the Corman Engineering Co., Toronto, and will carry large stocks of the Chapman line in Toronto and Montreal.

Canadian Westinghouse Company has secured the contract for the generators for the Quebec Development Company in connection with the great power project at Lake St. John. The equipment will consist of eight 40,000 horse power water wheel generators. The construction work on the dam is being done by the Nova Scotia Construction Company. In addition to the above equipment the Westinghouse Company sold the Development Company the 15,000 horse power generator for the construction work. This generator will be delivered early in June.

Construction

Yorkton, Sask.—The city plans the construction of a power plant. Estimated cost $100,000.

Port Stanley, Ont.—The Hydro-Electric Power Comm., 190 University Ave., Toronto, plans to build a steam power plant, 1,000,000 h.p. capacity here.

Campbellford, Ont.—The Hydro-Electric Power Comm., 190 University Ave., Toronto, has had preliminary estimates made for developing about 10,000 h. p. at Dam 8, including power house, turbines, generators, switches, transformers, etc., on the Trent River, near here. Estimated cost $1,066,408.

Port Arthur, Ont.—The Hydro-Electric Power Comm., 190 University Ave., Toronto, plans to install a 12,500 h. p. unit in its plant, on the Nipigon River at Cameron Falls, including head 78 ft. vertical turbine directly connected to generator, 120 r. p. m., 10,600 kva., 12,000 volt, 3 phase, 60 cycle; circuit breakers; step up transformers. Estimated cost $1,500,000.

R. H. Cowley, chief inspector for the Board of Education, Toronto, has recommended that a new school be erected south of College Street, near Bathurst, and north of Dundas Street.

Quebec Exhibition Commission is erecting new buildings costing $300,000. The new Industrial Building will cost $125,000, and the Agricultural Building, $175,000. Foundations for the former are now being laid. It is expected the buildings will be completed for the 1924 Fair.

Over ten million dollars is to be spent on rehabilitating the plant of the New Brunswick Power Co. by American interests who have purchased the control of the company's stock. As soon as this work has proceeded to a certain point, steps will be taken to increase not only the company's gas business, but its power business as well.

Engineering & Radio Supplies, Ltd., Orangeville, Ont., have taken over the Cataract Electric Co., and the Industrial Engineering Co. of Canada, and will erect additions to the plant occupied by the Cataract Electric Co. at Cataract, Ont., to increase production from 800 h.p. to 3,000 h.p. R. G. Lee is president of the former company.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES **$1 A MONTH**
8754 ILLUSTRATIONS **$12 COMPLETE**

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________________

Occupation ____________________

Employed by ____________________

Residence ____________________

Reference ____________________

GEO. CALLARD
BUILDER & CONTRACTOR

Furnace and Boiler Work a Specialty

Highest References from All the Leading Engineers of the City

Phone: Uptown 1590

210 Quesnel Street
Montreal

SITUATION VACANT

FACTORY SUPERINTENDENT OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1¼-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order. Apply Box, 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

SAWMILL MACHINERY—MODERN DESIGN—most satisfactory to operate. Apply Box 105, Power House.

SAWMILLS—PORTABLE — DOUBLE EDGES; also all kinds sawmill machinery. Apply Box 106, Power House.

TAYLOR SAFES FOR SALE—RARE OPPORtunity to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250 00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

WELDING

ELECTRIC AND ACETYLENE WELDING of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

BELTING BARGAIN

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

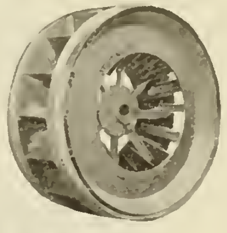
M. BARRY WATSON
B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer

Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W



Sturtevant Cindervane fans protect fresh paint, delicate fabrics or the surface of fine papers from discoloration by cinders and dirt.

Write for Folder 609.

B. F. Sturtevant Co.
of Canada, Ltd.

Montreal Galt Toronto

SEE BUYERS' GUIDE PAGES 48-50-52

YORK Ice Making & Refrigerating **MACHINERY**

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO., LIMITED

Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal

1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

THE BROWN INSTRUMENT COMPANY
Largest Pyrometer Manufacturers in the World.
PHILADELPHIA, PA., U.S.A.

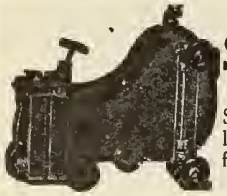
For Province of Quebec
LaChapelle Eng. Co.,
414 St. James St.,
Montreal, Que

For Ontario
Brown Instrument Co
1,21 Ford Building,
Detroit, Mich., U. S. A.

Send for Catalog No. 2.

Brown Pyrometers

HINTS TO BUYERS



McDaniel Improved

STEAM TRAP

FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

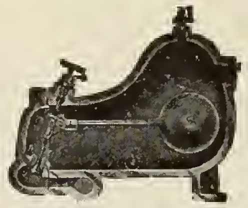
May We Send One on Trial?

Reduecing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

GARLOCK

Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS

THE GARLOCK PACKING COMPANY

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T.J. CUNERTY** *Company*
Room 240 17, Queen St, East. Toronto.

Why Individual Boiler Feed Water Treatment?

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)

Distributors : William C. Wilson & Co., 21 Camden Street, Toronto

Phone Adel. 1054 or write for full particulars.

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors

OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue*

Patterns *Machine Work*

INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE

OF POWER HOUSE

Be Rid of Boiler Furnace Lining Troubles

Arches and Furnace Linings in one piece. No brick, no joints. Any handy man installs it without special forms or tools.

Betson Plastic Fire Brick kept on hand for emergency repairs and for use in building sloping baffles always proves profitable. **Write for instructive booklet.**

Betson Plastic Fire Brick Co., Inc. P. O. Box 386-6. ROME, N. Y.

CANADIAN DISTRIBUTORS: International Chemical Co., 26-6 Adelaide St. E., Toronto, Ontario, Canada

OIL BURNING SYSTEMS

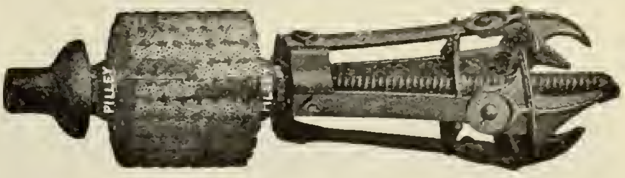
INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.

LAURIE ENGINE CO.

(The Service Engineering Company of Canada).

601 NEW BIRKS BLDG., MONTREAL, QUE.

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.

623 South Third Street - - St. Louis, Mo.

Eastern Office: 71 Fulton St. New York

Foxboro quality indicating and recording thermometers, pressure gauges, liquid level gauges, vacuum and draft gauges and CO2 recorders are designed and built especially for power plants and industrial processes. Write to Dept. C.F.

THE FOXBORO CO., INC.,
Foxboro, Mass., U.S.A.

FOXBORO
TRADE MARK
THE COMPASS OF INDUSTRY 4915

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES.

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Lunkenhelmer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Can. Johns-Manville Co., Ltd., Toronto,
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn,
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co,. Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co,, Limited.

BELT LACING
Bristol Co, The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co.; Ltd., Toronto, Ont.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd,, Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R. Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co. Cincinnati, Ohio
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, Ltd., Montreal
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co,, Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont,

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford,

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa,

CLUTCHES
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal,

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co,, Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

The Whole Story

Metallic Condenser Tube Packing

(Copyrighted April, 1923)

Covers causes for condenser tube deformation, disintegration, electrolytic action and remedy through use of metallic packing. Thoroughly illustrated and complete.

A Copy for Each Engineer. Write!

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
Beldam's Asbestos Packing & General Mfg. Co., Ltd.
Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver. B.C.
"MADE IN CANADA"

Dunlop Belting and Hose

DUNLOP
BELTING

"Gibraltar RedSpecial"

—the High-Grade Belt for Transmission Service.

"Gibraltar"

Conveyor and Elevator Belts

—the Belts with the protective covering of Cord Tire Tread Stock that effectively resists abrasive action.

DUNLOP
Belting Hose Packing
And General Mechanical Rubber Products
For Every Purpose

Standby Electricity at $0.03½ per K.W. Hour

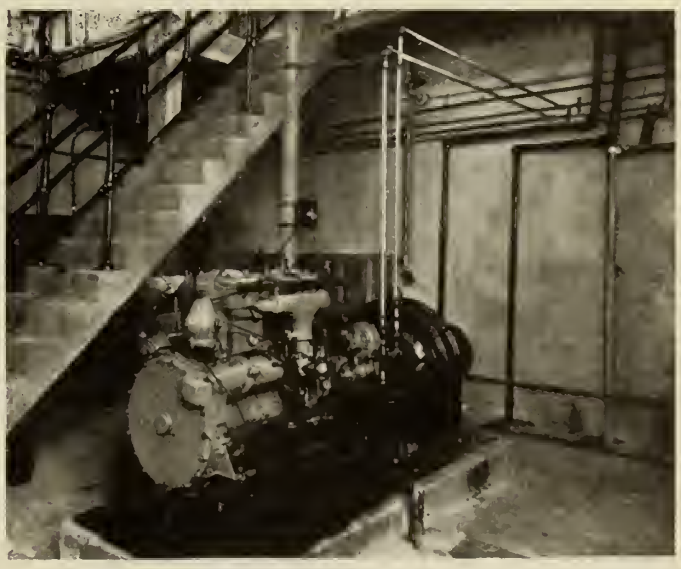
Sterling
THE ENGINE OF REFINEMENT

High Duty Gasoline Engines for Peak Load and Emergency Generator drives at 1,200 R.P.M.

Assure Dependable Service—at all times.

CENTRAL STATIONS

How do your customers feel about it when power is off? Coal shortages, strikes, transportation delays, line troubles or mechanical break downs may not be your fault. But—you can provide a really dependable standby for about $20.00 a horsepower. Check it against steam at an installation cost of about $210.00 a horse power. No fuel cost when standing by. Check that against maintaining 40 lbs. of steam in banked fires for emergency. In both cases the difference adds to your profits.



24 K. V. A. General Electric generator for emergency in power station at Defiance, Ohio. 4 cylinder Model FC STERLING.

Further particulars on request 50 to 300 h.p. in single units. 600 to 1,500 r.p.m.—centrifugal pump and electric generator speeds.

Sterling Engine Co. (Dept. C4) **Buffalo, N.Y., U.S.A.**

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N. Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa.

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa.
Graver Corp., East Chicago, Ind.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div. Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto. land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal,
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co, Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MADE IN CANADA

DEPENDABLE WRENCHES

Williams' line of "W. & B." Screw Wrenches are strong, sturdy, dependable tools.

Machinists' Knife Handle and "Railroad Special" Wrenches are recommended for the heaviest service; 7 sizes; 6 to 21 inches.

Agricultural Wrenches meet the demand for a good tool at a moderate price. 5 sizes; 6 to 15 inches.

J. H. WILLIAMS & CO., Limited
"The Wrench People"
78 Thorold Road St. Catharines, Ontario

Hospitals MUST NOT risk a boiler shut-down

-other power plants SHOULD NOT!

A modern hospital cannot risk a boiler shutdown in cold weather; **continuous service is a matter of life and death.**

That's why hospitals like nearly all of the large central stations— prefer the

A few of the internationally known hospitals which have the "COPES."

- U. S. Navy Hospital, Wards Island, N. Y.
- Good Samaritan Hospital, Cincinnati, Ohio.
- Rochester Hosp., Power House, Rochester, Minn
- Henry Ford Hospital, Detroit, Mich.
- Crownsville State Hosp., Crownsville, Md.
- Homeopathic State Hosp., Allentown, Pa.
- Mercy Hospital, Chicago, Ill
- Colorado State Hospital, Denver, Colorado.
- Army & Navy General Hosp., Hot Springs, Ark.
- State Insane Hosp., Farnhurst, Del.

COPES System of Boiler Feed Water Regulation

Unfailing reliability. Even when the COPES is neglected, it **mechanically** maintains a safe water level.

The feed rate is changed to meet every change in boiler load, so that there is less furnace forcing. Service records show that the COPES saves 2 per cent. to 8 per cent. of fuel costs.

Our new catalog "D" gives many charts made in actual service, charts which illustrate the **economy** of accurate control. WRITE FOR CATALOG "D"

NORTHERN EQUIPMENT CO., 112 West 11th St., ERIE, PENN.
Branch Plants: Hamilton Ontario, Canada; Croydon, England; Paris, France; Cologne, Germany

COPES
SYSTEM OF BOILER FEED CONTROL

FLAME BRAND
HIGH TEMPERATURE CEMENTS

RED FLAME
PLASTIC CEMENT
WHITE FLAME
INSULATING CEMENT
BLUE FLAME
FIRE BRICK CEMENT

"MONO" TRADE MARK
REG US PAT OFF
BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE

KING REFRACTORIES CO. INC.

SOLE CANADIAN REPRESENTATIVES:
GRANT E. COLE CO.
21-23 River St.
TORONTO, CANADA

Represented in
VANCOUVER, WINNIPEG,
MONTREAL, HALIFAX

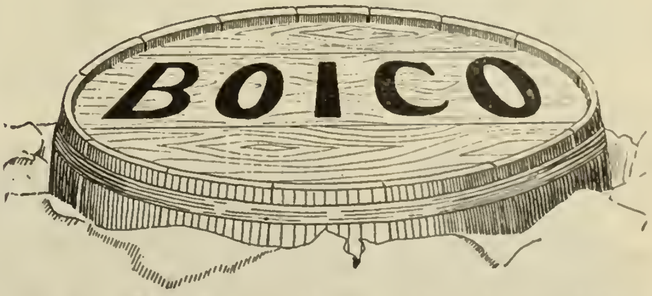
Makes Short Work of Boiler Scale

In hundreds of plants **BOICO** has been adopted as the one sure clean-boiler insurance. The speed with which it removes the most stubborn scale formations is surprising. Hurts nothing but boiler scale. It's economical, too.

TRY IT FREE—let us send you a sample to convince you. Write us to-day—you've nothing to lose.

SHELL-BAR BOICO SUPPLY LTD.
1-15 SAUNDERS AVE. - TORONTO

SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ontario.



PACKING, AMMONIA, STEAM AND WATER
Beveridge Suppy Co., Montreal
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co, Ltd., Peterborough, Ont.
Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Out.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P Q
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batie Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton,

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal,
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal,
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)
Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM TRAPS
American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Julian D'Este Co., Boston 14, Mass.
Sarco Co., New York, N. Y.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal,

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE
Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Barco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TACHOSCOPES
The Reliance Gauge Column Co., Cleveland Ohio.
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING
Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co. St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

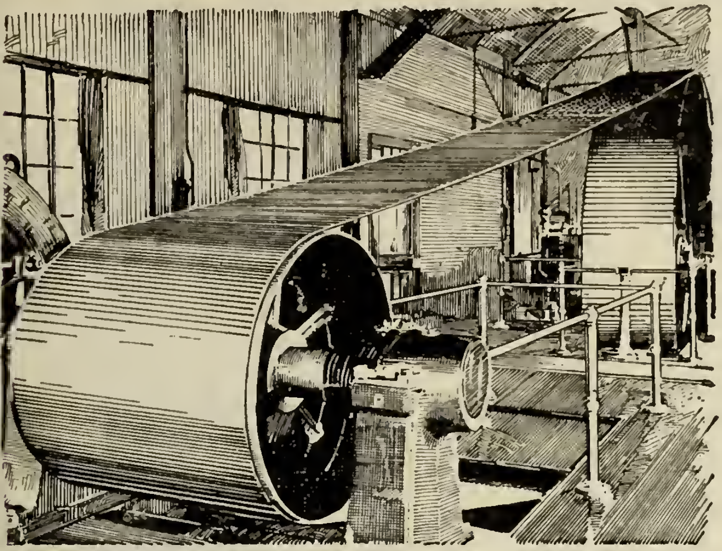
TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal,
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Shell Bar Boico Supply, Ld., Toronto.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa,

Underfeed Stoker Co., Toronto, Ont.

WALKWAYS, (Irving Subway)
Irving Iron Works Co., Long Island City, N Y.



Dick's Balata Belt

An unequalled combination of essentials:—

1. Tensile strength.
2. Tractiveness.
3. Pliability.
4. Elasticity.
5. Ability to hold fasteners.
6. Resistance to stretch.
7. Uniformity.
8. Durability.

Don't accept this as a mere statement. Write our nearest Branch for Booklet that shows clearly why this original Balata Belt is the Cost and Power Saver pre-eminent.

The Canadian FAIRBANKS-MORSE Company, Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary,
Vancouver, Victoria. 70

Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.

DURABLA

TRADE MARK REGISTERED

Strength; Goodness; Quality—these features distinguish durable Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

DURABLA is not affected by vibration or condensation. It will not burn out, blow out or pulp at the points. Let us send you a trial sample. Made in stock sizes 36 in. wide x 144 in. long, and 48 in. wide x 144 in. long in thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Orders Filled Promptly.

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

A Reasonable Saving of 5 to 10%

Should You Expect More?

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee St. PHONE G. 3660 Toronto, Ont.

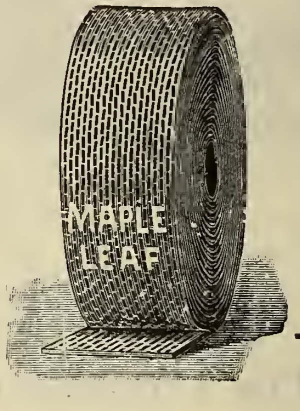
Power House
Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

$2.00 PER YEAR — Every Power Plant employee should read Power House



Canada's
National
Stitched
Cotton Duck
Belting

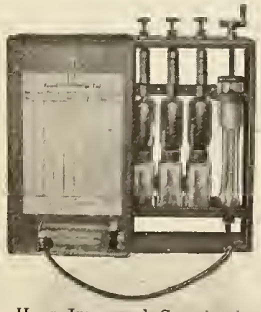
"Maple Leaf" Brand

Sole Manufacturers

The demand for "Maple Leaf" Brand Stitched Cotton Duck Belting (of which we are the sole manufacturers in Canada) has steadily increased in popularity. The standard quality of this belting is always maintained—it costs you less than other belting and is decidedly more efficient.

Have you ever used "Maple Leaf" Belt Dressing? Write for prices and further information.

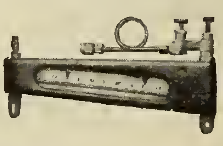
Dominion Belting Co., Limited
Hamilton - Canada
Quebec Branch: 51 Duluth Bldg., Montreal.



Hays Improved Gas Analyzer.

Are You Wasting Fuel?

Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO_2, O_2 and CO; 1-chamber Analyzer for CO_2 only. Stocked by Canadian Agents listed below.



HAYS DRAFT GAGES, "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts" and Draft Regulation."

P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
Michigan City, Indiana

General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.

85% Magnesia

"Featherweight"

MAGNESIA
KEASBEY & MATTISON CO.
FEATHER WEIGHT
85%
AMBLER, PA.
SECTIONAL COVERINGS

Retains its
Coal-Saving
Qualities

It Never
Deteriorates

DON'T be misled! Many pipe coverings made in the past few years show up well under efficiency tests but in practice fail to stand up. Durable qualities are lacking. Cases are on record where such coverings have been shaken to pieces within a year.

You need pipe and boiler covering that holds its heat-conserving qualities for years. That is the only kind that pays. You want K. & M. "Featherweight" 85% Magnesia Pipe and Boiler Covering.

The same heat saving efficiency, the same saving of coal is registered, whether 85% Magnesia coverings have been on steam pipes for a week, a month, a year or a quarter of a century.

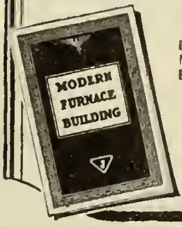
Let us explain more fully 85% Magnesia.

Keasbey & Mattison Company
25 Front St. East, TORONTO

PLIBRICO
JOINTLESS
FURNACE LINING

The beginning of furnace economy

This 50-page book FREE



WHEN you have opened your first container of Plibrico Furnace Lining then—and not until then—you have started on the direct road to economical furnace operation.

Plibrico is a plastic lining that is installed with mallet and trowel. When baked, it forms a jointless lining that is airtight, gastight, resistant to temperatures to 3100 deg., and that outlasts ordinary fire-brick linings two to four times. Because of its putty-like form, Plibrico is ideal for baffles, arches and other special shapes.

Plibrico is delivered only in steel containers of distinctive appearance as shown above and below.

DISTRIBUTED BY: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's Ltd., Calgary, Alta.

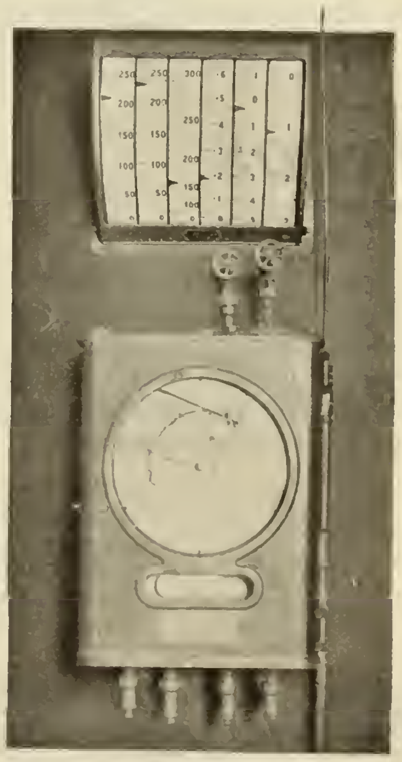
JOINTLESS FIRE BRICK CO
1142 Clay St., CHICAGO, ILL.

How Much Coal Are You Wasting?

Blindfolding yourself to the fact that your boiler room is different, because you can see no pipe line leaks, or the water alarms don't blow very often—doesn't help to pay for the needless fuel waste caused by the invisible losses within the boiler furnaces.

Get at the REAL FACTS and at the same time give your men a positive and simple guide that will enable them to keep the plant at top notch efficiency—by installing the

BAILEY BOILER PANEL



The Bailey Boiler Panel is a combination of the Bailey Multi-Pointer Gage and Bailey Boiler Meter.

It shows, almost immediately, the effect of improper furnace adjustment and enables the men to make the necessary correction before a large amount of preventable fuel waste has taken place. Good work on the part of the men is shown up by the charts as well as any inattention. The engineer can check the efficiency of his men as well as that of the individual boiler.

Let us send you fully descriptive Bulletins.

BAILEY METER COMPANY Limited
177 DELORIMIER AVE. - MONTREAL, QUE.

INDEX TO ADVERTISERS

A

Audel, Theo. 45
Allen Feed Water Furifier Co... 47

B

Babcock & Wilcox, Ltd., ... 39
Betson Plastic Fire Brick Co., Inc. 47
Bailey Meter Co. 55
Brown Instrument Co. 45
Bristol Co. 5
Boiler Repair & Grate Bar Co... 14
Buyers' Directory...... 48, 50, 52
Builders Iron Foundry......... 17

C

Callard, Geo. 45
Canadian Fairbanks-Morse Co., Ltd. 53
Canadian Steam Boiler and Equipment Co. 54
Superheater Co., Ltd., The..... 47
Conveyors Corp. of America..Front Cover
Cory & Sons, Inc., Chas........ 5
Combustion Engineering Co. ... 13
Cunerty Co., T. J. 46
Can. Mead-Morrison Co. 43

D

Dart Union Co. 6
D'Este Co., Julian 56
De Laval Steam Turbine Co... 6
Detroit Stoker Co. 15
Dominion Belting Co. 54
Dunham Co., C. A. 41
Durabla Mfg. Co. 53
Dunlop Tire & Rubber Co., Ltd. 49

E

Engineer and Mach. Works of Canada 17
Edward Valve & Mfg. Co. 8

F

Fisher Governor Co. 4
Foxboro Co., Inc. 47
Flexible Steel Lacing Co. 7
Flexible Metallic Packing Co... 49

G

Garlock Packing Co. 46
Garth Co., The 46
General Engineering Works.... 53
Goldie & McCulloch 20
Gutta Percha & Rubber Co..... 2

H

Hays Corp., Jos. W. 54

I

Irving Iron Works............. 19
Imperial Oil Co. 9

J

Jamieson Cold Storage Door Co. 12
Jenkins Bros. 11
Jointless Fire Brick Co. 55

K

Keasbey & Mattison Co. 55

L

Laurie Engine Co. 47
Lunkenheimer Co. 3

M

Magnolia Metal Co. 44
MacLean Underfeed Stoker Co. Inside Front Cover
McGowan Co., The John H..... 10
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncreiff, Ltd. 47
Mueller Mfg. Co. 18

N

Northern Equipment Co. 51

P

Pilley Packing & Flue Brush Mfg. Co. 47

R

Refinite Co. of Canada........ 46

S

Sterne & Sons, G. F........... 44
Sarco Co., Inc. 4
Sanford Riley Stoker Co. 16
Shell Bar Boico Supply Co..... 51
Sterling Engine Co. 49
Sturtevant Co. 45
Cole Co., Grant E.............. 51
Sexton Boiler Setting Co., W. R., Inside Back Cover

T

Taylor Instrument Co., The..... 56
Thomson-Gordon, Ltd. 46

U

Underfeed Stoker Co. of Canada 16

V

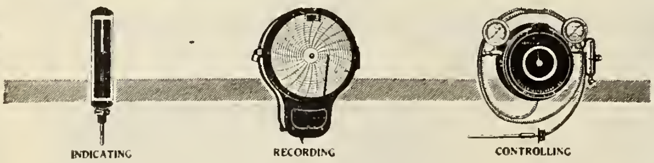
Victoria Foundry Co. 17

W

Wall, W. J. 47
Waterous Engine Works Co..... 1
Watson & McDaniel Co. 46
Watson, M. Barry, M. E........ 45
Williams & Co., J. H.......... 51

Y

York Mfg. Co. 45
Young Pump Co. of Canada. ... 8



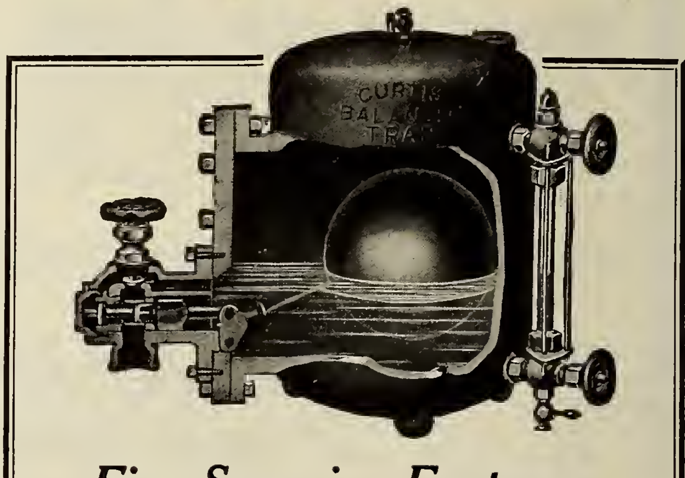
Tycos
temperature
instruments

Prove their worth by their ability to meet every temperature condition encountered in the power house. Specify *Tycos* whenever a problem comes up involving either the indicating, recording or controlling of power plant temperature.

The *Tycos* Power Plant Catalog Part One is a reference book that should be on the desk of every engineer and power plant operator. Write for your copy.

Taylor Instrument Companies
Canadian Plant: *Tycos* Building,
110-112 Church St., Toronto, Ont., Can. 892 AZ
There's a *Tycos* and *Taylor* temperature instrument for every purpose

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

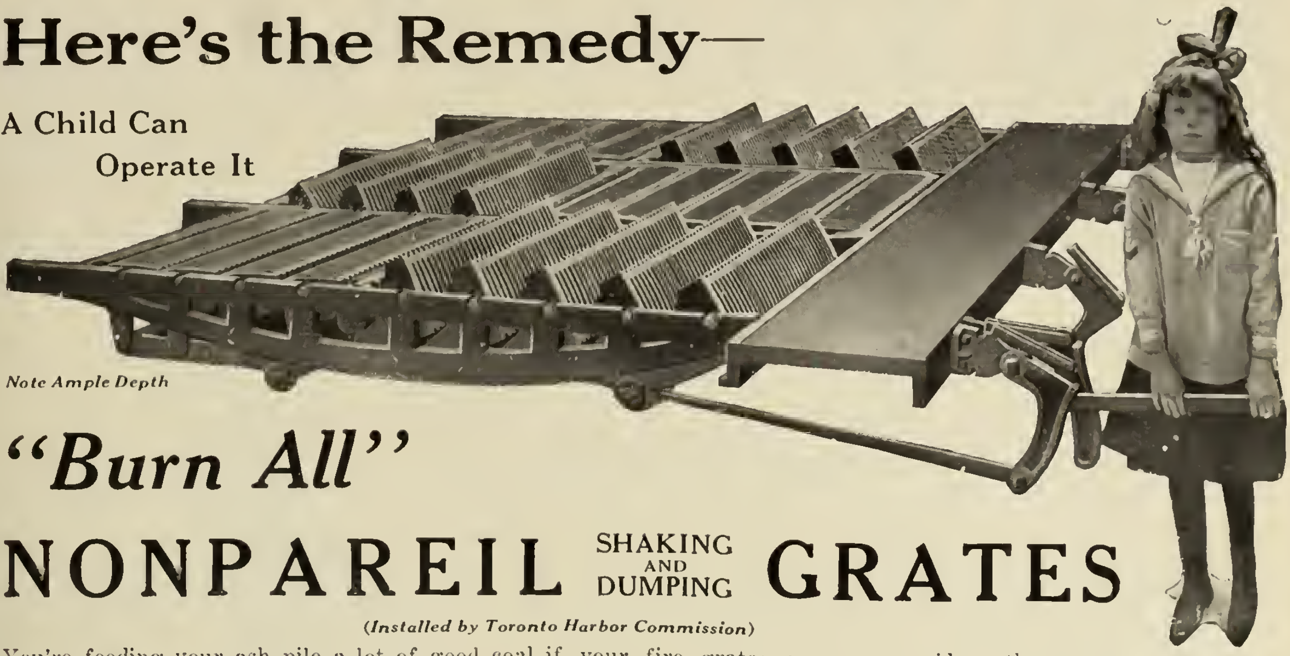
Send for descriptive circular of this trap.

Sole Distributors for Canada:
DARLING BROS., 120 Prince Street, Montreal, P. Q.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.

Got Any Fuel Troubles?

Here's the Remedy—



"Burn All"

NONPAREIL SHAKING AND DUMPING GRATES

(Installed by Toronto Harbor Commission)

You're feeding your ash pile a lot of good coal if your fire grates are not providing the proper proportion of air to get complete combustion.

The 65% air space and 95% underdraft that is a feature of NONPAREIL GRATES under normal conditions means that you are getting full value for every dollar you spend in fuel.

That's the way some of the largest Canadian concerns figured when they decided to instal

NONPAREILS

after putting them to the test. Not only that, but they found out that they could get maximum heat value even out of cheaper grades of fuel. Now they're saving both ways! Why not investigate?

FIRE BRICK WORK

Our Specialty

Let "Safety-First" Sexton handle your fire brick work, building-in boilers and general repairs. Only the best high tension fire cement is used. Sexton has gained a reputation for doing the work with rare efficiency. His work lasts longest and many of the largest plants are ready to back up this statement.

Call in Sexton for renewals and repairs for all kinds of Shaking and Dumping grates for all sizes of boilers.

Agents:

GATES ENGINEERING CO., Montreal, Que.
MR. C. BERRY, Ottawa, Ont.
MR. A. McTAGGART, Leamington, Ont.
W. GREEN, Church St., Smiths Falls, Ont.

MANUFACTURED SOLELY BY

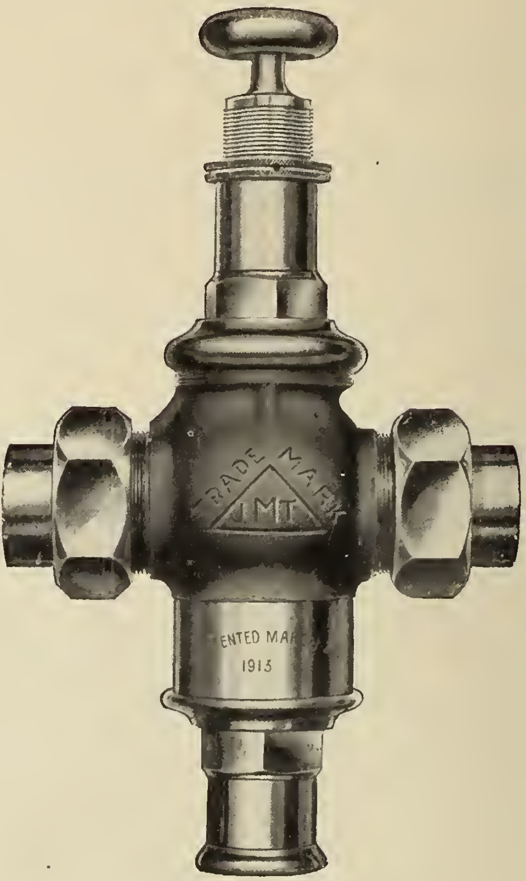
THE W. R. SEXTON BOILER SETTING CO.

Established 1900 114 Grenadier Road, Toronto *Phone Junc. 2765W*

MORRISON

STEAM GOODS

Steam Fan Regulators



THE application of a close study into the requirements of steam specialties during our fifty years' experience is reflected in the widespread popularity of Morrison Steam Goods.

Exacting engineers appreciate the fact that superior quality, workmanship and design ensures dependability at all times, even under the shocks of constantly changing conditions.

The Regulator here shown may be depended upon to maintain a uniform boiler pressure by varying the speed of the Fan Engine according to the requirements of the plant. They are also used for controlling steam jet blowers.

"Every Installation is a Demonstration of Merit"

We shall be pleased to send you a catalogue describing our products.

The James Morrison Brass Mfg. Co., Limited
93-97 Adelaide St. W. TORONTO

POWER HOUSE

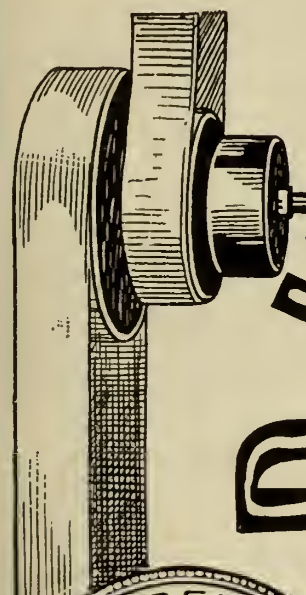
Fostering Economy and Efficiency in Steam, Gas, Electric, Air and Water Power; Refrigeration; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG. 88 Fleet Street, E.C. NEW YORK, BOSTON, CHICAGO.

Vol. XVI—No 9. Toronto—May 5, 1923 A Semi-Monthly Newspaper. Canada, $2; U. S. $2.50 a year.

D. K. McLAREN'S

Genuine British-
-Oak Tanned
Leather Belting



EVERY time a belt needs repairing during working hours a tremendous waste of time is incurred—men are idle, machines are idle, production is retarded.

All belts require repairing at some itme. But the belt that requires the least amount of repairing is the most valuable. In the course of a year a good quality belt will save many hours of production time.

D. K. McLaren's Leather Belting is of **good quality**—the kind that can be depended upon to require the least amount of repairing. It gets its good quality from the fact that it is made from the choicest part of carefully selected hides (the best part of the hides for belting the backs) and furthermore each piece of leather is then treated with the famous **British Oak Tanning Process** by expert men of long experience. Specify D. K. McLaren's Belting on your order and you will be assured of less belt breakage, less belt slippage and all-round belting satisfaction.

GENUINE OAK

D·K·McLAREN
LIMITED

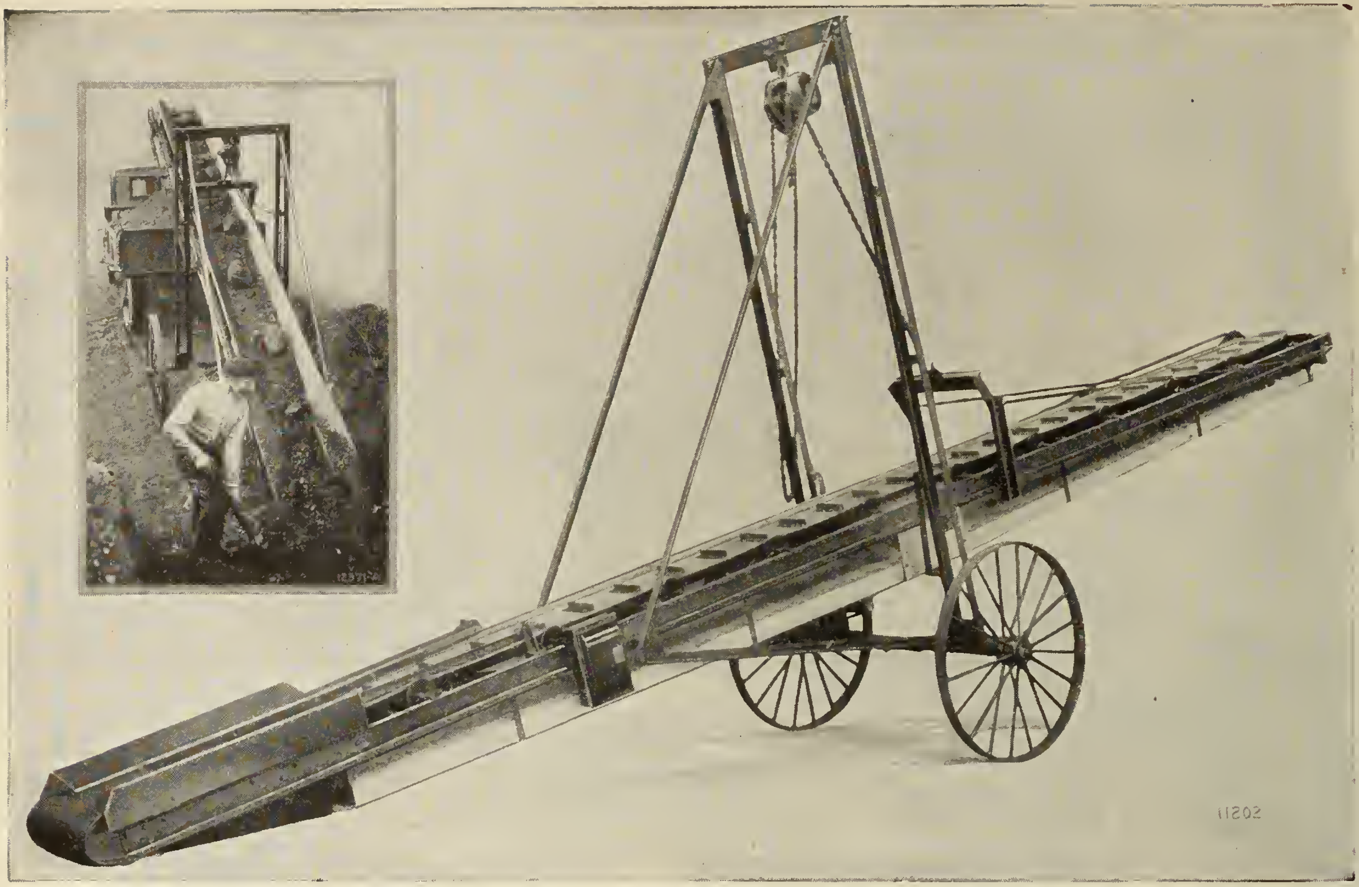
GENUINE OAK

Head Office and Factory: 351 St. James St., Montreal, Que., Can.

BRANCHES: Toronto, Ont., 194 King St. West; St. John, N.B., 90 Germain St.
STOCK DEPOTS: Vancouver, B.C., Gorman's Limited, 1158 Homer St.; Edmonton, Alta., Gorman's Limited; Calgary, Alta., Gorman's Limited.

IN THIS ISSUE

Manitoba's Daily Heating "Log"
Corrosion Problems in Power Plants



THE "CUB"—A LINK-BELT LOADER—$790.00

FEATURES

- Simplicity of design.
- Length of conveyor, 21 ft.
- Substantial construction—weighs about twice as much as some machines of this type.
- 18" wide belt, giving large carrying capacity.
- Belt guaranteed against cutting or fraying.
- Wide loading hopper at foot of conveyor is hinged—easily and quickly opened.
- Requires little power—2 H.P. motor, 2 or 3 phase, 60 cycle, A. C.

HERE'S a thousand-dollar Link-Belt Portable Belt Conveyor at our new low price—$790.00. It is one of our standard types, built to the high Link-Belt standard. It is guaranteed.

Increased production, due to our large volume of sales, has made this low price possible.

Even if you load only a small quantity of material—at intervals—can you afford to pass up an opportunity like this ? Fill out and return the coupon.

1187

Date................

CANADIAN LINK-BELT COMPANY, LIMITED, 265 W. Wellington St., Toronto.

☐ We are interested in the Link-Belt " Cub " Portable Belt Conveyor. Send us further information.

☐ We handle.............tons of.............per.............from.............to.............

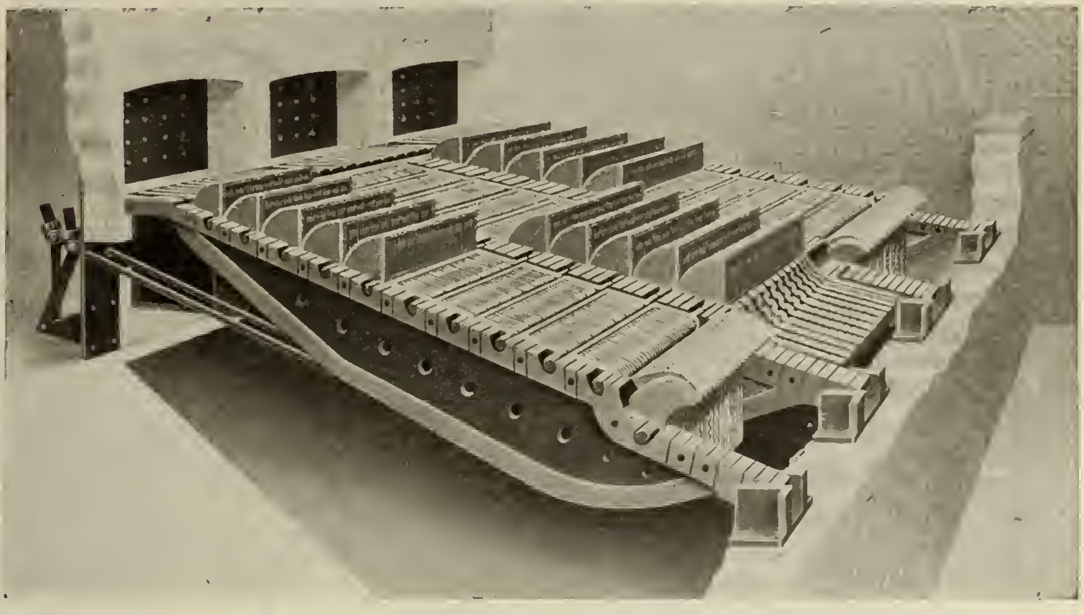
☐ Send us the Link-Belt Portable Loader Book No. 550, showing the complete Link-Belt line of Portable Loaders.

Name.. Firm..

Address.. City.................................... Province....................

(Power House)

LINK-BELT



THE FILES STOKER

Pays for Itself in One Year

Below is a copy of one of the many letters we have received, telling of the efficiency and economy of the Files Hand-Operated Stoker

Re FILES HAND STOKERS.

Gentlemen:—

Frequently we receive letters from manufacturers, asking for information and our experience with the "Files Hand Stokers"—the most economical and efficient system of burning coal with the utmost conservation of labor.

As these inquiries are becoming more and more frequent, our better plan will be to furnish you with a letter to pass on, outlining our experience and satisfaction.

In September, 1920, we placed an order with you for two 150 H.P. Tubular Boilers, specifying our desire to have them equipped with "Files Hand Stokers." This we did on the recommendation of our United States Engineering Department, who had installed "Files Hand Stokers" in some seventeen plants, finding in them a decided saving and advantage over flat or shaking grates.

Speaking for ourselves, we have found them most satisfactory and economical, particularly so in regard to the elimination of smoke, rapid disposal of ash and clinker, thorough cleaning of fires without disturbing the active fire, and in maintaining an even bed of fuel.

We are able to keep a clean fire at all times; we have no cleaning period, for with the "Files Hand Stoker" the grate can be cleaned at peak load. It is only a matter of working one rod on each section, which can be done in less than two minutes.

The better the coal the better the result, but almost any kind of coal that will burn free can be used. With good coal, however, it is an easy matter to procure 150% boiler rating, which in reality is 12½ lbs. evaporation per pound of coal. Generally speaking, evaporation is around 7 or 8 lbs., and often as low as 5 or 6 lbs.

Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel.

And what we have done and are doing with them others can do.

We know they effect a saving; we know they are a convenience; they have proved satisfactory in every particular, and we have no hesitation in recommending them.

Yours very truly,

THE MERIDEN BRITANNIA CO., LIMITED.

Why not Profit by others Experience?

Waterous

BRANTFORD, ONTARIO, CANADA

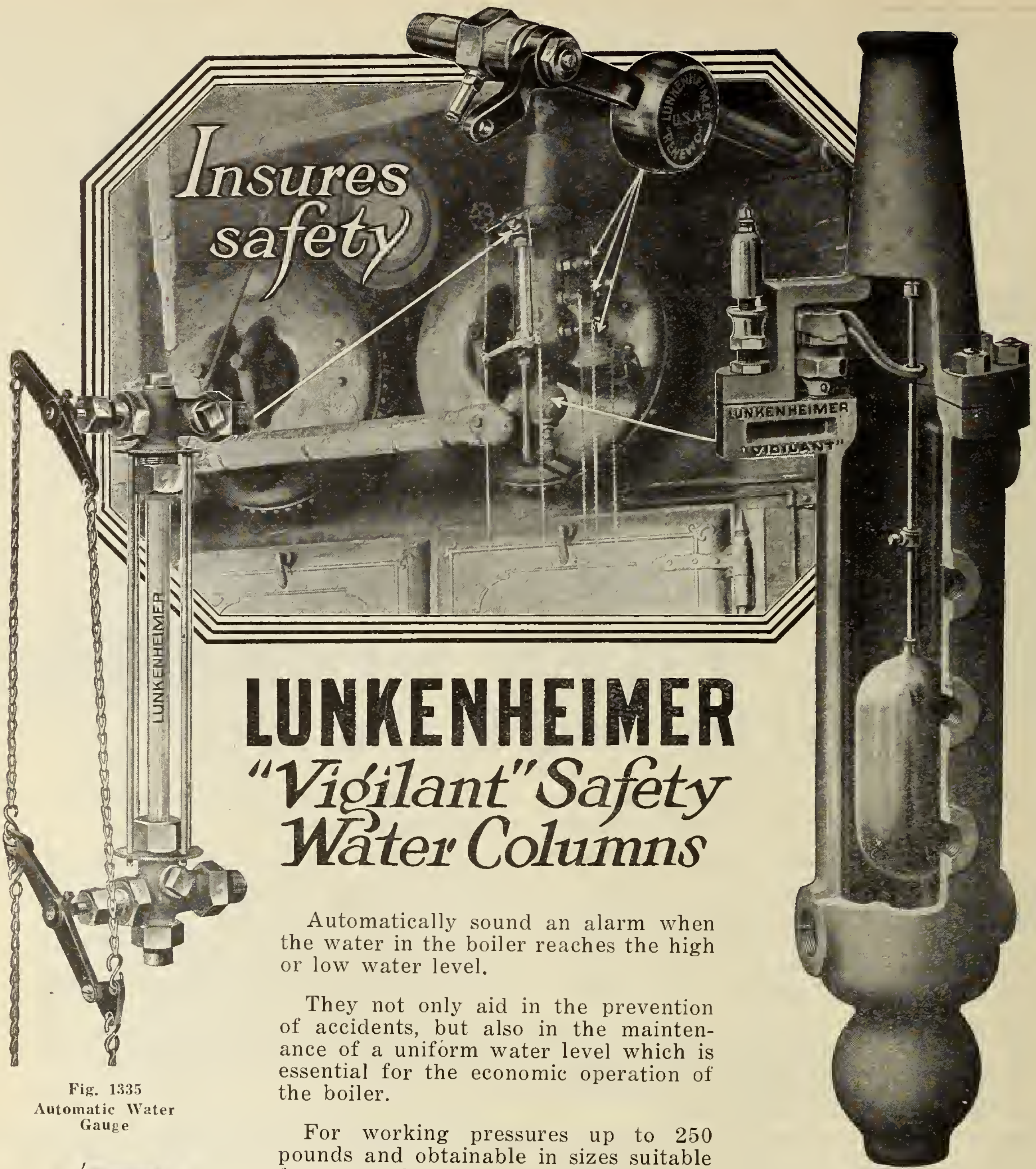


Fig. 1335
Automatic Water Gauge

Fig. 919
"Vigilant" Safety Water Column

LUNKENHEIMER
"Vigilant" Safety Water Columns

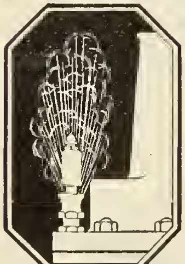
Automatically sound an alarm when the water in the boiler reaches the high or low water level.

They not only aid in the prevention of accidents, but also in the maintenance of a uniform water level which is essential for the economic operation of the boiler.

For working pressures up to 250 pounds and obtainable in sizes suitable for any make or type of boiler.

LUNKENHEIMER WATER GAUGES AND GAUGE COCKS are also very important factors in the safe operation of a boiler. The extensive line permits of a selection particularly adapted for individual requirements.

Complete data pertaining to the entire line of Lunkenheimer Boiler Mountings is given in Catalog 58-DC, a copy of which will be sent upon request.



Sounds an alarm

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO CINCINNATI, U.S.A. LONDON
EXPORT DEPT 129-135 LAFAYETTE ST, NEW YORK

20027-18-43

"America's Best since 1862"

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Tenacious!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

Every "Power Plant Engineer" Should Have—

in his possession a copy of our new 84-page Catalog, 1006, Recording Gauges for Pressure and Vacuum. It is the biggest and most complete of its kind ever published.

It illustrates and tells about all the latest developments. It gives information you as an engineer should know about.

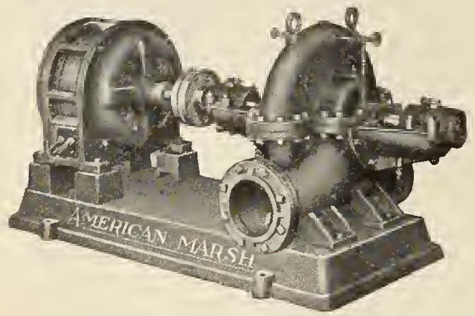
Send us your address—refer to this advertisement, and your copy will be mailed.

THE BRISTOL COMPANY
Waterbury, Conn.

Branch Offices:
Boston New York Philadelphia Pittsburgh
Detroit Chicago St. Louis San Francisco

AMERICAN-MARSH PUMPS

Centrifugal and Direct Acting



Designed for use in power plants where absolute reliability and high efficiency are essential. For over thirty-five years American-Marsh Pumps have been recognized as standard throughout the Dominion. There are over 160,000 in successful operation.

The sturdy rugged construction and heavy cast bronze fittings insure long life and a minimum repair expense.

American-Marsh Centrifugal Pumps are built with the same painstaking care that characterizes the construction of the direct acting line.

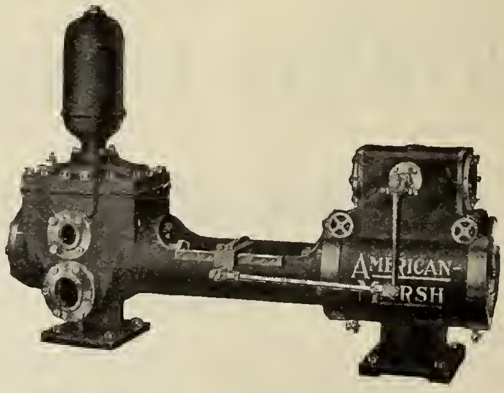
The Line includes :

- Boiler Feed Pumps
- Air Compressors
- Deep Well Engines
- Centrifugal Pumps
- Jet Condensers
- Vacuum Pumps
- Condensation Pumps
- Sump Pumps

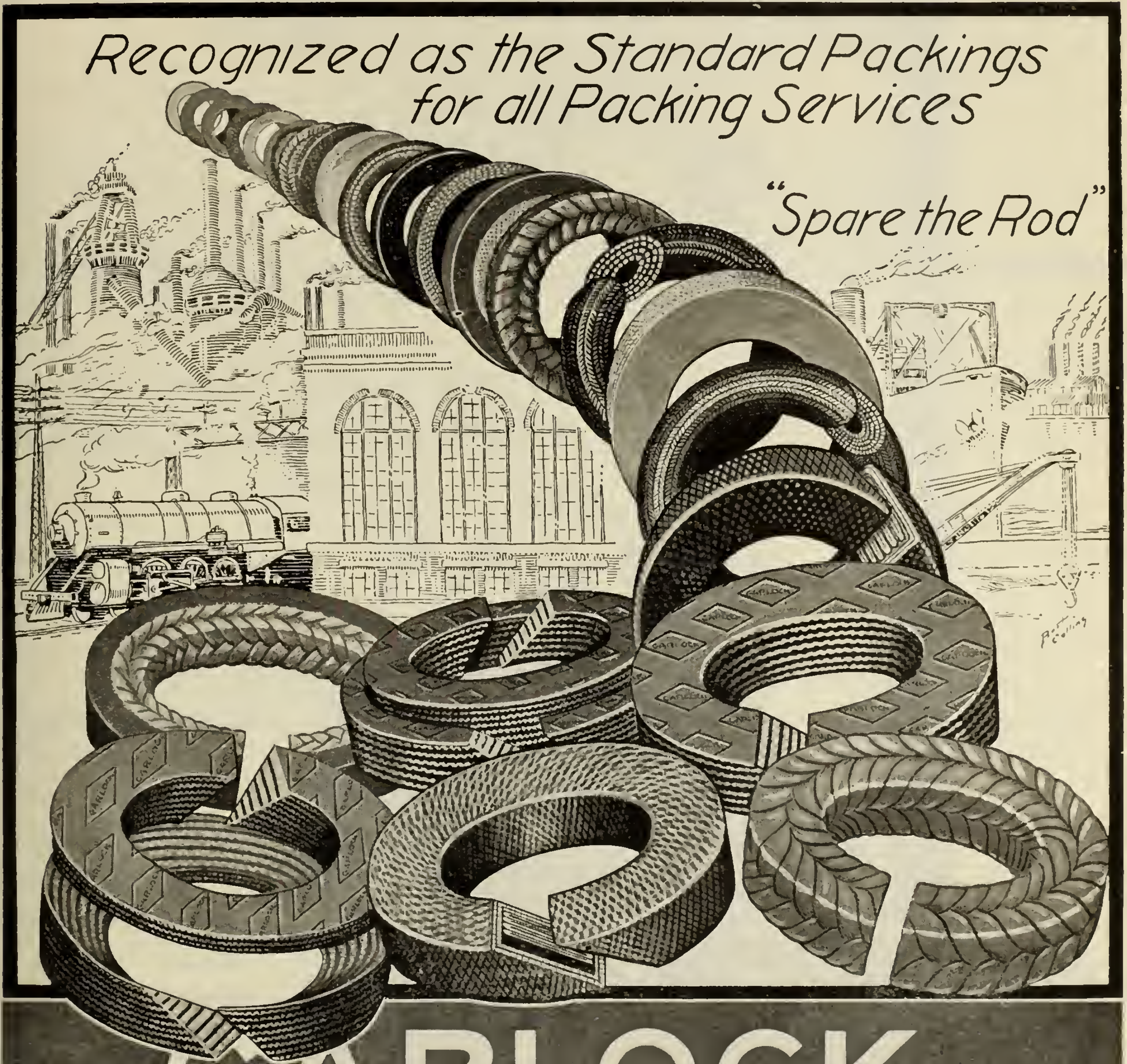
May we send you our general Catalog ?

AMERICAN STEAM PUMP CO.
BATTLE CREEK, MICH.

CANADIAN AGENTS:—A. R. Williams Machinery Co., Ltd., Toronto; Williams & Wilson, Ltd., Montreal; London Engine Supplies Co., Ltd., London; A. R. Williams Machinery Co., Ltd., Winnipeg; Mechanics' Supply Co., Ltd., Quebec; Gorman's Ltd., Edmonton and Calgary; J. T. Allan Ritchie, Vancouver.



GARLOCK
RING PACKINGS

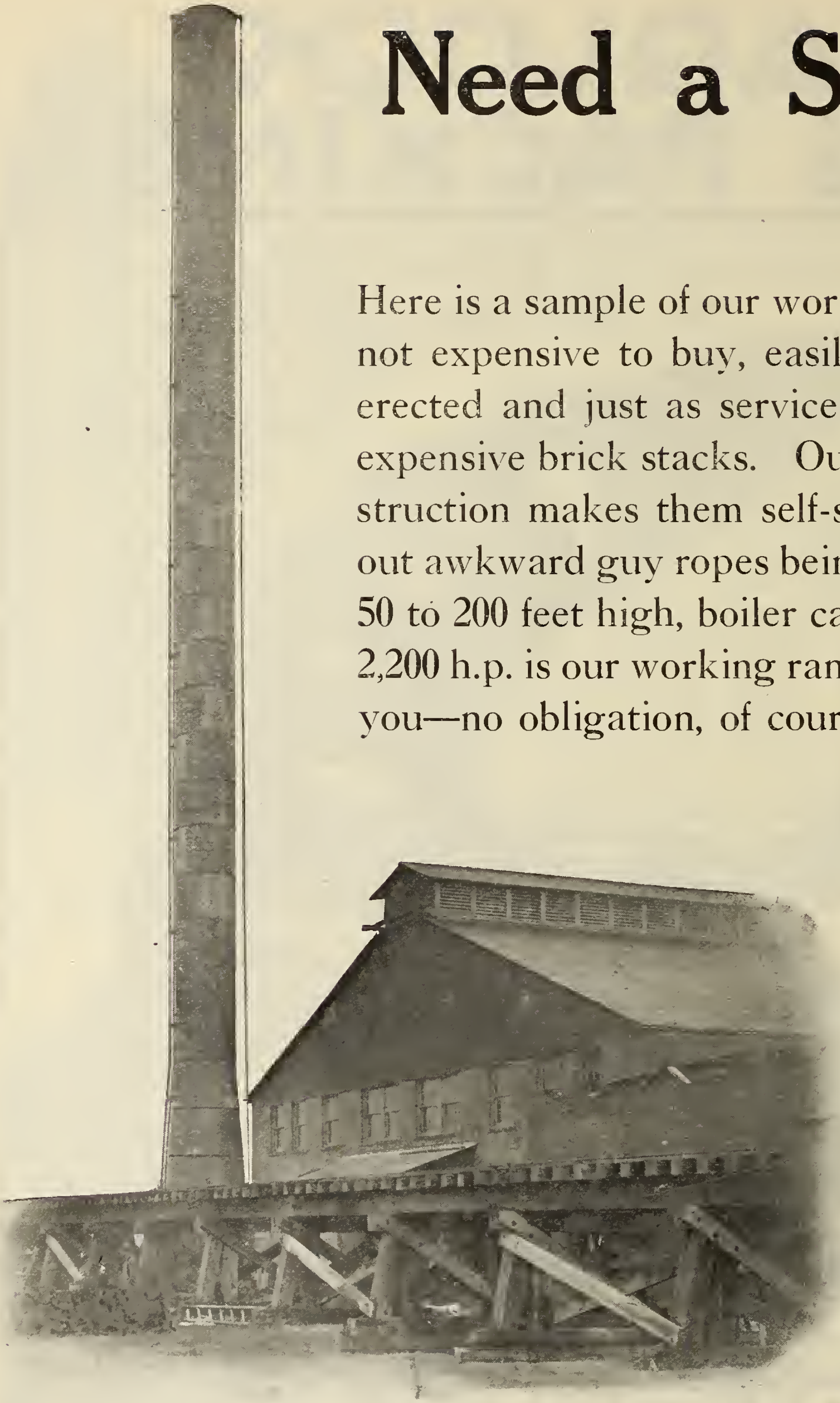

Recognized as the Standard Packings for all Packing Services
"Spare the Rod"

GARLOCK
PACKINGS

THE GARLOCK PACKING COMPANY,
HAMILTON, ONTARIO
Branches:
Montreal, Que. Toronto, Ont. Winnipeg, Man.
Calgary, Alta. St. John, N.B. Vancouver, B.C.

Need a Stack?

Here is a sample of our work—a Steel Stack, not expensive to buy, easily and promptly erected and just as serviceable as the very expensive brick stacks. Our flare base construction makes them self-supporting without awkward guy ropes being needed. From 50 to 200 feet high, boiler capacity 20 h.p. to 2,200 h.p. is our working range. Let us quote you—no obligation, of course.



A self supporting steel stack, 140 feet high, 6 feet 6 inches diameter, erected by us for Pilkington Bros., Limited, Plate Glass Works, Thorold, Ont.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

Are You Getting Satisfactory Service From the Hydraulic Packing You are Using ?

If not, try

SQUARE
PALCO
PLAITED PACKING

Its Long Service Quality Will Surprise You

Palco is made of a cotton having a far higher tensile strength than flax, and is an ideal packing for centrifugal pumps.

Because of its thorough lubrication it withstands friction, and does not wear and score the rods as other packings are apt to do.

Palco does not swell and so bind as to prevent reciprocating pumps from developing their full efficiency.

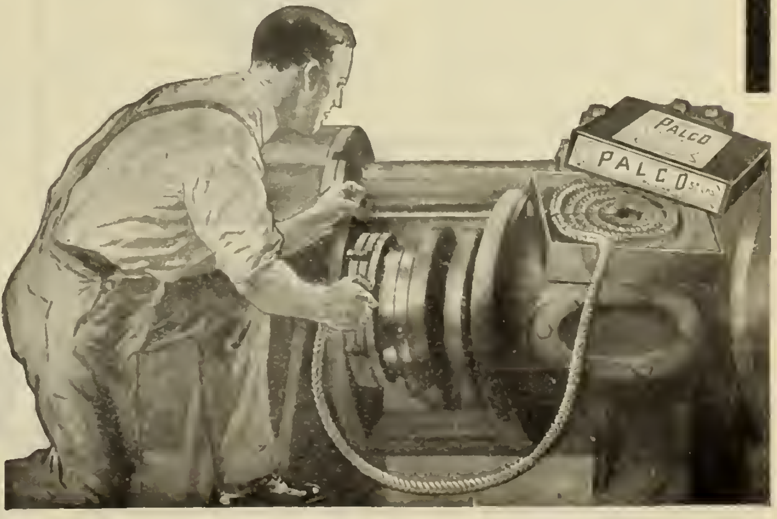
Palco will give most satisfactory service under low pressure saturated steam.

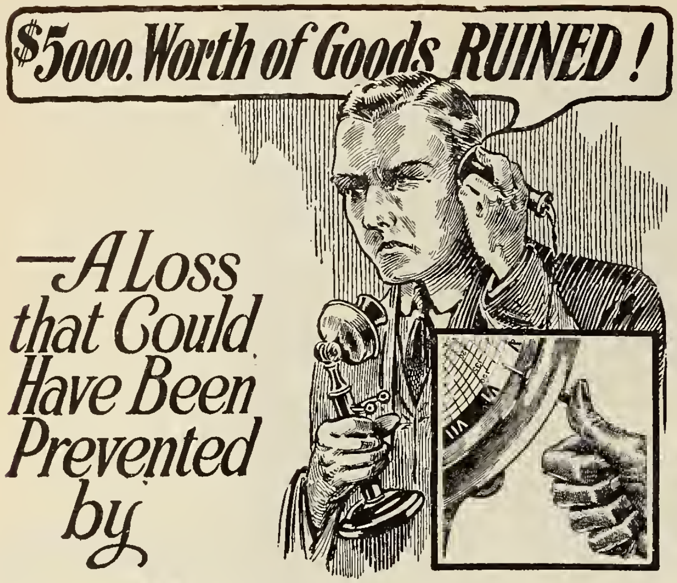
Let us send you a working sample to test under your own conditions —no charge. Advise size desired.

Greene, Tweed & Co.

Sole Manufacturers
109 Duane St. New York

CANADIAN AGENTS:
The Canadian Fairbanks-Morse Co., Limited,
Montreal, Ottawa, St. John, Toronto, Winnipeg,
Calgary, Saskatoon, Victoria, Vancouver.




$5000. Worth of Goods RUINED!
—A Loss that Could Have Been Prevented by

Columbia

Recording Thermometers

With Time PUNCH

The TIME PUNCH on Columbia Recording Thermometers practically compels the heat tender to maintain an even temperature in heat-treat processes, where wide variations may mean spoilage. For he knows if he doesn't "ring up" at regular intervals that the absence of the punch holes on the chart will tell that he was delinquent.

Side by side with the Time Punch holes on the day-and-night chart runs the line that indicates the temperature. Let that line deviate too much from its proper course and you have positive evidence of deliberate neglect.

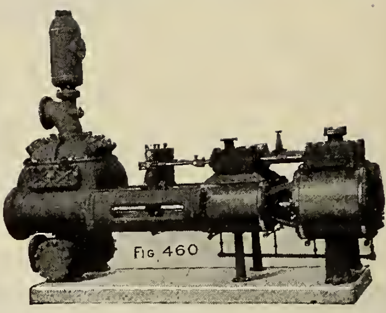
Under these conditions you may depend upon it that your operator will exercise more than usual care. The Time Punch and the temperature line combined protect you against loss in heat-treat processes as you have never been protected before.

The Time Punch is an exclusive feature found only on Columbia Recording Thermometers, Gauges and Tachometers.

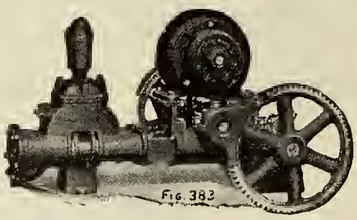
Write to-day for our interesting booklet H-33.

THE Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO. DIVISION
BROOKLYN, N. Y.
Canadian Agency:
THE CANADIAN FAIRBANKS-MORSE CO., LTD.,
Montreal - Toronto

STEAM DRIVEN DUPLEX PUMPS POWER DRIVEN



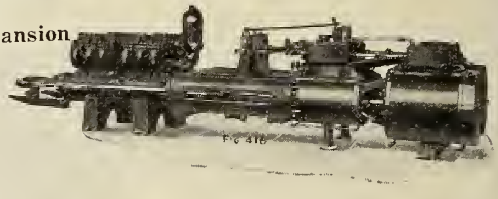
How many Sundays and holidays has your engineer spent in the plant tinkering with a pump so it will be ready to start and perform its part in the cycle of plant operation? Try a McGowan and be convinced that it is the best.

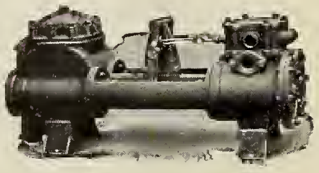


**SIMPLE
DUPLEX
STEAM
POWER**

**Condensing
Non-Condensing**

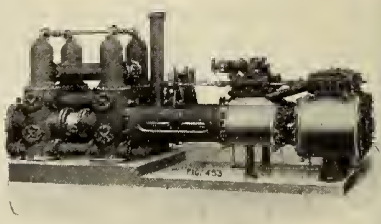
**Compound
Triple Expansion**





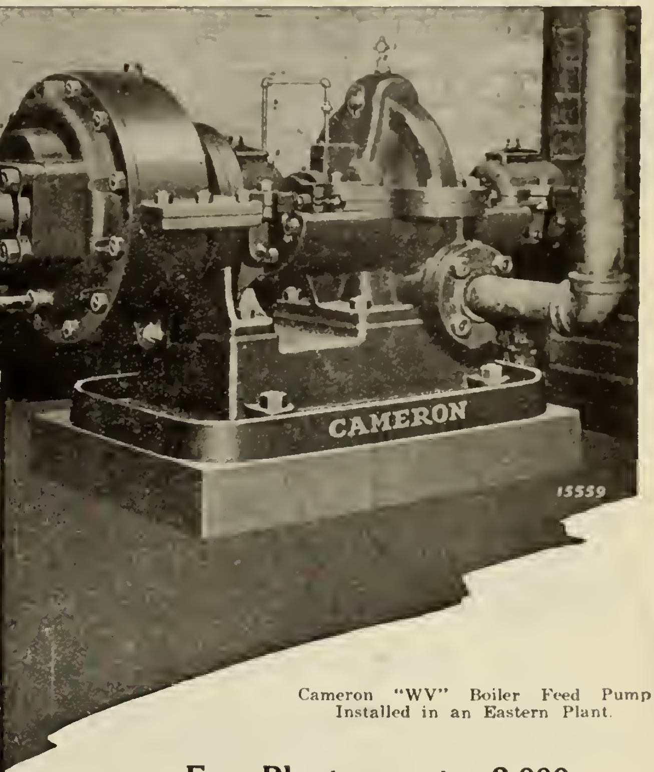
**Pressure Patterns
Packed Piston
Semi-Corliss
Piston Valve**

For All Conditions of Service.

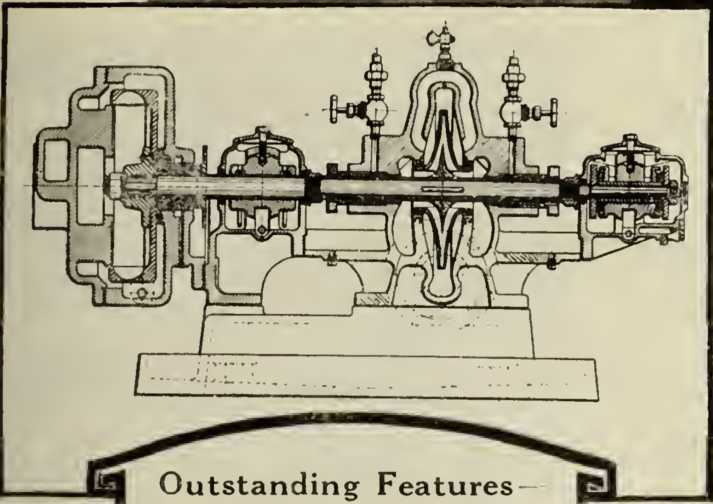


**THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.**

The Boiler Feeder you have been waiting for



Cameron "WV" Boiler Feed Pump Installed in an Eastern Plant.



Outstanding Features—

- No couplings—No valves
- Only two bearings
- Only one gland on the turbine
- Reduced floor space
- Horizontally split casings
- Impeller and rotor on same shaft
- No pipe vibration
- Only one moving part
- No high pressure stuffing boxes

For Plants up to 2,000 Boiler Horsepower 150 pounds pressure

The new Cameron single-stage, turbine-driven Centrifugal Boiler Feed Pump is designed for boiler plants having up to 2,000 boiler horsepower and using steam pressures of 150 pounds or less.

The outstanding feature of this Pump is its simplicity. The single-stage impeller and turbine rotor are mounted on the same shaft. The absence of a coupling and the compact design results in a remarkably large capacity per unit of floor space required.

With this unit the small boiler plant can now secure the outstanding advantages of a Centrifugal Boiler Feed Pump.

Let us send you Bulletin 7056. Our Engineers are at your service. Write our nearest office.

CANADIAN INGERSOLL-RAND COMPANY, LIMITED

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

Associate Offices in all Foreign Countries.
D.V.

Ingersoll-Rand

Drills, Compressors, Condensers, Gas and Oil Engines, Pneumatic Tools

REFRIGERATION DEPARTMENT

LINDE

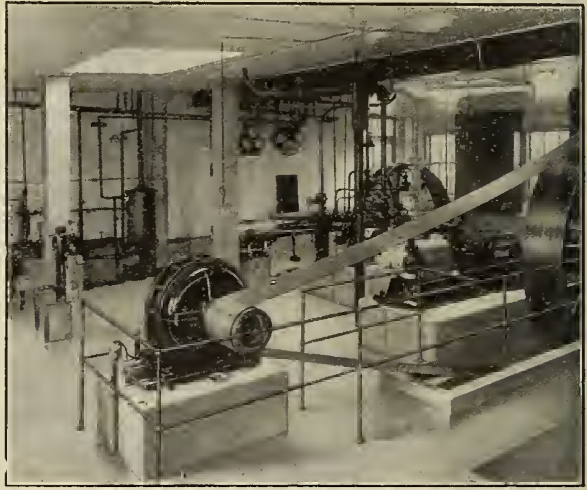
Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants
Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

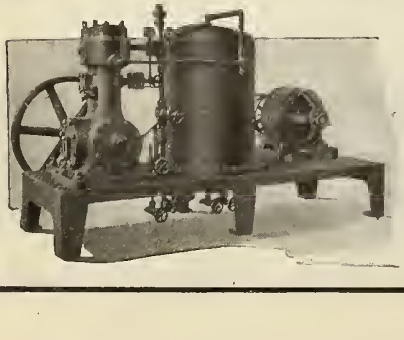
Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.
37 St. Peter Street, MONTREAL, Que.
TORONTO WINNIPEG VANCOUVER

VILTER
ICE MAKING AND REFRIGERATING MACHINERY



A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada

Nonpareil Corkboard in process of erection for the John J. Woodside Storage Company, Atlanta, Ga.

Yours is a Special Case.

Every cold storage room or building is an individual problem in insulation. *Your* conditions must be studied, *your* requirements analyzed and *your* insulation planned to suit *your* needs. Rule-of-thumb methods like "So many inches for such and such a temperature," will not assure *you* efficient and economical insulation for your rooms.

Most users of refrigeration recognize Nonpareil Corkboard as the standard cold storage insulation. But thousands of them know that the efficiency of their rooms is due as much to the helpful suggestions, the expert knowledge and the skilled workmanship that constitute Nonpareil Service as to the high quality of the material itself. The resources of an experienced organization applied to your individual case are what assure you the results you expect from your insulation.

There may be little *apparent* difference in materials, but remember this: Insulation should include a service as well as a material. Consider the value to you of this Company's years of experience in planning and installing insulation, in studying the mistakes that have been made, and in endless research for better methods. This experience and Nonpareil Corkboard are your best assurance that your insulation will be adequate for your requirements, efficient, economical and permanent.

Have you rooms to be insulated? It will not obligate you in the least to consult with our Engineering Department. Ask for a sample and a copy of "Small Cold Storage Rooms," sent free on request.

Armstrong Cork & Insulation Co., Ltd.

902 McGill Bldg., Montreal, Que. **11 Brant St., Toronto, Ont., Can**

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers, tanks and cold surfaces generally; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

KERR

"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited

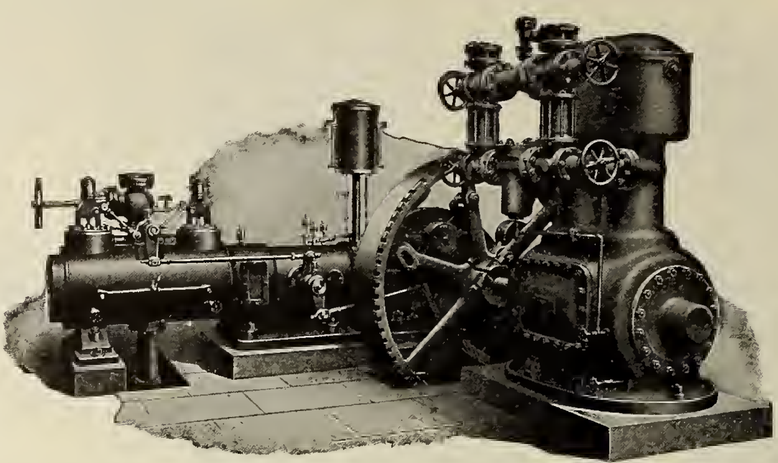
Valve and Hydrant Manufacturers

Walkerville Ontario

FRICK COMPANY, INC. TRADE FRICK MARK WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical



Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U. S. A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

---

When Overhauling

—Dependable Ammonia Valves, Fittings and Auxiliary Equipment are of paramount importance.

YORK Valves and Fittings of every size, style and type are made of either malleable iron, drop forging, or air furnace iron, tested and inspected at every stage of manufacture and guaranteed to give satisfaction under all usual working conditions.

Every heat of metal going into York Valves and Fittings is tested physically, analyzed chemically and inspected metallographically. All materials entering into the construction of York Products are subjected to similar rigid tests, insuring a uniform high grade product.

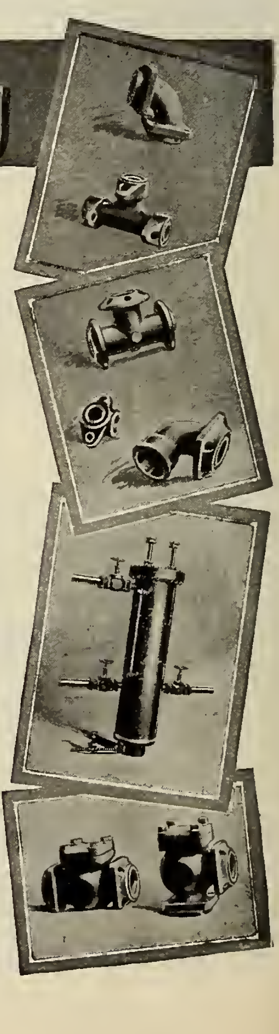
YORK Auxiliary Apparatus, such as Ammonia Drier-Cooler-Purifiers, Ammonia Distillers, Condensers, Receivers, Automatic Can Dumps and Fillers, Hoists, etc., all help materially in increasing the efficiency of the plant and the profits of its owner.

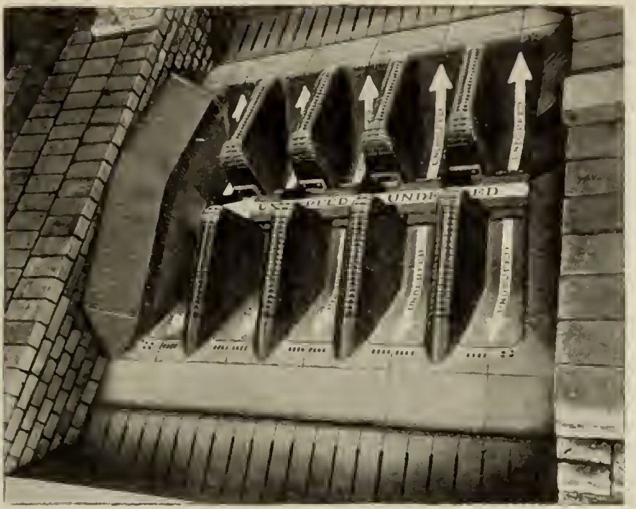
Our Engineers will assist you in selecting the apparatus best suited for your purpose, and in solving your ice making and refrigerating problems. Write us today.

CANADIAN ICE MACHINE CO., LTD.

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals;
MONTREAL: 324 Craig St. West; WINNIPEG: 1415 Whyte Ave.;
VANCOUVER: 1158 Homer St.

Representing
YORK MANUFACTURING COMPANY, YORK, PA.





Trade Mark

"Multiple retort" in everything but price—

BEFORE the *"lateral retort"* principle was developed there was no such thing as a strictly *underfed* side-cleaning stoker. Consequently, the many advantages of underfeeding coal were confined to more expensive stokers of the high-duty multiple retort type.

Now, as a result of the revolutionary *"lateral retort"* principle, the advantages of the multiple retort stoker —high capacity and efficiency—are combined with the advantages of the side-cleaning stoker—lower first cost, reduced installation cost, and adaptability to old boilers.

The *"Lateral Retort"* Stoker is not claimed to be a substitute for multiple retort stokers – *but*—it *does* bring the advantages of multiple retort stoking to the plant that otherwise would install an inferior stoker, thus providing multiple retort efficiency while effecting a marked saving in initial and installation cost.

The illustration above shows how the truly underfeed effect is accomplished. The coal follows the path of the arrows. It is first underfed along the line of the main arrow into the central retort by means of a main ram. It is then underfed—always underfed—into the *"lateral retorts"* by means of an auxiliary steam cylinder which operates lateral pusher rods.

There is only one simple moving unit for distributing fuel in five or more *"lateral retorts"* and, since this feeding mechanism is controlled independently of the main fuel feed, ideal distribution is possible under all conditions.

A trench 6 to 18 inches below the floor line is sufficient excavation for ash pits. This reduces installation cost and makes the stoker adaptable to boilers already in service. The many good points of this stoker are covered in greater detail by a new bulletin. Where shall we send it?

The Under-Feed Stoker Co. of Canada, Ltd.
146 King Street, West · Toronto

Sales agents for: Jones Stokers, Riley Stokers and Murphy Automatic Furnaces

Alta. & West. Sask.:	Man. & East Sask.:	British Columbia:	Quebec:
Mr. J. Twomey Camrose Alberta	W. W. Hicks & Co. Winnipeg	E. A. Earle, Ltd. Vancouver, B. C.	The Cleaton Co., (Can. Ltd., Montreal, Que.)

The "Lateral Retort"
Trade Mark
Stoker

Advantages of the *"Lateral Retort"* Principle

Coal is underfed throughout—not overfed on to side grates. This is the only truly *underfed* side-cleaning stoker.

One simple moving unit for five or more retorts—The feeding mechanism of the *"lateral retorts"* is controlled independently of main feed, permitting ideal fuel distribution under all conditions.

Simplest cleaning mechanism—a perfectly balanced dump plate easily operated by hand.

No need for basement ash pits—A trench 6 to 18 inches below the floor line is sufficient excavation for ash pits. This greatly reduces installation cost and makes the stoker adaptable to boilers already in service.

Plate tuyeres — reduce siftings and lower replacement cost.

High air cooled front and rear tuyere blocks—keep fire and clinkers away from front wall and bridge wall, reducing furnace maintenance.

The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
JONES
MURPHY

How Much Coal Are You Wasting?

Blindfolding yourself to the fact that your boiler room is different, because you can see no pipe line leaks, or the water alarms don't blow very often—doesn't help to pay for the needless fuel waste caused by the invisible losses within the boiler furnaces.

Get at the REAL FACTS and at the same time give your men a positive and simple guide that will enable them to keep the plant at top notch efficiency—by installing the

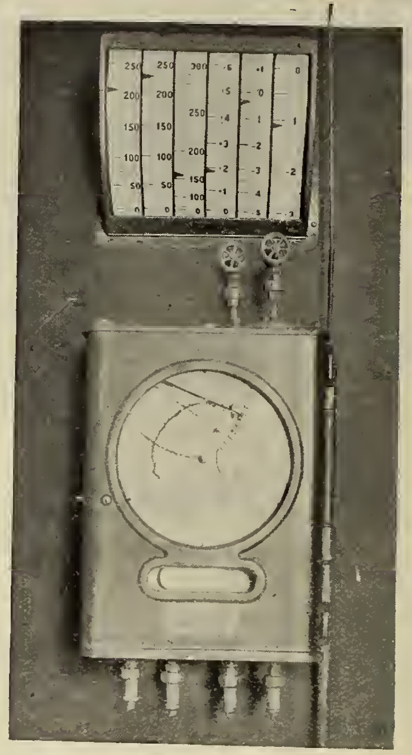
BAILEY BOILER PANEL

The Bailey Boiler Panel is a combination of the Bailey Multi-Pointer Gage and Bailey Boiler Meter.

It shows, almost immediately, the effect of improper furnace adjustment and enables the men to make the necessary correction before a large amount of preventable fuel waste has taken place. Good work on the part of the men is shown up by the charts as well as any inattention. The engineer can check the efficiency of his men as well as that of the individual boiler.

Let us send you fully descriptive Bulletins.

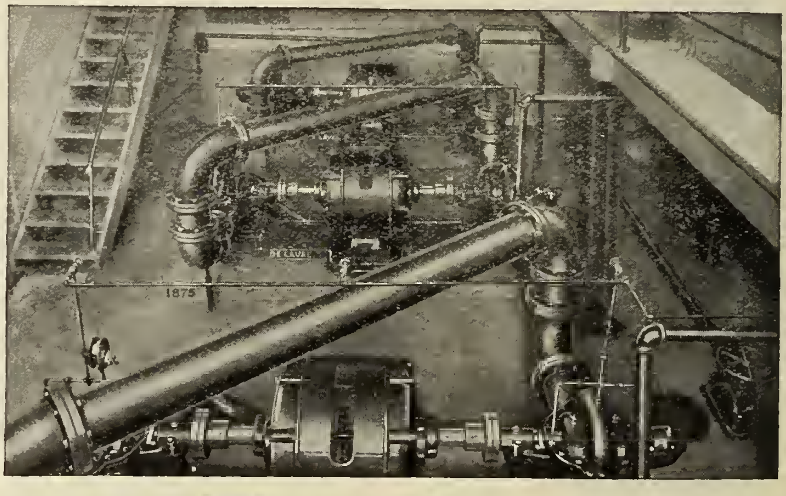
BAILEY METER COMPANY Limited
177 DELORIMIER AVE. - MONTREAL, QUE.



De Laval Motor Driven Pumps
For Belleville, Ontario

THE City of Belleville, Ont., has installed three De Laval motor driven centrifugal pumps for its water supply, each consisting of two De Laval single stage pumps, on one base plate, with a driving motor in between. One unit, with 8-in. pumps, delivers 1,870 gal. per min. against 200 ft. head at 1,740 r.p.m., one with 6-in. pumps delivers 1,300 gal. per min., while another with 6-in. pumps delivers 960 gal. per min., each against 285 ft., at 1,740 r.p.m.

The pump casings are split horizontally, the top half being removable without disturbing piping. All internal parts are then accessible, and can be taken out after removing the bearing caps. Parts are made to limit gages on an interchangeable basis, and parts subject to eventual wear, such as wearing rings and shaft sleeves, can readily be removed and replaced by ordinary unskilled workmen. The De Laval labyrinth wearing ring permits of large running clearances and its life is much longer than that of a flat ring.

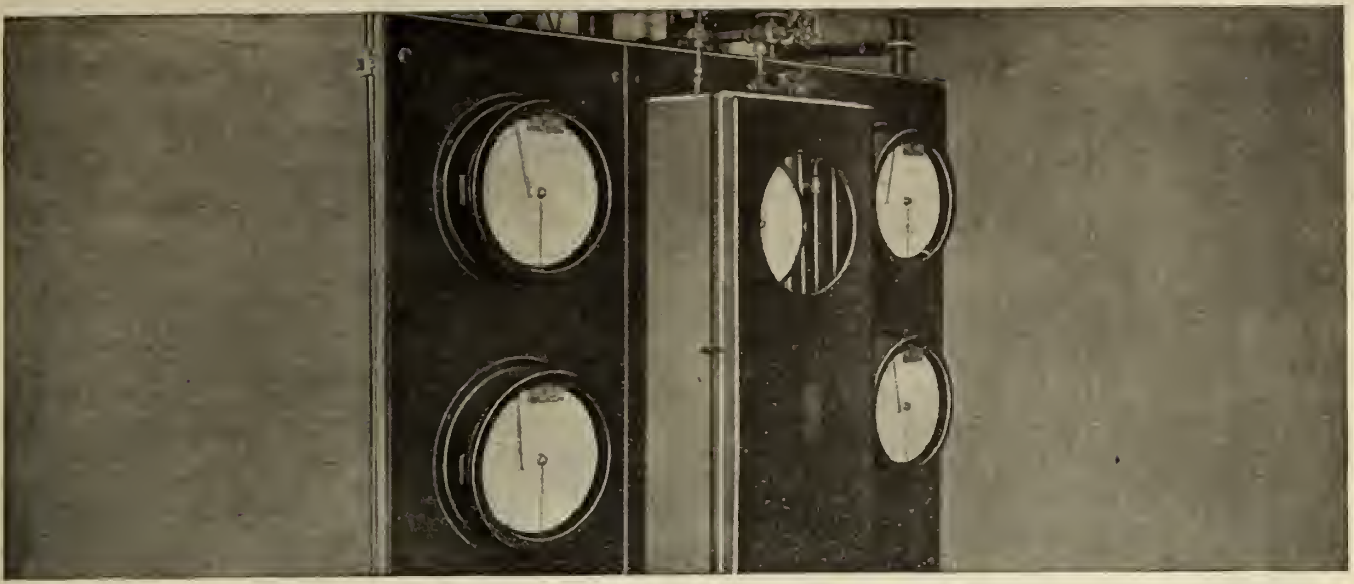


Where electric power is purchased for driving pumps, the user can easily calculate how much more he can afford to pay for an efficient pump than for an inefficient pump. In making this calculation, he should consider, however, not only the initial guaranteed efficiency, but also durability, that is, whether the construction of the pump is such that the efficiency will be maintained in service and can easily be restored, when necessary, by replacing parts subject to wear.

The efficiency of every De Laval unit is guaranteed, and the guarantee is corroborated by a test at the works before shipment. Ask for special catalog B-100.

De Laval
Steam Turbine Company

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto
THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.



Waste Has No Hiding Place at the Rockford, Ill. Water Works

Waste can't sneak into the boiler plant of the Rockford, Ill., Water Works unannounced.

The records from the Foxboro Instrument Board, illustrated above, and three Foxboro 3-pen Draft Recorders not shown, provide protection against the many lurking robbers of the coal pile.

The clean, accurate, continuous records of CO2 content in flue gases, flue gas temperature, feed water temperature and draft in the last pass, above the fire, and in the wind box, make possible careful development and constant maintenance of wasteless operating standards.

Foxboro Recorders are designed and built by engineers who know power plant conditions and realize the importance of permanent accuracy in the instruments which produce these vital records.

Every Foxboro Recorder must pass tests which prove it fully capable of performing the service expected of it as "The Compass of Industry."

For full information, write for Bulletins CF104-1 and 114.

How This Instrument Board Helps.

This board contains one Foxboro-Heath CO2 Recorder, three Foxboro Recording Thermometers for flue gas temperatures and one Foxboro Recording Thermometer for feed water temperature.

Roughly:

- **Every 1% increase in CO2 (between 11 per cent. and 14 per cent.) means 1 per cent. saving in fuel.**
- **Every 25°F reduction in flue gas temperature means 1 per cent. saving in fuel.**
- **Every 10°F increase in feed water temperature means 1 per cent. saving in fuel.**

Foxboro records help to keep conditions close to the standards set for maximum economy; minimum waste.

THE FOXBORO CO., Inc.

FOXBORO, MASS. - - U.S.A.

NEW YORK CHICAGO BOSTON TULSA CLEVELAND PITTSBURGH
PHILADELPHIA SAN FRANCISCO BIRMINGHAM
Peacock Brothers, Limited, 179 Delorimier Avenue, Montreal, Canada.

FOXBORO
TRADE MARK
THE COMPASS OF INDUSTRY

5184

Graton & Knight

Standardized Series

Leather Belting

A Belt for Every Purpose

No one belt will give maximum service under all conditions, so the Graton & Knight Company, after exhaustive research, have evolved a SERIES of Belts that solve every belting problem.

From the raw hide to the finished belting each piece of leather is selected, tanned and manufactured to perform a definite service under definite conditions. Naturally such belts give better service than general purpose belting—and naturally Graton & Knight Belts carry exceptional guarantees.

This series is described in a booklet that shows the proper belt for practically every drive. It contains invaluable information. Our nearest branch will gladly mail it to you.

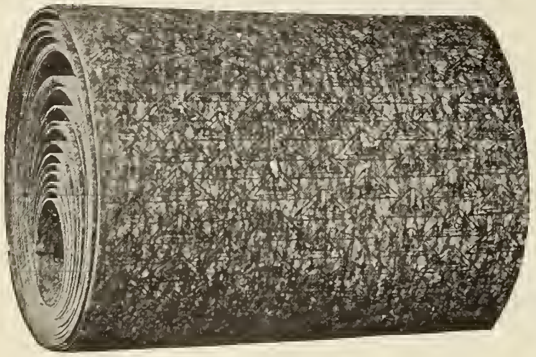
The Canadian
FAIRBANKS-MORSE
Company, Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor,
Winnipeg, Regina, Calgary, Vancouver, Victoria.

56

Durabla Gaskets Make Tight Joints

Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.



Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

DURABLA
TRADE MARK REGISTERED

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in. long.

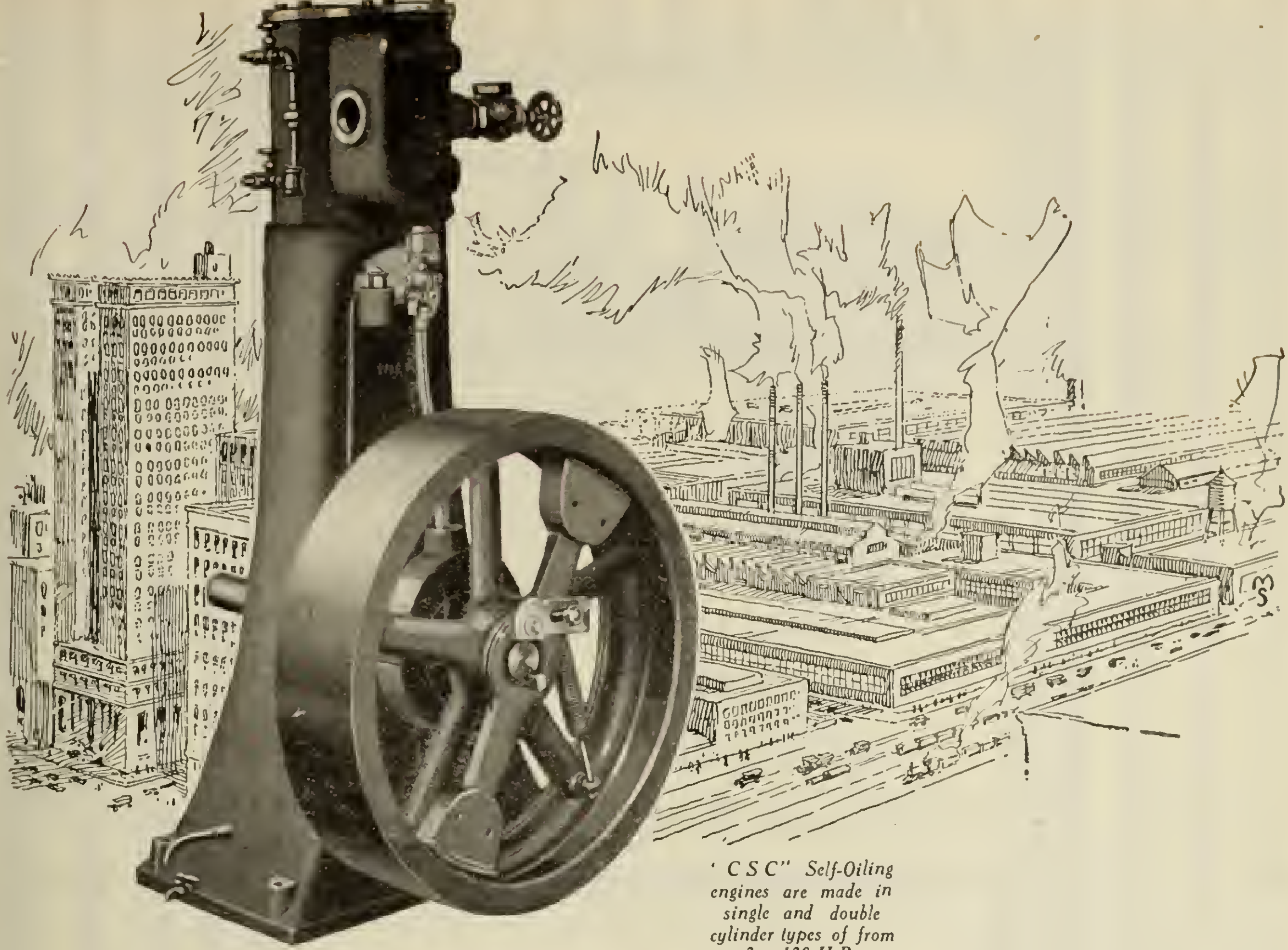
In thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Let us send you a trial order.

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA



"CSC" Self-Oiling engines are made in single and double cylinder types of from 2 to 120 H.P.

This Sturdy Engine Gives Unfailing Power for Months Without Attention

It is hard to realize that any steam engine could endure day-and-night operation—seven days a week—for ten, fifteen and even twenty years. Yet such instances are not uncommon in the case of "CSC" Self-Oiling Engines.

These remarkable power units are designed especially for the operation of blower fans, mechanical draft apparatus, lighting plants and other uses where stops are days or weeks apart. Ample lubrication under all conditions, rugged construction and high efficiency make the "CSC" Engine one of those rare pieces of equipment that you can install and then almost forget.

Write for details of construction and startling testimonials of its wonderful performance.

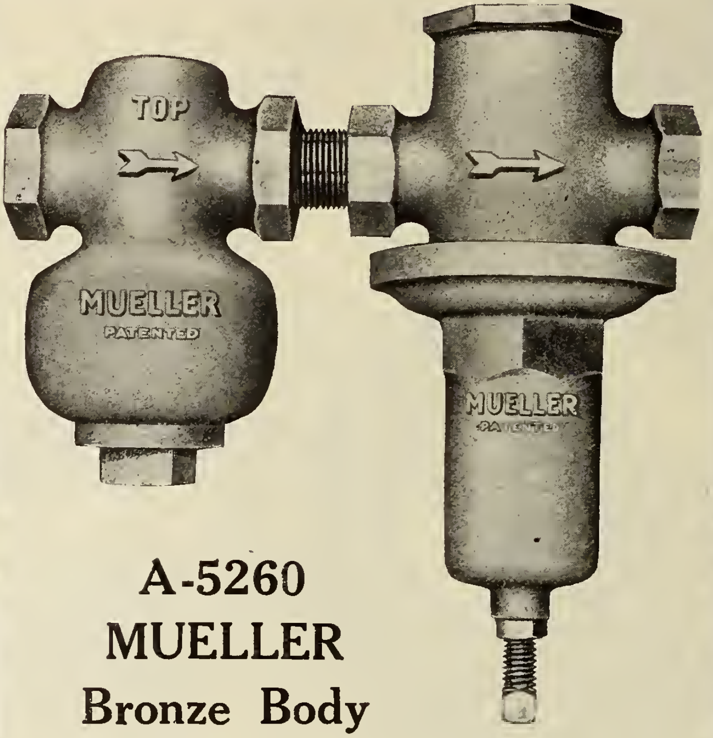
CANADIAN SIROCCO COMPANY, Ltd., WINDSOR, Ont.
BRANCH OFFICES IN ALL PRINCIPAL CITIES

(276)

"Sirocco" Products
TRADE MARK

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT



A-5260
MUELLER
Bronze Body
Reducing & Regulating Valve

SPECIAL sensitive, wear-resistant composition diaphragm to insure accuracy—full seat opening to pass a large volume of water—simple in construction to permit of easy access to working parts—made from MUELLER Bronze and therefore non-corrosive—these features combine to place this valve in a class by itself. And these are the points we bore in mind in designing this Regulator, since careful investigation proved them absolutely necessary to provide a satisfactory valve for the regulation of pressure on cold water lines.

This Valve will fill your requirements for cold water pressure regulation—let us know your problem.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Illinois, U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Port Huron, Mich.; Makers of "Red Tip" Brass Rod, Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

Automatic Valved Soot Blowers

Diamond "Valv-in-Head"

Soot blowers having automatically operated valves were originated and developed by us, and are covered by patents issued and pending. Infringements of these patents will be prosecuted.

Diamond Specialty Limited, Windsor, Ont.

In Service More Than Six Years—Not Even Re-packed

Back in 1916, the Unity Cotton Mills, La Grange, Ga., put 5 Yarway Seatless Blow-off Valves on their boilers. In December 1922—more than six years later—Mr. James Newsom, manager and superintendent, wrote that the valves............"have not been re-packed nor repaired since we bought and installed them, and have been and are still giving entire satisfaction. They are the best blow-off valves that we have found."

The experience of this well-known Southern mill has been duplicated by hundreds of other users in all parts of the country. The "no-seat-to-leak" construction of the Yarway Seatless Blow-Off Valve makes possible its many records of six, eight and ten years' service without repairs.

The Yarway Seatless and the Yarway Double-Tightening Valves in tandem form the ideal combination for blow-off service, complying with laws of every state.

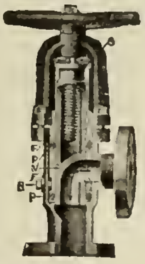
Both valves are fully described in Booklet B-410—free at your request.

YARNALL-WARING CO.

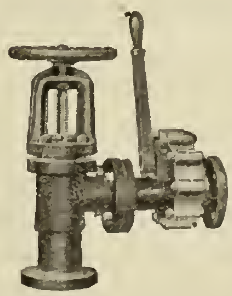
Mermaid Lane & Ardleigh St., Philadelphia

207 St. James St., MONTREAL.

400 Penobscott Bldg., DETROIT



YARWAY SEATLESS BLOW-OFF VALVE. (Formerly The Simplex.) Send for celluloid model illustrating operation of this unique valve.



YARWAY SEATLESS and YARWAY DOUBLE TIGHTENING VALVES in tandem, for lines where two valves are desired.

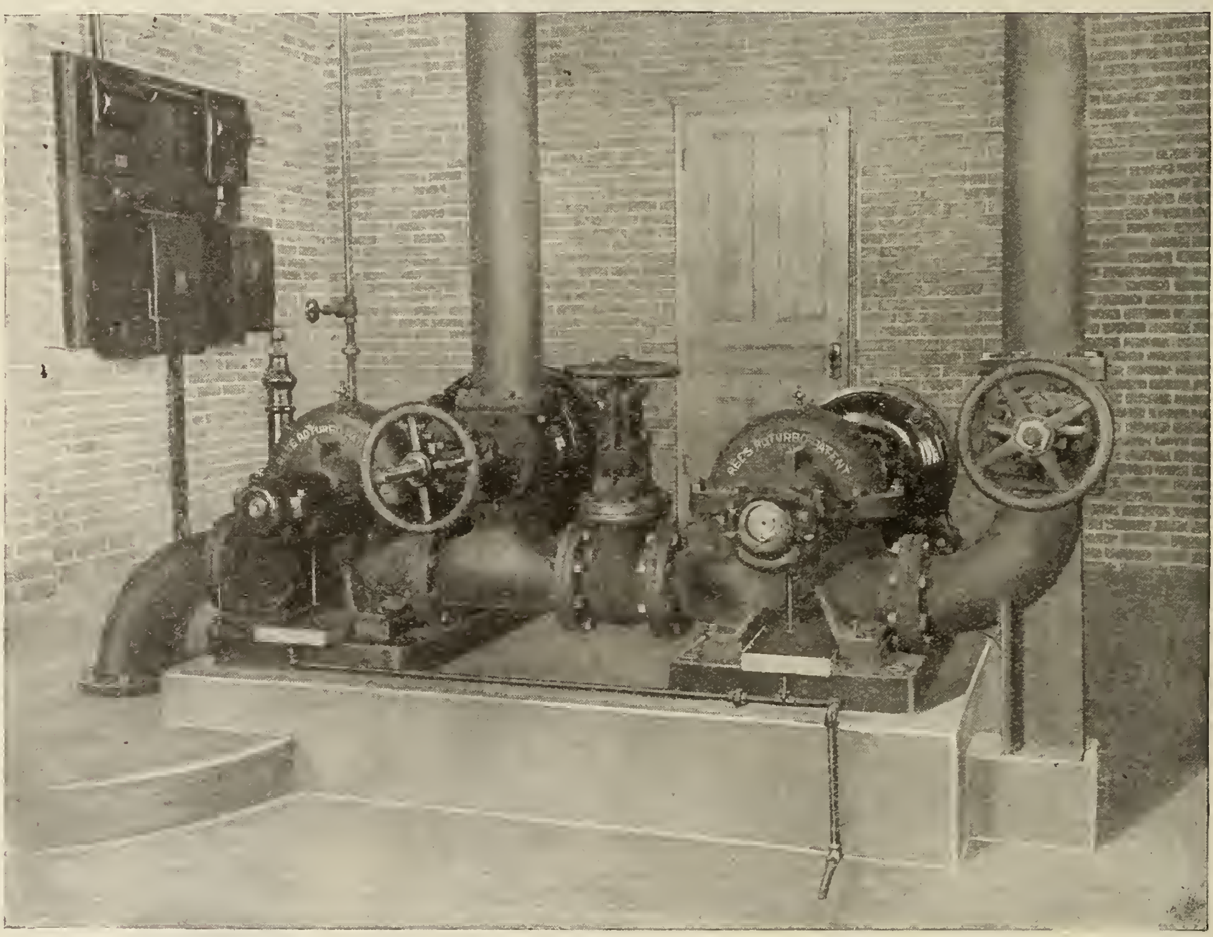
Six-year-old YARWAY SEATLESS BLOW-OFF VALVES at Unity Cotton Mills, La Grange, Ga.

YARWAY

POWER PLANT DEVICES *to save fuel*

THE REES RoTURBo

A Centrifugal Pump for Any Service



Showing two REES RoTURBo Pumps at the Waterworks Pumping Station, Carleton Place, Ont.

REES RoTURBo PUMPS ARE SELF REGULATING

They automatically adjust themselves to sudden Drop or Overload without injury to themselves or the prime mover, and they assure a high and constant efficiency over a wide range of duties.

Municipal and Industrial Plants all over Canada are installing REES RoTURBo PUMPS.

The above installation has been so satisfactory that a third pump of the same make has since been installed.

Catalogs and further information on request.

The GOLDIE & McCULLOCH CO. Limited

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bldg.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Grieg,
400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B. C.

POWER HOUSE

ESTABLISHED 1907 *Toronto, May 5th, 1923* A SEMI-MONTHLY NEWSPAPER

Central Heating of Manitoba's Parliament Building

Daily "Log" Kept of Water of Condensation From Which Statement of Total Cost of Operation is Prepared for Minister of Public Works Each Month—Novel Color Scheme Adopted in Piping Throughout System

BY GEO. R. ARCHDEACON, A.M.I.E.E.

ALTHOUGH Winnipeg, the "Gateway of the West," possesses many things that its citizens are proud of, there is nothing in which their pride is so well justified as the Manitoba Parliament Building.

The plans were selected in a competition open to all architects practising in the British Empire, the successful design being that of Frank Worthington Simon, F. R. I. B. A.

The building is constructed of Tyndall stone and its general outline resembles the letter "H," each arm of the structure being 300 feet long.

The final cost was approximately $8,000,000 and it is therefore apparent that nothing was neglected to make it comparable with the historic public buildings of Europe.

The engineering service is naturally in keeping with the size of the building itself.

The power house is situated about 2,000 ft. from the main building, and it may be safely said that the equipment rivals that installed in any other central heating plant in Canada because it typifies the ideal heating layout in as much as the power house is in the centre of the system of distribution.

System of Tunnels

A complete system of reinforced concrete tunnels connects the power house with the various buildings as follows:

Parliament Bdg. 2,000 ft., 6 ft. 9 in. x 8 ft. 0 in.
Law Courts, 300 ft., 6 ft. 0 in. x 6 ft. 0 in.
Old Law Courts, 500 ft., Conduit.
Provincial Jail, 500 ft., Conduit.
Electrical Bdg. 900 ft., Conduit.
Science Bdg., 900 ft. Conduit.
Land Titles Bdg. 70 ft., 5 ft. 0 in. x 5 ft. 0 in.
Greenhouse 100 ft., 4 ft. 0 in. x 4 ft. 0 in.

> **If you can reach out and touch the door that will open on your success, turn the knob and walk in. Never admit that the threshold of success is new to you, for if it should be, over-anxiety will lock the door. Do not push with all your soul, for when you do, you show your fear and doubt as to whether the door will yield, and it has never opened yet in the power plant field to the man who doubted his own ability.**

The power house itself, viewed from the exterior, has the appearance of an old university chapel and its location in a wide court yard, surrounded by the Manitoba University Buildings completes the illusion.

The boiler room is well lighted and lofty, the coal being taken in by a 10 ton automatic weighing machine, which at the same time automatically punches a ticket with the correct weight and date similarly to the cash register of retail store fame.

This machine was designed and made by the Canadian Fairbanks-Morse Co.

After being weighed, the coal passes on to a crusher. Here it is crushed into small pieces, by a machine operated by a 10 h.p. Westinghouse induction motor. From this crusher, the coal drops into a rotary filler, with 6 openings or outlets. Each outlet as it rotates synchronizes with a bucket moving on a belt, the contents of the rotary filler being fed to the bucket without spillage. This ensures the actual amount of fuel weighed arriving safely in the boiler.

This bucket conveyor has a capacity of 20 tons per hour, and elevates the coal to a bunker with a capacity of 700 tons, located over the tops of the boilers.

Ash Weighed Daily

This conveyor is also made to serve the purpose of an ash conveyor, and in turn handles the ashes, and conveys them to a 40 ton ash bunker above the platform scales, the ash is there weighed and a daily record made to check against the weight of coal taken into the boilers.

There are 5, 250 h.p. B. & W. boilers 4 in. tubes. Drums 36 in. x 21 ft. 6 in. Working pressure 150 lbs. equipped with B. & W. chain grate stokers, with in addition Copes automatic boiler feed regulators connected to each boiler.

Uehling draught gauges are installed throughout. There is a CO_2 recorder on each boiler to permit the firemen to observe conditions whilst in the chief's office a CO_2 recorder from the main flue is installed which permits the use of a low chimney stack.

A set of B. & W. economisers are connected to each boiler, and the inlet and outlet temperature is carefully observed by means of electrical pyrometers made by Schaeffer & Budenburg.

There is also an electrical generating station, supplied, it is claimed, with high tension electric power at approximately half of one cent per K. W. Hr., the equipment consisting of:—

2—200 K. W. motor generator sets, each set comprising a 2,200 volt Synchronous motor, direct coupled to a 22V D. C. dynamo operating at 900 Revs.

Switchboard of Marble

The switchboard is 10 ft. long, and 7 ft. high, of unpolished black marble, and comprises the usual control panels for the branch circuits, and also for the high tension and low tension sides of the motor-generator.

There are 2 Ingersoll-Rand Automatic air compressors, direct-connected to 2, 10 h.p. induction motors.

When the pressure in the air tank reservoir falls below a certain value, the air compressor automatically starts up.

There is a 40 h.p. single cylinder steam engine so installed, as a stand by for the induced draught system, that the drive from the electric motor to the fan is accomplished by running the belt from the motor to a pulley on the crank shaft of the engine, which in turn is connected to the induced draught fan.

The electric motor being exactly in

the centre of the two steam engines, this drive may be changed over from one fan to the other by merely slipping off the belt on the engine on one side and slipping on the engine on the other side.

The motor used for this purpose is a 20 h.p. Westinghouse induction motor, and the fan is 12 ft. in diameter.

Heating and Ventilating

The general heating, ventilating, and hot water equipment for the various buildings is of large dimensions, and of a comprehensive character.

There is a 30,000 C. F. M. fan and set of steam coils in the basement of the Parliament Buildings, for heating entrance vestibules, and main stair hall.

The suction of this fan is connected to re-circulation registers, in the main stair and central halls, also to the main steam pipe tunnel from the power house and to a fresh air shaft, at the roof level.

During the heating season this fan is operated to pull sufficient air through the tunnel to utilize the heat radiated from the 8 in. high pressure mains.

Approximately 35,000 sq. ft. of direct radiation is installed in the building, and about 12,000 sq. ft. of indirect radiation.

For ventilating the building six fans are used, two of which each have a capacity of 43,000 cubic feet of air per minute.

The necessary fresh air for these fans is taken in through a louvre opening at the ground level; this is heated and washed, and then discharged into large plenum tunnels in a sub-basement, from which galvanized iron flues are run to rooms above and there delivered about 8 ft. above the floors.

Fan No. 3 has a capacity of 16,000 cubic feet.

Fan No. 4 has a capacity of 30,000 cubic feet.

Fan No. 5 has capacity of 20,000 cubic feet.

Fan No. 6 has capacity of 7,000 cubic feet.

Manitoba's New Parliament.

The heating coils for the fans are the regular vento section, set on the inlet side of the fans and contain a total of 12,145 sq. ft.

Control Steam Supply

The steam supply to the coils is operated by temperature regulating valves and thermostats, which control the air entering the offices at any desired temperature between 60 and 80 degrees. The return connections to the coils are provided with float type traps.

Two vacuum cleaning machines are installed in the basement, each having capacity for operating four cleaning tools, while maintaining a vacuum of 9 inches. Vacuum cleaning pipes with outlets are distributed all over the building, the dust collected being washed into the drains. To permit the chief engineer to always observe the condition of this service, a pipe was connected to the instrument board so that the degree of vacuum maintained could readily be observed by the "chief" at any time.

The water supply is from the city mains. A 6 inch pipe runs into the power house and from there is boosted by two centrifugal pumps through the tunnel to 2, 10,000 gallon steel storage tanks in the dome of the building.

A 6-ton York refrigerating machine provides the necessary cooling system for the kitchens, and the drinking water.

The drinking water system consists of a cork insulated copper tank with 100 feet of ammonia cooling coil. This water is distributed by means of two centrifugal pumps. There is an open copper tank in the dome to which are connected 16 pedestal fountains in corridors and 14 fountains and drinking faucets in the various offices.

The system is downward to the fountains and by connecting the supply risers back to the cooling tank, a continuous supply is maintained. As it is necessary to maintain uniform circulation to the various branches of the water supply, lock shield valves are installed which automatically govern the system.

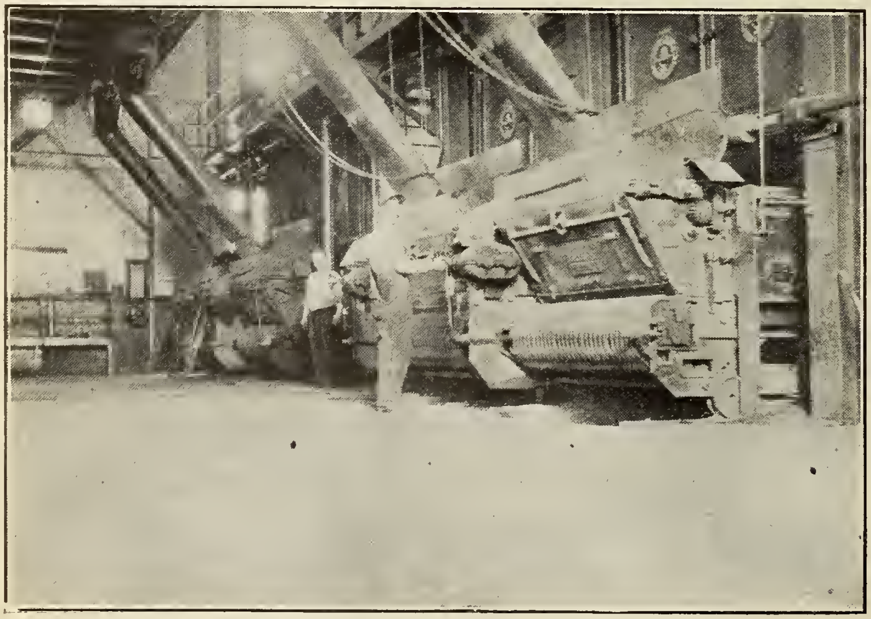
In a similar manner all the pumps in connection with this service are automatically controlled by float switches at the tank in the dome.

Hot Water System

The hot water is obtained from a hot water heating tank in the power house, this being heated by live steam from the economisers installed in conjunction with the steam boilers. Two centrifugal pumps located in the power house distribute the hot water. These pumps have a capacity of 380 gallons per minute. The insulation of all steam piping is of such an efficient character that it is seldom necessary to inject live steam to augment the temperature obtained from the economisers.

In all cases of central heating, after generating the steam efficiently, the important question arises of how to conserve the heat units in the steam and not permit them to be lost by poor insulation.

The method of insulation in this plant is of particular interest as it has a remarkable degree of efficiency. When walking along the main tunnels, one is not conscious of any uncomfortable degree of warmth although in close proxi-



Boilers and Chain Grate Stokers in Power House.

mity to several main steam pipes conveying high pressure steam.

Considering temperatures of the nature of 30 to 40 degrees below zero are of common occurrence during the winter months, the added importance of perfect insulations is readily appreciated.

The fresh air intakes between the outside walls and the first bank of heating coils, are insulated with two layers of 1 inch cork board. Air cell covering is on hot water piping, and wool felt is used on the cold water piping, whilst on the drinking water piping there is a cork insulation 2 inches thick.

Conduit in Tunnel

Where the buildings are connected by a conduit instead of a tunnel, the conduit consists of vitrified sewer pipe 8 inches in diameter. Special man-hole covers are inserted in the conduit at various intervals, and at all places where expansions joints are connected.

These conduits, the work of the Johns-Manville Co., are installed about 7 feet below the surface.

All steam pipe is covered with 85 per cent. magnesia covering, 2 inches thick on all high pressure mains, and 1 inch on low pressure, finished off with a water proofing varnish.

In large buildings it is a bewildering task to attempt to locate any defect which may arise on a particular piece of piping, due to the multiplicity of the number of pipes, sizes, services, etc. No such difficulty is apparent in this plant as each pipe is given a distinct color throughout the building, the color depending upon the particular service for which the piping in question is used. The color scheme of piping is as follows:

H.P. Steam, white with brass bands.

L. P. steam, white with black bands.

Domestic hot water, brown with black bands.

Heating hot water, brown with white bands.

Vacuum, yellow with white bands.

Return, green with white bands.

Air, grey with white bands.

This scheme was carried out by the Johns-Manville Co. and Hilton & Sons, of Winnipeg. It is to be highly commended and should suggest itself for adoption in any plant where a somewhat complex system of piping has to be installed for the distribution of the various water power and heating services.

The pump house is replete with modern equipment including:

2, Worthington feed pumps direct connected to 15 H.P. D. C. motors.

2, Centrifugal Pumps running at 1,800 Revs. 3 H.P. D.C. motors.

2, Centrifugal pumps running at 1,600 Revs. connected to 1-H.P. motor.

Chain Overhead Valves

All overhead valves are operated by chains, arranged at a convenient height.

To permit of a record being kept of the heating services, a complete system of condensation meters are installed on the various systems of heating.

Tunnel From Power House.

From these meters is collected each day the amount of water condensing in the heating system. This is measured in lbs. and entered in the daily "log" from which a complete statement is made up of the total cost of operating the central heating plant each month and presented to the Minister of Public Works.

The enormous figures attained by this condensation are worth while recording:

Condensation Water, from Heating System

For month in 1923:—

Parliament Buildings, 7,250,000 lbs. condensation.

University Buildings, 4,880,000 lbs. condensation.

Land Titles Buildings, 375,000 lbs. condensation.

Jail Buildings, 854,000 lbs. condensation.

The cost of generating 1,000 B.T.U's. in this plant is claimed to be 0.03655c per 1,000 B.T.U's.

T. M. Power is chief engineer of the plant and is also responsible for the efficient operation and maintenance of all the electrical and mechanical equipment of the Parliament Buildings.

Mr. Power is a Canadian born, and served his apprenticeship with the Mitchell Brass Works of Montreal. After gaining his experience in various large plants, he held several very important positions, being engineer in charge of construction for the Sturgeon Falls Paper Mill, Ont.; Chief Engineer, Lyle Construction Co., Montreal: Chief Engineer, Fort Garry Hotel, Winnipeg.

Mr. Power holds a 1st class engineer's certificate, and is a member of the Board of Examiners for engineer certificates in the province of Manitoba.

He is also Past Worthy Chief of the Universal Craftsmen Council of Engineers and a member of the Manitoba Electrical Association.

In addition to his professional interests Mr. Power is an active member of the Masonic Fraternity and the Order of Oddfellows.

PIPE LINES

UNCOVERED IN ANY OLD SPOT

Cracks or flaws in a smooth metallic surface can be rendered visible by thoroughly moistening the surface with kerosene, drying with a clean cloth and subsequently rubbing the surface with chalk. The location of flaws will be revealed by traces of the kerosene oozing from the cracks on the chalk surfacing.

* * *

Always remember that your brains can accomplish more in a boiler room than your boss's money.

* * *

In changing the speed of an engine, care should be taken to adjust the governor springs so that the sounds, when they are tapped with a hammer, will be as nearly alike as possible. If the sounds are different it is a case of unequal tension which will result in unequal strain and may cause racing.

* * *

There isn't any luck in the way the B.T.U. go through your boiler.

* * *

Do not stop a motor by turning the rheostat arm back to the "off" position and leave the line switch in. Open the line switch first and then note that the no-voltage release causes the rheostat arm to fly back to the "off" position.

* * *

Dirt on your hands doesn't clog up the machinery in your head.

* * *

A 220 volt shunt motor will run at 10 to 25 per cent. below normal speed when operated on a 110 volt circuit.

* * *

The safety valve capacity on a boiler should be such that the valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to increase more than 6 per cent. above the maximum working pressure or more than 6 per cent. above the highest pressure to which any valve is set.

* * *

Is a chimney a device for organized waste? Or isn't it?

* * *

Every care should be taken to keep all high-pressure steam lines drained of water all the time. Water-hammer is dangerous and often responsible for fatal accidents and serious damage.

* * *

Our idea of nothing at all is the brain cavity of the man who never uses his rear boiler damper.

* * *

It is always good practice to use tees or crosses instead of elbows in bends in the feed-piping, so that the pipes may be easily washed and cleaned.

Universal Craftsmen at Anniversary Banquet

Spirit of Goodwill Dominates Canada Council No. 27 as Grand Worthy Chief Patton Urges Engineers to Humble Their Antagonists by Gaining Their Objective on Sheer Merit

CANADA Council No. 27, Universal Craftsmen's Council of Engineers, held the most successful banquet ever staged by the organization in the Oddfellows' Temple, College street, on April 23.

Well attended by out-of-town visitors and Toronto members alike, an enjoyable evening was had by everyone from the first hearty handshake to the last waltz.

A brief but satisfactory business meeting preceded the festivities at which the following visitors were present: Grand Worthy Chief J. M. Patton, Past Grand Worthy Chief Jos. H. Nicholls, Past Grand Worthy Chief H. C. Senn, Jas. Magill, St. J. Gample, S. R. Finley, H. Lawrence, and A. Johnson, all of Buffalo; S. E. Cosford, Wm. Barclay, G. A. Leckie, and H. Lindgar all of Hamilton, and Campbell Bradshaw, editor of Power House.

Among Toronto officers present were H. E. Terry, Past Grand Worthy Chief; L. J. Cudbird, Grand Trustee; Chas. L. Holmes, Worthy Chief; and W. J. Hudson, Secretary.

'Twas Scene of Gaiety

Following the business session, the Council chamber became the scene of much gaiety when the ladies arrived by the score to start the evening's entertainment with progressive euchre. J. R. Grimshaw, as official announcer, instructed the players in the rules of the game, with a zest that won the approval of everyone.

The winners in this feature of the program were: H. Potter, S. Nelson, P. Davies, Mrs. Stephen, Mrs. Albert Baker and Mrs. A. M. Auchterlonie. J. H. Morrison and Mrs. Bunting captured the booby prizes with ease. Handsome trophies were awarded the skilful disciples of Hoyle during the banquet. Curiously enough Mrs. Stephens, Mrs. Auchterlonie and Mrs. Bunting are sisters.

Mayor C. Alfred Maguire, of Toronto, an honorary member of Canada Council for several years, welcomed the visitors in a witty and entertaining speech. Mr. Maguire said he was proud to be a member of such an organization, and emphasized the part played by the Council in fostering the spirit of goodwill ever present in the hearts of the members. The mayor's address met with an enthusiastic ovation.

Following the official welcome the 200 guests descended to the banquet hall where a sumptuous repast had been prepared.

Mr. Patton, introduced as the youngest Grand Worthy Chief the order has ever had and one of the best, in a stirring talk on the success of the council emphasized the common ideals of all men and stressed the necessity of members working in harmony to attain the aims of the organization without ill-will to those of their fellows who possess ideas contrary to their own.

Anticipation seeks to protect gains made in the economy and efficiency of power house operation; to develop new ways to overcome waste, to determine what resistance may be met with—and where it is likely to come from, along with the development of steps necessary to meet it, that the engineer may proportion his efforts to the demands that may be made on them—all looking toward his ability to make events which will fit in with his objective.

Sink Bad Feeling

"Sink bad feeling and do everything possible for the good of the order," Mr. Patton urged. "Always do for your brothers in life what you would wish them to do for you. The secret of success lies in always treating the other fellow as you would wish him to treat you if you were in a like position."

After declaring that he was proud to be an honorary member of Canada and Hamilton Councils, Mr. Patton won the good will of the fair sex by declaring that there were more really beautiful women present than in any audience he had ever seen. At the command, however, of Mrs. Patton, he immediately had to admit that he was a married man although he reiterated his faith in Toronto's beauty.

That the Universal Craftsmen's Council should control the larger positions in all the cities of Canada and the United States was the firm belief of the speaker as he warned the members never to allow the order to lower itself to conflict with antagonists but always to gain an objective on a merit basis.

Will Come Again

In concluding Mr. Patton predicted that the order soon would have a Canadian chief worthy of its great traditions in the person of Mr. Cudbird and promised that he would again visit Toronto before his term of office expires in August.

Worthy Chief Holmes proposed the toast to The King, and the President of the United States, the audience responding with great heartiness. This was followed with a toast to the Grand Council, proposed by Brother Terry. Grand Trustee Cudbird then gave an able address on the question confronting the council as to whether to increase the membership, the order should transgress on other fields by permitting men engaged in other industries, such as plumbers, to become members of the Council.

In the opinion of Mr. Cudbird there is but one answer to this question and that an emphatic "No."

"Let the order embrace the cream of the engineers in every land and let it not look for larger numbers, but for quality, by keeping always to the present tradesman," the speaker said, commenting on the rapid expansion of both the Hamilton and Toronto Councils. He pointed out that in great part due to the popularity of Worthy Chief Holmes, Toronto had initiated twenty-five members since June.

Mr. Cudbird predicts the immediate dawn of an era of unparalleled success for No. 27.

The Grand Trustee was followed by Mrs. Nichols, of Buffalo, who gave an excellent talk on behalf of the Grand Council.

Can Move World

Mrs. Senn, of Buffalo, pointed out that since engineers alone can turn the wheels of industry, they should when aided by the weaker sex be able to move the world. Members were urged to develop kindliness and to help others to gain talents equal to their own, and above all things, to eliminate jealousy from their hearts and disregard bitter remarks. Mrs. Senn declared she was proud of her English parentage, her mother having been born in England. Amid much laughter she remarked that it were well that the teachers of Buffalo could not hear Mr. Patten's compliment to Toronto's fair sex, since that gentleman is chief engineer of Buffalo's Board of Education. Mrs. Senn here ended her remarks and was succeeded by Mrs. Geo. Aldridge, Chaplain of the Grand Council. Mrs. Aldridge stated that no one could be happier to be present at such a gathering, second only in the annals of No. 27 to the convention a few years ago. She heartily wished every member many happy returns on the Council's birthday. After this cordial talk which was well received, a handsome bouquet of flowers was presented to Mrs. Patton, wife of Grand Worthy Chief Patton.

In a brief reply Mrs. Patton said she was too tired to do other than thank everyone from the bottom of her heart for the kindness she had experienced. Brother Thos. McAree with a few well chosen words, then thanked the ladies for the hearty co-operation they had always given the Council in any project undertaken.

Was Star of Bill

Mrs. Darbyshire, wife of the chief engineer at the General Hospital, with a pleasing solo which was easily the outstanding vocal offering of the evening, received prolonged applause, and as an encore sang Tosti's Good-Bye. Mr. Morrison offered two splendid selections, accompanied by Mrs. Longmore at the piano.

Another exceptionally entertaining feature was a recitation by little Miss Johnson, entitled "On to the Bargain Store Rode the Six Hundred."

The entertainment was featured by the winsome Misses Jean "Babe" Russell and Agnes Russell in dancing and songs.

Howard G. Fletcher acted as accompanist for a number of jolly songs, such as: "Pack up your troubles in your old kit bag;" "All the nice girls love a sailor;" "Hail, hail the gang's all here," etc.

After Brothers G. A. Leckie and S. E. Cosford, of Hamilton, had congratulated No. 27 on its birthday, W. R. Sexton took the gathering by storm with the Power House Orchestra, composed of J. L. Percy, J. A. MacTaggart and K. W. MacTaggart. When the tables had been cleared away and the room made for enthusiasts who had remained, everyone indulged in fox trots and waltzes, which were featured with the swan-like dips and glides of Mr. Sexton.

By this time, the wee sma' hours were creeping by, and with the last strains of "Three O'Clock in the Morning" throbbing on the air, Canada Council, began its entry upon its year of majority, with the good wishes of everyone prophesying one of the most successful years in its history.

Regret was expressed at the absence of Wm. J. Ranton of Rochester, N. Y., Past Grand Worthy Chief, who from far off Kansas City, Mo., sent members his best wishes for a happy and enjoyable anniversary.

To dry out a generator run it with the armature short-circuited beyond the ammeter and circuit breaker and adjust the field so as to maintain a temperature in the winding of 58 deg. Fahr. This should require approximately full-load current.

Good oil without adulteration, if used intelligently, is cheaper and more satisfactory than cheap oil, loaded to give bulk and to make it apparently cost less per gallon.

Leaky boiler settings may be made lastingly tight by soaking cheap waste or asbestos from old discarded pipe covering in thin fireclay and hammering the mixture into the cracks. Paint the brickwork with thin cement.

Can Every Fat Man Defy Heat?

Engineers Find Stout Firemen Lose Weight But Retain Vigor at High Temperatures

FAT men endure high temperature and humidity better than thin men. This fact has been proved in scientific research conducted by the American Society of Heating and Ventilating Engineers, in co-operation with the Carnegie Institute of Technology.

In experiments to determine the relative effect of various temperatures and humidities on the human body, the scientists also found that sweat is the chief factor causing sore eyes, when a person becomes heated.

Another common belief was blasted during the experiments when they found that the drinking of ice water failed to develop cramps in men after they had been subjected to an hour's exposure to high temperature.

The object of the research work is to establish, by scientific study, the exact degree of temperature, and of humidity, or "comfort lines" a person should be subjected to in a room.

Can Endure Variations

One of the important results of the experiments was the discovery of the great variations of external temperature which the human being can endure, and at the same time, retain his physiological efficiency. Another fact discovered was that increasing pulse-rate is more the cause of discomfort than is body temperature, when in a heated room.

In a report of the experiments, just issued, are these assertions: While irrelevant to the present study, an attempt was made to determine the cause of the inflammation of the eyes, and also to find out whether or not drinking of ice water produces cramps, as so frequently complained of by workers in the industry.

"On a day when the eyes were normal, small quantity of sweat which had been collected during an experiment, was dropped in the eye. The conjunctiva almost immediately became inflamed and the eye felt sore. The sweat collected from the face seemed less irritable to the eye than that collected either from the chest or arms. Sweatbands were then applied to the forehead during the experiments, these preventing the sweat from falling into the eyes, and also prevented the inflammation. This proves sufficiently that sweat is the chief factor in producing the conjunctivitis which accompanies exposure to heat.

No Cramps Develop

"It has frequently been stated that workers, such as firemen, exposed to high temperatures developed severe cramps after drinking ice water. A few of the subjects of these experiments volunteered to drink ice water after about an hour's exposure to high temperature, and two of them, in one experiment, drank a quart of ice water in less than 15 minutes without ill effects. Cramps did not develop in any of the subjects at any time."

On entering and leaving the specially heated chamber the report shows, loss of weight varied with the individual, the heavier and stouter man losing more than the light and thin one. Notwithstanding this, the lighter man as a rule could not endure the temperature conditions as long, and complained more of the exhaustion which followed.

Book Reviews

MACHINERY FOUDATIONS AND ERECTION

By Terrell Croft. Published by McGraw-Hill Book Co., New York City. Cloth; 5½ x 8 in.; 668 pages; 772 illustration. Price, $5.

This volume is one of a series which the author has prepared upon steam power-plant practice. Nothing new is presented beyond the development of formulas for the calculation of foundation bearing surface and volume.

Unfortunately, the data given as to safe bearing pressures are so much beyond those encountered in machinery-foundation building that the formulas are of doubtful practical value. The pressure values given evidently are those where some settlement of the masonry is permissible. Needless to say this is quite undesirable in engine foundations.

As the author points out, the framing of most machines is such that the area within the foundation bolts exceeds the required area as derived from the formula. Most of the pages are devoted to methods of constructing foundations, aligning and erecting machinery and other data of considerable value to the engineers.

While the volume is in many respects a compilation of material that has appeared in various technical publications, this matter is so logical in arrangement and so complete in treatment that a considerable popularity is to be expected for the work. It would seem that it should be of particular benefit to machine designers and erectors, consulting engineers and architects.

A simple method of determining the polarity of the wires of a direct current circuit is to place the two leads about ¼ in. apart on a piece of moistened blue-print paper. The paper around the negative will turn white. It is well to place a lamp in series with one of the leads to avoid a possible short circuit.

Corrosion Problems in Modern Plant Equipment

Basic Principles of Feed-Water Troubles—Causes of Corrosion From a Chemical Standpoint and the Practical Application of Effective Prevention in Boilers and Economizers

IT IS proposed to deal in this article with the underlying causes of one of the problems which continually confront those who deal with the production of steam power—corrosion in boilers. While the process of corrosion is essentially chemical, the reactions taking place are of such a nature, and the basic principles upon which they operate so clear, that it is possible for any stationary engineer to become thoroughly familiar with them without the necessity for wading through realms of seemingly vague technicalities.

General Troubles

Since we are here concerned with the question of corrosion only it is possible at the beginning to eliminate the three other difficulties in boiler operation due directly to the water—priming, foaming and scaling. The first two of these are surface tension, they are ebullition or boiling phenomena whose symptoms are the faulty distribution of boiler water. Scaling and corrosion are sharply differentiated since, with a single exception, one rarely accompanies the other.

Scale, consisting chiefly of silicates, amalgamates with the boiler wall and destroys its smoothness. In addition, when it is removed it takes with it a film of the metal, gradually weakening the walls. As scales, these silicates are excellent heat insulators and are not entirely impervious to penetration by boiler water. The corrosion caused by them is primarily mechanical and is due to localized overheating at the boundary surface. Aside from the silicate, boiler scale is a most excellent preservative, being far superior to any paint which it is possible to apply.

Theories of Corrosion

Corrosion proper, is a chemical reaction between the boiler wall (metal) with one or several of the constituents of the boiler water. The ultimate result of this continuous process is the solution of the metal. There are three theories generally put forth in explanation of these reactions: Whitney's Electrolytic Theory; Calvert's Carbonic Acid Theory and the more recent Colloidal Theory of Friend. Each of these differs from the others in the details of the argument but all are founded upon the same generalities. It is to these latter that we shall devote our attention.

Mind is the basis of all business organization. Brawn alone in the midst of present day production machinery is more or less worthless. The big economic force is not merely man power or the instruments of which man power makes use, but mind power. It designs and builds power plants, factories and skyscrapers. It opens up mines, cuts down forests, and turns dry lands into garden spots.

Basic Reactions

These major premises, however, include practically all the observations which it is possible to make and are therefore the sort of information of value to the engineer in the field. The chemical equations of the electrolytic theory are the most direct and we shall use them as an example of the general process. They are listed here for reference and on the basis of the greatest convenience.

(1) $\text{Fe}+2\text{H}(\text{OH}—\text{Fe}(\text{OH})_2+\text{H}_2$
(2) $2\text{H}_2+\text{O}_2—2\text{H}_2\text{O}$
(3) $4\ \text{Fe}(\text{OH})_2+\text{O}_2+2\text{H}(\text{OH})—$
$4\ \text{Fe}(\text{OH})_3$

Very little chemical knowledge is needed to understand the mechanism of the reactions for which these equations are an abbreviation. We are all familiar with the fact that water is ionized into two particles called ions, which carry electric charges of an opposing nature and which are designated as hydrogen ions (H) and hydroxide ions (OH). Iron by virtue of its position in the arrangement of the elements according to their electrolytic activity, is able to displace the hydrogen ion from solution, depositing hydrogen gas upon the iron surface, and itself going into solution as ferrous iron. The extent of this interchange is the first consideration in dealing with corrosion.

Ionization

For water, the product of the concentration of the hydrogen and hydroxide ion is a constant quantity. It is impossible to increase one without simultaneously decreasing the other. Increasing the hydrogen ion concentration increases the acidity and likewise the corrosion. Upon these facts are based several observations of a very practical nature.

Alkalinity, or causticity of a boiler water is usually associated with softening either by the zealite or lime-soda process. In practice, alkalinity and causticity are rather sharply defined---alkalinity being due to carbonate additions of sodium and causticity to hydroxide additions---while from a chemical viewpoint, both are alkaline. Very frequently, the selection of carbonate instead of sodium hydroxide is a matter of cost rather than of the best practice while on the other hand, many recommendations made for corrosion prevention may not accord with minimum operating costs in softening processes.

The addition of caustic soda by the direct addition of hydroxyl ions, or the addition of sodium carbonate with its resulting hydrolyzed product, increases the concentration of hydroxide and simultaneously decreases the hydrogen ion concentration and corrosion. This, however, is a broad statement which requires some reservations.

General Exceptions

In spite of our chemical logic set forth above, it is true that relatively pure waters, made alkaline by the addition of sodium carbonate are much more corrosive than the water in its original state. Generally speaking, therefore, the addition of sodium hydroxide is to be preferred to the addition of sodium carbonate. The only cases where sodium carbonate ever approximates the protective value of the hydroxide are those of waters containing appreciable quantities of chlorides and magnesium salts, such as sea water.

The addition of caustic soda or sodium carbonate to boilers operating on distilled water produces practically no benefits. With natural waters, fed into the boiler in the raw state, without distilling, the addition of sodium in either of the two forms mentioned is much more beneficial, but very much depends on the nature of the other totally soluble salts, which, in ionized form, affect the concentration of the hydrogen ion.

Negative Ions

The order of corrosion due to soluble and ionized salts in boiler water from the standpoint of the negatively charged ions which they produce, is as follows: Nitrates, chlorides, sulphates, chromates and arsenates. It is impossible to suppress corrosion in a water carrying nitrates by the use of soda. These nitrates, however, ordinarily originate from pollution and nitrate waters are comparatively rare. With chloride waters, sodium carbonate is perhaps more useful than sodium hydroxide, but the order of the merit is open to dispute and neither of them will prevent corrosion, but only minimize it. With predominantly sulphate waters containing magnesium in particular, high causticity is almost a complete corrosion preventive. Chromates and arsenates are usually compounds which are added to boiler water to help out the addition of other corrosion preventing reagents and do not occur in natural water. They are most useful in the case of boilers operating upon comparatively pure water.

Positive Ions

It is desirable at this junction, to make some mention of the other ion in the combination for dissolved salts, viz —the ion carrying the positive charge.

The bivalent ions in this case produce more corrosion resistance than the monovalent, and the trivalent more than the bivalent. This, however, is significant only where other reagents are to be added to comparatively pure water to make up for the deficiencies of caustic.

It is possible to summarize the conclusions in the foregoing paragraphs by saying that causticity or the addition of sodium hydroxide serves best with impure natural waters, containing very considerable quantities of dissolved solids.

There is still to be considered the bugaboo of operating engineers—caustic embrittlement of the boiler metal with high hydroxide concentration. This has been a real and serious difficulty in certain localities, either from industrial pollution as in by-product and alkali works or in certain localities where the subterranean water was heavily charged with carbonate of soda. It is not a corrosion phenomena in the sense that we have previously described corrosion in this paper, but rather an osmotic penetration of gases into the metal, and a subsequent embrittlement. Fear of caustic embrittlement has deterred and will deter many engineers from the use of sodium as a corrosion preventive. It is still so mysterious and its occurrence has been so comparatively rare that no definite explanation for its prevention can be offered.

Raw Feed Water

Where causticity is used for corrosion prevention in boilers using raw water, it is necessary to work out a scale of blow-down concentration by experiment. As boiler waters concentrate over periods of operation, the conditions of soda alkalinity change also, and for complete control it is necessary to supervise boiler concentrations closely. This makes the use of causticity very tedious. Foaming or priming occurs only with a combination of high alkalinity and suspended matter in the boiler water.

Dissolved Gases

One other, but very vital criticism of causticity in boiler water is to be noted, and it may very conveniently furnish an introduction to the succeeding section. We shall next speak of the influence of dissolved gases and in particular, dissolved oxygen, and before leaving the subject of causticity, it is to be noted that the oxidation of the primary corrosion, ferrous hydroxide, which is a feature of dissolved gas corrosion to be stressed in later paragraphs is accelerated in alkaline solution. This is a very significant objection in the case of boilers fed with distilled water.

A second factor influencing corrosion, viz.—dissolved gases and in particular dissolved oxygen, has been intimated in the previous paragraph. Equation 1 of our previous discussion is still useful in explaining this form of attack on the metal, but it is necessary to consider also equilibrium conditions which are dependent upon equations 2 and 3. Equation 1, from the chemist's standpoint, is a reversible reaction, which does not go on indefinitely in one direction, but on the contrary has natural limits, which occur when the electrical forces, producing the solution of the metal in the water, are exactly balanced by the electrical forces in the solution. These electrical forces counterbalance each other with a very minimum amount of solution, determined by the concentration of the dissolved product, not enough in the lifetime of a boiler to produce any trouble.

Reversible Reactions

The solution of iron in the boiler water occurs, by the inter-change of hydrogen and iron, the iron going into solution and depositing the hydrogen on the metal surface. This deposited hydrogen gas film would speedily polarize the metal surfaces and add its influence to checking the reaction, if it were not promptly destroyed by the dissolved oxygen in the water through the same chemical reaction, which produces the water (equation 2). This is the first step in the destruction of the equilibrium condition of equation 1, which nature would otherwise impose.

The important thing in any work is happiness and contentment. An engineer may be capable of filling the very highest places in engineering circles yet may prefer the dirt and grime of problems solved to the honor and income of a higher place. Of such men there are many in the world. We look at them and pass by, just a wee bit sorry, but as we look back, we see a puzzled look on their faces because we do not see their point of view any more than they have seen ours.

The natural equilibrium of equation 1 is displaced still further by dissolved gases. The corrosion product ferrous hydroxide, $Fe(OH)_2$, is soluble in water. However, in the presence of dissolved oxygen in the water, ferrous hydroxide is oxidized to ferric hydroxide, which is insoluble. Dissolved oxygen in the water, therefore, removes the solution product, whose concentration, in a large measure, by virtue of electrical forces in the solution, was responsible for equilibrium. This is illustrated in equation 3. The natural checks upon the attainment of equilibrium are, therefore, removed and the limit of corrosion, instead of being the presence of a minimum amount of dissolved ferrous hydroxide, is now the complete elimination of the oxygen from solution by corrosion processes. This is a most serious feature, since the dissolved gases are in sufficient quantity to produce a very decisive attack on the metal.

These statements as before, furnish a groundwork for understanding the influence of dissolved gases on corrosion in a theoretical way. To this discussion also may be added certain pertinent facts which experience develops.

The fact that the oxidation phenomena, as abbreviated in equation 3, is a reversible process, is most significant. The reversibility is, however, what one might call polarized, in the sense that it proceeds from left to right much easier than it does from right to left. However, below .6 c.c. per liter of dissolved oxygen (cubic centimeters per liter being the usual means of expressing dissolved oxygen content in water and correspondig to parts per thousand by volume), the equation proceeds in some slight degree in this reversed direction, the velocity increasing as the oxygen content reduces, and if pipes heavily corroded from previous oxygen contamination are fed with air-free water, the product of the previous corrosion is reduced in some measure by the de-oxygenated solution and the products become soluble and detached.

Layer Corrosion

Usually observation of corroded pipe sections will indicate two or three layers of oxide, the ferrous closest to the metal surface; the ferrous-ferric next, and finally the ferric. The ferrous-ferric, Fe_3O_4, is to be regarded merely as a mechanical-chemical mixture of the ferrous and the ferric. Color of the oxide layers varies with the water of hydration; usually they are black, brown and red in the order named. The ferric oxide constituent serves as the binder for conglomerating all of the oxides and any scale present and the change in the reversibility by reducing the ferric hydroxide, destroys this binding action and clears out corrosion products at a slow rate. It is to be expected, therefore and experience coincides with this, that corroded surfaces will be cleared of their corrosion products. This is a big operating advantage in connection with deaerated water in hot water sanitary systems, where pipe stoppage from corrosion products is a formidable factor.

We have discussed, perhaps at the expense of apparent sequence, the facts that ferric hydroxide was insoluble and also that it has considerable cementing action. These two facts have a further significance. Ferric hydroxide in the solid form has a solution electrolytic potential different from iron, and as a result, acts when imbedded in an irregularity of the iron surface, as one electrode of a most excellent electrolytic cell, which continues the attack on the metal and produces a characteristic pit hole. Several things may produce chemical oxidation besides oxygen. One of them is electric currents as in the case of the pit hole formation.

Pitting

The corrosion due to dissolved oxygen which is most serious is pitting, and it is necessary to differentiate sharply between ferric and ferrous corrosion. The ferric corrosion produces the pit hole through the formation of electrolytic couples, as previously outlined. The ferrous corrosion, where it occurs, is a very uniform wasting of a metal at a slow rate. Sharp oxygen limits do not exist as transition points. It is possible that this is due partly to our facilities for observation, but it is more probable that it is gradually changing phenomenon. It is safe to say, however, that present experience with a variety of waters indicates that .6 c.c. per liter is sufficient to produce some reverse reaction in equation 3, and some freeing of pipes from corrosion products. The amount of corrosion is proportional always to the concentration of dissolved oxygen. This limit .6 c.c. per liter is therefore the upper limit at which some control of the form of the corrosion product is first exercised. Definite pitting, however, has been experienced with boiler waters of continuous oxygen content as low as .15 c.c. per liter. Corrosion has not been experienced with waters which have been de-aerated and have values substantially zero to a trace, a trace being defined as less than .2 c.c. per liter. The middle ground, as far as the writer is aware, between these values—.025 and .15 is still unexplored and will be explored only when practical operating values are available.

A remark made previously, that the difference in electric potential between iron and precipitated iron hydroxide was responsible for the pit hole formation, suggests the advisability of using high water velocities to prevent ferric hydroxide lodgment, in other words to wash out the hydroxide rather than have it adhere. It is possible to secure some merit by using high water velocities, but the velocity required is in the neighborhood of the condensor range and considerably above turbulence, the minimum useful value being about 4 ft. per second. Such velocities are impossible in natural circulation of boilers and cannot be maintained except under conditions of high load and high pumping loss in economiser practice.

Oxygen

It is desirable at this point to summarize oxygen corrosion prevention very much as we have previously summarized hydroxide corrosion prevention. Dissolved gas removal with pure waters is a corrosion preventive. With acid waters having a high hydrogen ion concentration, it is an inhibitive. It cannot prevent the attacks due to the acid pollution, but it can very definitely prevent any regenerative action. Neither can the removal of dissolved gases prevent the pitting of defective material, which, in the process of manufacture has segregations of manganese and mill scale to produce electrolytic couples. Commercial boiler materials have proven sufficiently pure to avoid this objection. Aside from these, it is more useful than causticity in that it aims directly at the seat of the trouble. Addition of soda protects only the boiler; the economizer is included only when the caustic feed is continuous, as with 100 per cent. make-up. Corrosion may be suppressed in the boiler by hydroxide ion concentration and reappear again where the steam is condensed as a typical case of dissolved gas corrosion.

Having dealt fairly generally with the underlying principles of corrosion in boilers we will now turn our attention to economizers or feed water heaters in particular and observe how the facts which we have outlined find application in one of the most important pieces of equipment in the modern plant.

Much has been heard in recent years regarding ways and means for the utilization of waste heat, presumably owing to increased fuel costs and a general call for economy. In work of this nature, particularly in connection with internal combustion engines, considerable duplication of effort might be avoided by reference to several means which have contributed to the efficiency of such plant for many years. In boiler practice it is safe to assume that every basic principle of waste heat utilization likely to be used for many years to come has already been applied. Forced draught, feed water heaters, special furnace tubes, and internal combustion heaters, super-heaters, water tubes and mechanical stokers have all contributed their quota to boiler efficiencies, and are the outcome of years of practical experience in the production and utilization of as much steam as possible for a minimum consumption of fuel.

It is proposed to deal in this section more particularly with economisers or feed-water heaters, with special reference to the corrosive influences to which they are subjected.

General Principles

The aim in boiler design to communicate to the water as much as possible of the heat generated, it follows that the temperature of the flue gases should be reduced to a minimum before going to waste; and this may be effected, within certain limits, by providing a maximum heating surface for a minimum grate area.

One method of increasing the effective heating surface is by introducing an economiser, a system of tubes through which the feed water passes and receives heat from the flue gases in which it is stationed. Where economisers have been installed in steel mill plants a regular saving of 10 per cent. in fuel costs has been made. Forced draught is necessary in connection with the use of economisers.

Other Types

There are other types, of feed-water heaters in which the water passes through brass tubes which are heated by exhaust steam from an engine; but we are mainly concerned with economisers as understood by a series of cast-iron or wrought steel tubes, conveying the feed water and set in the flues. whence they utilize some of the heat of the combustion products, which otherwise would escape by the smoke-stack. A typical economiser of this nature consists of several vertical cast-iron pipes about 4 in. diameter and 9 ft. long, communicating at the top and bottom by longitudinal headers, known as boxes. These boxes are connected by top and bottom branch pipes, situated on opposite sides of the economiser and outside the brickwork by which it is surrounded. The feed water is pumped into the economiser through the bottom branch pipe near the point where the flue gases enter. The economiser should be situated in a by-pass in the main flue, in order that it may be cut out of action by a damper, to facilitate inspection without shutting down steam. An automatic scraper travelling up and down continuously to keep the surface free from soot should be provided on each tube.

Corrosion Conditions

Economisers are subjected to the most corrosive conditions prevailing anywhere in a boiler plant, the tubes being attacked on the inside by the feed water and on the outside by the gases and vapours of combustion, as well as by soot, which, when moist, may be highly corrosive. It is only comparatively recently that economisers of the type set in the flues have been made of any other material than cast-iron but, with the adoption of higher steam pressures than formerly, wrought steel economisers are finding favour, by reason of the great resistance which this material offers to bursting. The wrought steel tubes are lighter and occupy less space than those of cast iron. but these advantages are offset by the fact that the steel is considerably more corrodible; and it is only on account of its superior strength that it has been called into service in economiser work. Wrought steel tubes, having a safety factor of the same order as the actual boiler, which can be attained also with cast-iron but only with considerable complication, have been rendered useless by internal corrosion after less than twelve months service.

Prevention Means

Although economiser tubes whether of cast iron or wrought steel are very susceptible to corrosion effective measures can be taken to mitigate this trouble, and, indeed, in the case of wrought steel must be taken if the tubes are to render any useful service at all. Internal corrosion as already stated has been known to necessitate replacement of wrought steel economiser tubes within one year. Such rapid depreciation is mainly due to dissolved oxygen in the feed water. and may be lessened by the use of one or other of the available appliances which provide means for heating the water in an open heater and withdrawing the dissolved gases under vacuum in another vessel. With cast iron economisers the final oxygen content, after de-aeration of the feed water, should not exceed .03 per cent., or three parts of 10,000 and where wrought steel tubes are used, two parts in 10 000 or .02 per cent. is the working limit. A de-aerating plant suitable for use with cast-iron is not necessarily suitable therefore, if wrought steel condenser tubes are used.

(Turn to col. 3 page 29)

A.S.M.E. Makes Plans for Spring Meeting

DEFINITE plans are being made by the executive committee of the American Society of Mechanical Engineers for the spring meeting which is to be held at the Mount Royal Hotel, May 28 to 31. At their invitation, the Canadian Engineering Institute is co-operating in the arrangements for the convention and the Montreal branch is taking care of local requirements. It is expected that about 600 delegates will be in attendance from all over the continent.

The program of the convention itself will be largely of a technical nature. In addition to the general sessions on the opening day, there will be technical sessions on following days devoted to the following subjects:—Power, textiles, machine shop practice, management applied to the pulp and paper industry, port development, fuels, railroads and general mechanical engineering.

Following will be found the daily program, by sessions:

Monday, May 28

Morning—(Morning sessions at 9.30) Council meeting.

Afternoon—Business meeting. Address by Calvin W. Rice, secretary, A. S. M. E., on his South American trip. Public hearing on power test codes.

Evening—Joint dinner at St. James Club, Council of the Engineering Institute of Canada, and Council of A. S. M. E.

Tuesday, May 29

Morning—Power development in the Province of Quebec, by Julian C. Smith; Development of Hydro-electric Power Plants in Ontario, by Frederick A. Gaby; Management Engineering as applied to the Pulp and Paper Industry, by R. B. Wolf; Practical Laboratory and Drawing Room Course in Industrial Engineering, by M. A. Lee; Street Car Construction at the Angus Shops of the C. P. R., by H. R. Naylor; Notes on Some Recent Developments in Railway Motor Cars, by C. E. Brooks.

Afternoon—Excursions.

Evening—Smoking Concert, by the Montreal Branch of the Engineering Institute of Canada, in the Mount Royal Hotel.

Wednesday, May 30

Morning—Bleachery Engineering and Operation, by F. P. Bascom and J. C. McDowell; Port Development, by R. S. MacElwee; Harbor of Montreal, by Frederick W. Cowie; Modern Hydraulic Turbines of Large Capacity, by H. G. Acres; Sectionalization and Remote Control of High-Pressure Steam Lines, by Peter Payne Dean.

Afternoon—Excursions.

Evening—Dinner Dance.

Thursday, May 31

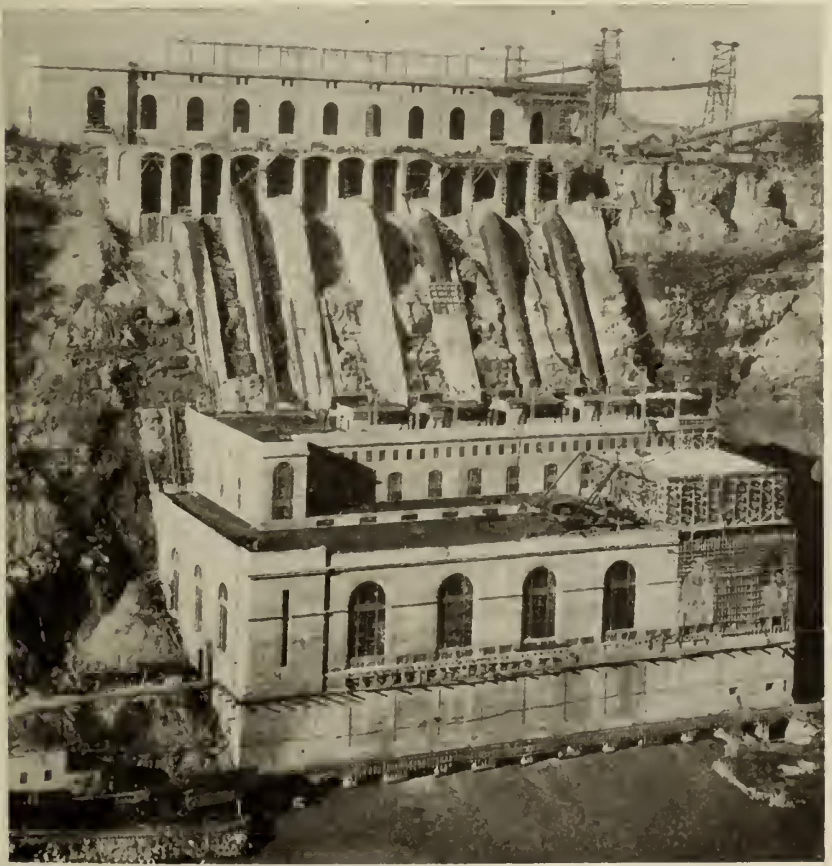
Morning—Recent Developments in Balancing Machines, by Carl R. Soderberg; Machine Tool and Paper Industry, by G. E. Williamson; Chimney Design, by A. Cotton; Lignite Char, by O. P. Hood; Endurance Test Data and Their Interpretation, by K. Heindlhofer and H. Sjovall; Bending Stresses in Curved Tubes of Rectangular Cross-Section, by S. Timoshenko; Control of Flying, by the Aeronautic Division.

Afternoon—Excursions.

The executive of the A. S. M. E. is also planning for those members in New York, New England and Eastern States, an automobile trip to Montreal. This trip will be taken by way of New York-Albany-Plattsburg-Montreal. A plan has also been arranged for those from the Western States to make a visit to the Queenston-Chippawa Power Plant on the way by train. Those members will meet at Niagara Falls, Ont., 10 a. m., Sunday, May 27, and visit the power plant, then going forward to Toronto by train, leaving for Montreal Sunday night.

While in Montreal, several interesting industrial visits will be made. The excursions will be planned as follows:—Tuesday—C. P. R. Angus Shops and Cedar Rapids Manufacturing and Power Co. Wednesday—Montreal Harbor and the plants of the Canadian Vickers Co., and the Frontenac Brewery. Thursday—Dominion Engineering Works and the McGill University. Other trips will include St. Anne de Beaupre, St. Helen's Island, Mount Royal Park, Art Gallery, Antique Buildings in Montreal, and the Lachine Rapids.

A ladies committee has also been organized, with Mrs. Fred B. Brown as chairman, to arrange a program of entertainment for the ladies of the party.



General exterior view of Queenston-Chippawa Hydro Power Station.

CORROSION PROBLEMS

(Continued from page 28)

The water should, of course, be as pure as possible and free from mineral acid.

External Corrosion

External corrosion of economiser tubes is caused mainly by condensation of moisture from the flue gases, and may be prevented to a large extent by maintaining the temperature of the feed water in the tubes at from 120 deg. to 175 deg. Fahr. The exact figure will vary probably in particular circumstances, but for most work 140 deg. F., will provide sufficient heat in reserve to cope with intermittent working, during which the liability of moisture to condense, if the tubes are allowed to cool, has to be reckoned with. The difficulties of countering external corrosion in intermittent service are increased also by soot, which, collecting on the outside of the tubes, is liable to become moist when the economisers are shut down or during starting up. Moist soot may be highly corrosive, especially if derived from fuel having a high sulphur content. The feed water should always be kept at a slightly higher temperature in the economisers when coal of a sulphurous nature is being burned.

Why Flue Gas Analysis Talks Furnace Efficiency

Three Simple Requirements of Combustion Apply to All Fuels, Namely, High Temperature, Proper Air Supply, and a Complete Mixture of the Air With the Fuel Gases

ANALYSIS of waste gases has come to be an accepted method of determining the completeness of combustion, the efficiency with which fuel is consumed, whether it be coal, oil, gas or refuse.

There are three parts of CO$_2$ in 10 000 parts of air—an insignificant fraction—but if the air were to be robbed of it, all vegetation would cease upon the earth, all plants would die, for plants live very largely upon carbon, and they get it all from the air. With the end of plant life would come the end of all animal life.

High fuel bills, freight rates and the like have all combined forces in pointing out the importance, the economic necessity of analyzing flue gases as a guide to the proper regulation of draft and the feeding of fuel, and as an index to the condition of baffles and settings and the efficiency of firing methods.

Steam Production Economy

To make steam with economy, two things are necessary:

Convert sleeping energy in fuel into live heat energy.

Transfer as much as possible of this heat energy to water in boiler.

The first of these has to do with the furnace; the second has to do with the boiler. The degree to which they are accomplished is expressed in the combined efficiency. **Gas analysis has to do with furnace efficiency and furnace efficiency is the controlling factor in combined efficiency—the key to high boiler room economy.**

The quality of the fire may vary to such an extent that it will cause all of the heat to be wasted, or make useful to the boiler as much as 85 per cent. of it. There is necessarily a loss of about 15 per cent. due to the fact that the gases must leave at a higher temperature than they enter.

What is Combustion?

Combustion is a chemical process. It is a process of oxidation or the chemical union of an element with oxygen. Combustion may be slow and accompanied by little heat, as when iron rusts, it may be more rapid, as when it occurs in the lungs of animals, it may be still more violent. as when coal is burned in a furnace; it may be instantaneous, as when powder is exploded in a gun barrel.

The principal combustible elements in fuel are carbon, hydrogen and sulphur. Three simple requirements of combustion which apply to all fuels are: (1) high temperature, (2), proper air supply, (3) complete mixture of this air with the fuel gases.

The supporter of combustion, oxgyen, is a chemical element. In its free state it occurs as a gas. The oxygen for the combustion with which power plant men are concerned is provided by the air, which is a mechanical mixture, not a chemical compound. It is important to distinguish between "Mechanical" and "Chemical" union. Oxygen is found in water in chemical union with hydrogen. It requires more or less energy to separate elements chemically combined. Little or no energy is required to separate elements mechanically combined.

> **It's lucky a man possesses the monkey trait of imitation. Engineers must read how other men have succeeded that they may imitate, not their exact methods, but their persistence, their efficiency and their energy. They must read about what they did and how they did it—to win out themselves.**

Hence it follows that the oxygen of the air is substantially free to combine with the carbon contained in coal, while the oxygen contained in water or carbonic acid gas is not free to enter into such combination. Apply air to the furnace fires and combustion flourishes—apply water or carbonic acid gas and combustion ceases.

Composition of Air

When the oxygen in the air passes through a hot bed of fuel or into the heated combustion chamber of the furnace, it unites with the carbon of the fuel to form a gas known as carbon dioxide, which is represented by the symbol CO$_2$.

Air can be said to consist of 79.3 per cent. nitrogen and 20.7 per cent. oxygen by volume, as the minute quantity of other gases that may be present, such as sulphur dioxide, ozone, carbon dioxide, moisture, etc., are negligible from the point of view of flue gas analysis.

Nitrogen performs no useful office in combustion and passes through the furnace without change. It dilutes the air, absorbs heat, reduces the temperature of the products of combustion, and is the chief source of heat losses in furnaces.

The combustibles with which we are concerned in the order of their importance are carbon, hydrogen and sulphur. (In steam engineering the term "combustibles" is applied to that portion of the fuels which will burn. Sometimes oxygen and nitrogen and other gases together with what is called "water of composition" are included with the combustibles but this is not correct.) The product of the combustion of carbon is carbon dioxide; of hydrogen, water; and of sulphur, sulphur-dioxide. The reactions in all three cases give off heat.

Combustion and Heat

Combustion is perfect when the combustible unites with the greatest possible amount of oxygen, as when one atom of carbon unites with two atoms of oxygen to form carbon dioxide, CO$_2$. $C+2O=CO_2$. Combustion is imperfect when complete oxidation of the combustible does not occur. Sometimes the volatile matter is distilled and passes off without burning at all. Again, the combustible may not unite with the maximum amount of oxygen, as when one atom of carbon unites with one atom of oxygen to form carbon monoxide, CO, which may be further burned to carbon dioxide. $C+O=CO$. $CO+O=CO_2$. When carbon is burned completely there is liberated 14,600 B. t. u. for every pound of carbon burned but when it burns to carbon monoxide only 4,550 heat units are liberated. If carbon monoxide can be burned to carbon dioxide the additional 10,150 B. t. u. are given up.

A mere statement of these facts might prove to be misleading by offering an exaggerated idea of the importance of CO. There is little danger for CO in boiler furnace gases when the CO$_2$ content is less than 15 per cent. With a little experience you can learn to recognize the furnace conditions that are likely to produce CO, and when these are observed you should test for CO with a hand analyzer. When it is considered that an average of a great many analyses showed less than 25/100 of 1 per cent. CO and that only under conditions resulting from bad firing could as much as 1 per cent. CO be found the problem of trying to automatically record this percentage becomes apparent. The first problem is to find the conditions and methods that will produce above 10 per cent. CO$_2$. Only in comparatively rare cases is a steam user sufficiently interested in his boiler plant to adopt good methods of firing, see that the brickwork does not leak, and get the CO$_2$ percentage up toward fifteen.

Kindling Temperature

Before combustion can take place we must first raise the combustible to the kindling temperature which varies with different fuels. Curiously enough, the gases have higher ignition temperatures than the solid fuels. The ignition temperatures for gases range from about 900 deg. to 1,400 deg. F., and for the coals from about 600 deg. to 1 000 deg. F.

For every three pounds of carbon that we burn in the furnace we send 11 pounds of CO_2 up the chimney, mixed with several times its weight of nitrogen.

If the fuel were pure carbon and if all of the oxygen combined with the carbon as it passed through the fuel bed the resultant gas would be 20.7 per cent. CO_2 and 79.3 per cent. nitrogen. In practice, however, it is found that excess air has to be introduced to insure complete combustion of ordinary coals and other fuels. For coal this excess should be somewhere between 20 per cent. and 60 per cent.—usually about 40 per cent. This lowers the percentage of CO_2 in practice to from 13 per cent. to 15 per cent., depending upon the nature of the fuel. Pulverized fuel, and oil can be burned with a smaller proportion of excess air since an intimate mixture can be effected.

Fuel Variation

The terms "coal," "fuel," "oil," etc., are general terms only. Coal may range from almost straight carbon with only a trace of volatile matter to a fuel that is more than 50 per cent. volatile. It may contain all the way from a trace of sulphur to as much as 10 per cent. or more. Crude petroleums vary in their compositions in about the same way as bituminous coals. The heat values range from 17,000 to 20,000 B. t. u. Sulphur ranges from a small fraction of one per cent. to more than 2.5 per cent. The present practice of "skimming" crude oil for gasoline makes it impossible for anyone to say how the gases of combustion from the delivered oil residues will analyze—the greater the percentage of volatile oils removed the higher the percentage of CO_2 from the residues will run.

Natural gas varies even more in composition and heat value than fuel oil. The values shown in the table will not, however, be far from the real facts in any natural gas field.

Before being able to say exactly how the gases of combustion should analyze, it is necessary to know how the fuel analyzes. The following table assumes averages of the respective fuels:

Fuel	% Theoretical CO_2	% Practical CO_2	% Air Excess
Anthracite	20.7	15.0	38
Bituminous Coal	17.9	14.0	28
Pulverized Coal	17.9	15.0	20
Sub-Bituminous or Lignite Coal			
Fuel Oil	15.0	14.0	7
Natural Gas	11.9	11.0	8
Wood	17.0	14.0	28
Bagasse	17.9	14.0	28
Gasoline	14.2	13 to 14	5
Kerosene	14.5	13 to 14	5

It is easier to mix air with gas than it is to mix it with coal unless the coal is crushed to an impalpable powder. These facts serve to explain the differences in temperature of the flue gases and the water in the boiler. If carried to such an extent that the gases are chilled below the ignition point, carbon (soot) is deposited on the metal surfaces of the boiler and the chimney smokes. Carbon which might otherwise have been burned, adding to the sensible heat of the gases, is lost. This soot also acts as an effective insulator, preventing the absorption of heat by the boiler surfaces. Too much excess air (faulty draft regulation) is by far the greatest cause of fuel waste.

What We Learn

Flue gas analysis "talks" in direct terms about combustion efficiency. The highest efficiency is attained when we get complete combustion with the minimum air supply. In doing this, we may get a temperature so high that the brick work of the furnace will be melted and the ash fused with the carbon to form a slag upon the grates. There are accordingly, limits to the CO_2 percentages which it is desirable to secure.

The most efficient percentage of CO_2—that is, the percentage of CO_2 that can be maintained without appreciable loss due to incomplete combustion—will vary: (a) With hydrogen carbon ratio; (b) the physical condition of the fuel, solid, liquid or gaseous; (c) the relation of volume of the combustion chamber to the grate area; (d) the method of firing; (e) the available draft, etc. But for every condition there is a percentage of CO_2 that will give maximum combustion efficiency for the conditions prevailing.

Flue gas analysis furnishes a check or measure on vitally important factors, which, while they cannot be observed with the naked eye, have considerable bearing on economy and efficient operation. There is a definite relation between the percentage of CO_2 in the flue gas and the chimney loss, hence the analysis of the flue gas for CO_2 offers a convenient and accurate gauge as to the quantity of air being used for combustion, thus enabling steps to be taken to maintain the best efficiency.

CO_2 and Efficiency

The apparatus which will constantly and accurately analyze the CO_2 in the flue gases and show the draft condition places in the hands of the boiler room operator the key to efficiency in his fuel consumption. All authorities agree on this point, that the CO_2 percentage is the index to furnace efficiency.

Combustion analysis tells us the efficiency of our boiler furnaces, neglecting the carbon that is being wasted with the ash and the heat that is being radiated from the furnace. It tells us whether there is combustible carbon monoxide passing off with the flue gases and how much, whether an excess of air is being taken, where the excess air is entering and what it amounts to.

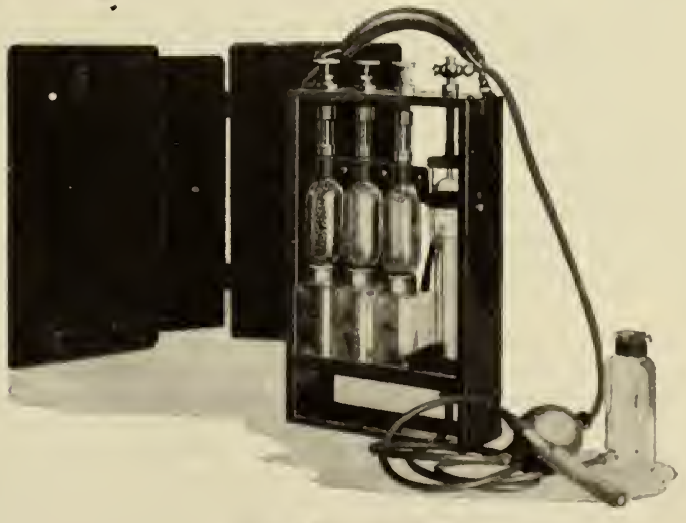
It tells us what draft we should employ to insure the best efficiency, provided we have a draft gauge with which to measure the draft. The draft that goes with the desired percentage of CO_2 when the load is satisfactorily met, is the draft to be employed.

Applicable Anywhere

It makes no difference whether you are burning coal, wood, oil, tar, gas, tan, bark, bagasse or buffalo chips; whether it is a cook stove, a steam boiler furnace or an internal combustion engine. Use the right amount of air for combustion and you will get the highest efficiency. The percentage of CO_2 serves as a guide to show the ratio of the air taken for a useful purpose and the air excess that is taken for wasteful results. Learn what percentage of CO_2 there should be in the gases of combustion and make sure that you get it while avoiding CO. This is the beginning and the end of combustion efficiency. The details to be considered in working out your combustion problems will depend upon the fuel, the furnace or other contrivance in which the fuel is burned and the circumstances as to load, etc. Coal burns from the bottom up, sawdust burns from the top down. High volatile coals require an over-air supply as well as air under the grate. Gas, oil, and powdered coal should be mixed with air as far as possible prior to ignition. As you rise in the scale of fuels from lump anthracite to gas the air excess can be decreased.

Almost any question relating to economy in the combustion of fuel may be answered by flue-gas analysis when correctly interpreted. It indicates where,

(Turn to page 43)



Typical Modern Instrument.

Water Power Future in Austria

Possibilities for Economic Recovery in Dual Monarchy Despite Present Fuel Shortage

BY MAJOR D. H. PEARSON, F. R. ECON. S., F. R. C. I.

THE granting of a susbtantial loan to Austria has focused the attention of the business community on the possibilities for trade existing in that country and the difficulties with which the remnant of the great Austrian Empire has to contend

Economically, Austria is in a worse position than any of the former enemy countries; the important economic structure built up during the monarchy has come tumbling to the ground, shattered by the Treaty of St. Germain. Gone are the great industries, and seaports, the overseas trade; nothing is left but the skeleton of the industrial body of the former Empire.

Lack of Material

With such conditions it is difficult for the country to make a start, to get on its feet and to save what is left from complete commercial obliteration. It will be a long and laborious process, the more so as there seems no possibility of the country having its present boundaries extended to include some at least of the former districts in which industries thrived or from which raw materials for those industries were obtained.

Whatever the future may hold politically it is impossible to say; industrially, there may yet be a chance for Austria to recover now that outside financial help is forthcoming.

Coal Situation

The present Austria is deprived almost completely of fuel, without which it is obvious no industry is possible. According to the statistics of 1913, the last year of peace, the monthly requirements of coal amounted to more than a million tons, and of coke 110,000 tons. Against these normal requirements there is now an average coal production of about 240,000 tons a month in the Alpine provinces.

Only a very small quantity of this is black coal, the remainder being lignite of an even lower quality than North Bohemian brown coal. More than eighty per cent. of the coal requirements must be imported from foreign countries, to balance which there is practically nothing to export, The effect of these huge coal imports on the value of the crown is considerable. By eliminating them a sounder and more stable position would be attained.

Water Power Possibilities

There are, in the Alpine provinces, vast water-power potentialities, to the development of which more and more attention is being given. So long as coal and petroleum were available in practically unlimited quantities at comparatively low prices, such development did not offer enough profit on the great amount of capital necessary to finance the work.

Official reports on the water power sites in these provinces show that they total an amount of 1.7 million horse power, but these figures only take into account sites that yield at least 1,000 horse power mean yearly production.

Conservative estimates, taking into consideration all available sites, show that there are around three million horse power to be derived from water power works, and of this total two and one-quarter million horse power is regarded as easily capable of development. The present output of electrical energy from water power is small; on January 1st, 1920, the turbine output amounted to but 205,000 h.p. On the other hand the estimated requirements of electrical energy amounts to one million horse power. In other words, scarcely 10 per cent. of the water power available is at present utilized.

Development

There is some small development being carried out in the provinces, on the Grosse Muehl in Salzburg, in the Liechtensteinklamm, the Wiesthal and the Fuschertal, while small waterfalls are being used to provide power for farm purposes. The industrial district of Upper Styria, which is well within transmission distance of the great Styrian water power sites, would consume much electrical energy if it were cheaply produced, as it could be by water power.

Railway Electrification

Of the railways with a total length of about 6,000 kilometres, only one line of 63 km. and 15 local lines totalling 189 km. are operated electrically. For the next few years the electrification of main lines totalling 652 km. is proposed by the development of four water power sites.

The development of water power will mean much to Austria, and now that she has been granted an international loan such development is likely to be taken in hand to the ultimate benefit of the country and Canadian manufacturers.

Testing for flashpoint may be done in a simple manner by heating a few ounces of oil over a gas flame and trying a lighted match over the surface of the oil until a wave of flame can be seen to flash across its surface. The temperature of the oil when this takes place is called its flashpoint. Oils with specific gravities below 0.85 generally have flashpoints below 60 deg. Fahr. while those whose specific gravities exceed 0.85 have higher flashpoints.

Obituary

JOSEPH H. MacNeill, son of Archibald MacNeill, of Charlottetown, died at Irvington, New York, on April 18.

Mr. MacNeill was born at Charlottetown, Prince Edward Island, on Feb. 14, 1865. He was educated in the public schools and in Prince of Wales College. He was connected with the Prince Edward Island Railway in early life, both in a mechanical and executive capacity. He held the position of chief engineer of ocean-going vessels under licenses both from the United States government and from the British Board of Trade and for several years was an engineer officer of the Eastern Steamship Company, sailing out of the Port of Boston.

Later, Mr. MacNeill was engineer of the New England Piano Company at Cambridge, and of the Hood Rubber Company at Watertown, Mass. He left the latter position in 1898 to enter the service of the State of Massachusetts as a boiler inspector. About ten years later he became chief inspector and chairman of the Massachusetts Board of Boiler Rules. In both capacities he had much influence in shaping the laws and rules governing the construction, installation and operation of boilers in the East.

Mr. MacNeill resigned from the Massachusetts State Inspection Department on July 8, 1912, to take the position of chief inspector of the Boston Department of the Hartford Steam Boiler Inspection and Insurance Company, and at once entered on the duties of that new position. He remained in Boston until May, 1915, when he was transferred to the New York office of the company, where as chief inspector, he continued until his death to have charge for the company of inspection work in the State of New York and sections of Vermont and New Jersey.

* * * *

Canadian manufacturing and financial circles are the loser by the death in London, Ont., on April 20, of Frank E. Leonard, president of E. Leonard and Sons. The death of Mr. Leonard followed a short illness and was entirely unexpected by his many friends and associates.

During his connection with the Leonard Co., manufacturers of boilers in Canada for over 86 years, Mr. Leonard became associated with a number of enterprises. He was a director of the Huron & Erie Mortgage Corporation, and of the Canada Trust Co. and was a past president of the old London Board of Trade.

Mr. Leonard was a life long resident of London, having been born there 70 years ago. By strict adherence to the best principles of business he established an enviable reputation in the industry and his many friends share the sorrow at his passing

Editorial Comment

CAMPBELL BRADSHAW, Editor

Rule of Thumb Deadly

CONSISTENCY of the stick-in-the-mud routine type is the hobgoblin of small minds for there are few things more irritating than the human machine, the flesh and blood automaton.

When consistency is interpreted to mean the submerging of initiative to make room for phlegmatic living, the word has lost its worth.

It does everyone good to depart occasionally from the beaten path to take part in the unusual.

Medical men vouch for the beneficial effect of temporary relaxation or deviation from routine to something unorthodox.

Charles Dickens makes one feel tenderly sympathetic in "A Christmas Carol" when Scrooge magnanimously allows his office clerk Christmas day away from the "tank" where in a terrible monotony he had labored on a shiny high stool month after month.

While all who toil in the power plant field stage essentially alike repetition of their tasks, engineers are to be envied, who, in leisure time, throw off the restraint of routine and, according to mood and temperament, follow the example of the members of Canada Council No. 27 of the Universal Craftsmen at their anniversary banquet a few days ago.

The most helpful friends an engineer can have are those engaged in his own vocation and beyond question the best place for him to meet friends of this sort is at meetings of organizations such as the U. C. C. of E. and the C. A. S. E.

If the hundred engineers present at the festivities in the Oddfellows Temple in Toronto left the banquet table without either adding to their store of knowledge or gaining inspiration for the task of the to-morrow, they at least were enriched by the friendships they renewed and by the spirit of goodwill to all men which pervaded the building for six hours.

At the annual convention of the Canadian Association of Stationary Engineers in the Central Technical School, Toronto, June 25, 26, 27 and 28, another opportunity will be given engineers to enjoy complete relaxation by meeting hundreds of their fellows who consider interest and application not only necessary to progress but as putting a more attractive complexion on the day's work. It must not be forgotten that although engineers and firemen work methodically and systematically to keep the steam at the required pressure with a minimum of expense, if they play systematically, read according to discipline, and use their leisure time to the beat of a pendulum, they "stunt" the essentials of life.

When the hobgoblin of a mistaken consistency settles on their shoulders they write on their own tombstone the inscription: "Died for want of a change."

How to Bribe Engineers

RATHER a surprising title, that—and one that does not, seemingly, inspire confidence.

Graft is much talked about these days—so often played up in newspapers and magazines with black or red "streamers," reeking with cheap sensationalism—that engineers as well as business men are peculiarly sensitive about their reputations.

"Where will exposure strike next?" has become a by-word in the field of human endeavor, so many unexpected instances of graft have been brought to light—cases where men in the business world supposedly of the highest ideals leaned and bent under the sudden pressure of unusual misfortune and went down in the wreck, wrecked in reputation as well as finances.

If the business world loves success and abhors failure, at least the business world respects honest failure and so not withstanding all this talk of graft the majority of honest workers is so large—so much greater than the grafters, that the latter class dwindles to a very small percentage.

In no profession is honesty more marked than in that of engineering. In no profession can more honest integrity and less liability to lean toward dishonest practices be found.

Yet, there are ways in which an engineer may be bribed. Be he little or big, every man has his price—and engineers are no more exempt than others.

How, then, can an engineer be bribed? If he is honest how can he be approached and induced to throw his influence toward the installation of certain equipment, for example?

The field representatives of every firm can exert personality—limited or unlimited—according to the amount of their influence and the range of its power. Every engineer is more or less affected by the influence brought to bear upon him by the men with whom he comes in contact. He likes to purchase or recommend the purchase of apparatus known to be efficient and reliable and as a result he often places orders right over the heads of less recommendable manufacturers though the latter may be lower in price—simply because he "likes" this packing or "dislikes" that valve, so it remains for the wise manufacturer to make his product "liked."

How can he do this?

First, get a reputation for good service; have the news spread broadcast that the equipment in question never causes annoyance—but always works efficiently without friction.

This is easier to do than one realizes, for reputation is the widest circulating wireless intelligence in the world.

The manufacturer who wants to influence engineers his way must pry his way instead of pushing. Let him quietly, calmly keep in touch with the men he wants to do business with, taking every opportunity to pound home the idea that he knows his business, that his product can do the work claimed for it and that it can be depended upon to give long and efficient service.

Such a man will always get the business because his product will always be "liked."

You can't bribe a Canadian engineer with money, but you can influence him by good service, dependable business methods and the sheer worth of your product.

Free But Not Cheap

EVERY fireman is aware that less than twenty tons of air will fully burn a ton of coal, but since no trust has as yet monopolized the freedom of our Dominion air, his fire-holes, all yawning wide, admit great chunks of atmosphere.

If some method could be determined to bottle up this air, and make the owner of each boiler pay a yearly rental to get his share a lot of careless operators would soon realize that a thing's not always cheap because it's free!

Practical Ideas From Practical Men

STEAM TIGHT GASKETS

*By James E. Noble

The article "Practical Gasket Hints" on page 31 of the April 5th issue of Power House, contains several inferences which in my estimation are not correct.

The writer of the article has had 10 years experience with gaskets, but as my experience is over 25 years while acting as chief engineer in several large plants, there is little egotism in my belief that I am entitled to give my ideas upon the subject.

Experience has convinced me that the thinner a sheet rubber or combination rubber and asbestos or some other material is at the final tightening of the bolt nuts, the longer it will remain steam tight under expansion, contraction and other strains.

I believe Mr. Bohner is mistaken when he states that wrenches, such as spanners are generally made the proper length. It is possible to purchase wrenches to fit 1¼ inch bolt nuts with handles from nine to twenty-four inches long.

Job for Sandow

It would require a Sandow using a wrench with a nine inch handle to exert enough pressure on a 1¼ inch bolt nut to make a satisfactory job in a number of different locations where such sized bolts are used.

It is not bad practice to use an extension handle 6 or 8 inches long on a short handle wrench when tightening large bolt nuts.

A steam line which has to depend upon the expansion and contraction possibilities of the flange gaskets to take care of all the movement of the pipe with no use of expansion joints, bends or other provision, would have small prospect of remaining steam tight or in safe condition.

Doubts Claim Made

The writer of "Practical Gasket Hints" claims he knows of many cases where thick flexible gaskets have taken care of all the expansion in ordinary saturated steam carrying lines. I confess I have never seen such a case in my experience outside of a line a few feet long; the lineal expansion on such a stem line will approximate two inches to the hundred feet. How is it possible for gaskets to take up this amount of movement?

I have made hundreds of permanently steam tight flange joints on lines where the steam supply was being constantly turned on and off and where the temperature in the rooms containing the joints constantly varied. The material I used was common 1-32 inch thick sheet asbestos.

Advises Great Care

The special method I am describing is to be used on flanges in a horizontal position whenever possible, great care being necessary when the flange faces are vertical. Carefully clean the flange faces, cut a round gasket the size required from the one thirty second inch sheet asbestos, cut out the center and bolt holes, separate the flanges, coat the face of the bottom one with clean thin liquid shellac. Place the asbestos gasket upon it and after pressing it down all around allow it to set a few minutes then thoroughly saturate the asbestos with water, next carefully bring the flange faces together being careful not to tear the wet asbestos. Place the bolts and tighten up as tight as good practice allows, then turn in enough steam to dry out the gasket before you give it full pressure and you will have a joint that will not leak as long as the bolts or nuts are not disturbed.

Heat Without Effect

Expansion and contraction or varying outside temperatures will have no effect upon it if the work has been done right. It is of course absolutely necessary to have the flange faces clean and in proper alignment.

A number of years ago when employed as repair man with the Canadian General Electric Co., at Peterboro, Ont., I connected the two halves of a heavy cast iron steam table, practically a pair of flanges, only much more complicated in design, over 30 bolts being used in holding the halves together. The bearing surfaces were narrow and long with channels between for the steam to travel through as it was necessary to have the whole of the table surface of 8 square feet at a uniform temperature.

A Steam Tight Job

I succeeded in making a permanent steam tight job using the method I have just described, although several other methods had been tried out without success.

The wet sheet asbestos joint comes close to an iron to iron one, as the thin wet sheet will compress to almost the vanishing point, and despite conflicting opinions as regards a compressed joint expanding, contracting, and leaking, I will guarantee any engineer will not find things so if he uses the method I have described.

---

*173 Macdonell Ave., Toronto, Ont.

In placing rubber packing joints together, use either graphite or chalk to prevent the rubber adhering to the metal when the joint is to be broken.

MOTORS IN DAMP

*By W. MacKenzie

Motors that drive various forms of mechanical equipment used in a modern pulp and paper mill, operate in the majority of cases, under conditions which are so very severe as to constitute a most rigid test of the insulating materials used in their construction.

Moisture and acid fumes are of course the cause of most of the motor troubles, and due to the large amounts of steam and water used for heating, washing and other purposes, the air is always saturated with moisture.

The maintenance and repair problems which are thus presented are further complicated by the fact that anything more than momentary interruption cannot be tolerated. Continuity of service must be maintained at any cost. We have developed, on completely rewound motors and generators, a special insulation and varnish treatment that has given excellent satisfaction in several of the pulp and paper mills of the Niagara district.

After the stator coil loop is wound, metal clips are put on the sides to hold the wires in place; the loop is then dipped in a special acid and moisture proof varnish and allowed to soak until no more air bubbles are given off. The loop is then allowed to drip until all excess varnish has run off and then baked for 10 to 12 hours in an electrical oven.

Following this, the loop is pulled to shape in a special machine, insulated with high grade varnished cambric and cotton tape, and the complete coil again dipped in varnish, allowed to drip and then baked for 20 to 24 hours at an approximate temperature of 100 deg. Centigrade.

The next operation is to wind these coils in the stator. After connections are made, the high potential ground and between phase test is applied for one minute. If the test is satisfactory, the stator is placed in the oven and baked for 10 hours and then immersed completely in a large dipping tank while still hot, allowed to drip and then again baked for 12 to 15 hours.

---

* Sterling Electric Co., St. Catharines, Ont.

TURBINE BLADING

*By J. W. Carruthers

Some time ago an article appeared in Power House on the operating methods employed in a certain power plant, and the different instruments and charts used were explained at length.

One paragraph, in relation to the steam flow to turbines, said: "That information relative to the condition of the blading is obtained by the indication of high or low ratios." It therefore occurred to the writer that some indication of what is going on inside the turbine would be very desirable before the steam consumption indicated that the blading was beginning to go. The writer remembers being carefully instructed by turbine experts in a large factory of the necessity of periodically making certain tests to obtain this information.

---

*Engineer, The Acadia Coal Co., Stellarton, N.S.

It might be remembered that a turbine is a heat engine, therefore a test taken on a thermal basis is a measure of its efficiency as a heat engine. If certain precautions are taken anyone may make such a test, and get at least an approximate idea of the condition of the blading. If such a test were taken say, when the machine is new, then any subsequent test would reveal valuable information. If the temperatures of the steam are taken at the throttle, 1st stage, and entering the condenser, the ratio of these readings is an approximate value of the efficiency of the machine, and any dropping of this efficiency, assuming that the other items had been carefully noted, would indicate that the blading was beginning to go, and incidentally the steam consumption would gradually go up.

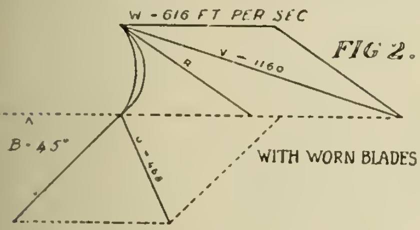


FIG 2.

Must Measure Pressure

With saturated steam the above test would probably be correct, but when using super-heated steam the pressures would have to be measured to find the total heat contents of the steam. Conditions of load, vacuum, barometer, would have to be the same, or corrections made when taking a comparative test such as the above. It might be interesting to go a step further and explain why it is that worn or broken blading increases steam consumption.

To many of the readers of Power House this would not be a very difficult matter, and they would probably make a better job of it than the writer, but in the interests of the many young engineers, and without going too deeply into intricate formula, it is believed that the following explanation will lay bare the reasons for the higher consumption of steam due to worn or damaged blading.

It is well known to all "rotary" men that the blades of an impulse turbine have the "entrance" and "exit" angles equal, the reason for that is, that there is no great thrust to be taken care of, because the re-action of the jet leaving the blading is balanced by the impulse of the jet entering the blading.

This can best be shown graphically or vectorially as it is sometimes called. To clearly show the action of the steam on the blading involves a discussion of certain angles and their reciprocals. The most important of these is the statement that in any triangle the square of any side is equal to the sum of the squares of the other two sides, minus twice their product into the cosine of their included angle.

Proof Unnecessary

Trigonometrical proof of this statement is unnecessary and would take too much space. Figures are more interesting to the average engineer, and more convincing. We will, of course, have to refer to a table of trigonometrical functions for the values of the angles under discussion. Before going further it must be borne in mind that the energy of 1 lb. of steam impinging against the turbine blades is

$$\frac{V^2}{2g}$$

and of 1 lb. as it leaves the blades is

$$\frac{v^2}{2g}$$

The energy of the vane is therefore

$$\frac{V^2—v^2}{2g}$$

and by the principle of machines the efficiency will be:

$$E = \frac{\text{Energy absorbed by blades}}{\text{Total energy delivered to blades.}}$$

The 2g cancelling out in each case so that the velocities need only be considered. Supposing then that we have the conditions illustrated by Fig. 1. Our load we will say is 1,500 kw. and we know that under our operating conditions our water rate is 14 lbs. per kw. This gives us a total weight of steam of 21,000 lbs. Now $V=\sqrt{2g} \times \sqrt{21{,}000}=1160$ ft. per second.

That is, the velocity of our steam is approximately 1,160 ft. per second with the other values essentially as shown in the sketch. That is, the initial angle A is 20°. The angle C is made twice the value of A because according to the best authorities of blade design, this gives the condition of highest efficiency. And B (final angle) which is equal to C to make the blade symmetrical, is also 40°. The value of W (speed and direction of blade) and hence of R. can be calculated by this formula:

$$W=\frac{V}{2 \cos A} \therefore W=\frac{1{,}160}{2 \text{ x}.94}=616 \text{ ft.}$$

per sec. .94 is the cosine of the angle A=20°. The final absolute velocity is calculated by $v=w\sqrt{2}$ (1 cos. B) $\therefore$ $v=616\sqrt{2}$ x .234=132 ft. per sec.

And the efficiency of such blading in good condition would be

$$E=\frac{1160^2—132^2}{1160^2}=90\%$$

approximately.

When Wear Appears

But now let us go further and try and find out what would be the condition of the above machine, supposing that the blading was beginning to show signs of wear. We will perhaps find that the blading is worn away quite a bit where the steam leaves the wheel, or in other words, that the final angle has become greater than formerly. We will suppose, then, that the final angle B, instead of being 40° is now 45° as in Fig. 2 owing to the wearing away of the blading. We will insert this value into our formula and we find the following:

$v=w\sqrt{2}$ (1 cos. B) $\therefore$ $v=616\sqrt{(2\text{x}.707)}$ $=468$ ft. per second, instead of 132 ft. per second, which was the value when the blades were in good condition, and it can be shown that the efficiency now is

$$\frac{1160^2—468^2}{1160^2}=80\%$$

with the blading in bad condition.

It is obvious that to obtain high efficiency the final velocity (v) of the steam must be small as otherwise energy would be wasted without doing work on the blading of the machine.

The deterioration of turbine blading has always been an interesting subject for turbine engineers. No successful means has yet been found to stop this action. Various theories have been put forth as to the cause of it, but we are still looking for a metal for our blading which will not be affected by the severe conditions which obtain in actual practice.

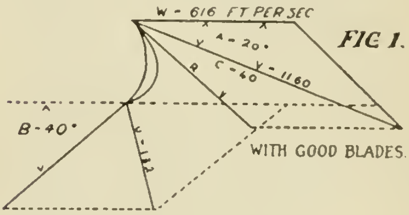


FIG 1.

Causes of Corrosion

Some of the causes of the corrosion of turbine blading are interesting. Some engineers say that critical conditions as regards temperature, pressures, loads and speed cause the blades to go. Others say that organic matter carried over with the steam may cause chemical action on the blades. In this connection Sir A. C. Parsons a number of years ago suggested that strainers made of the same metal as that of which the blading was composed, should be inserted in the steam pipe near the throttle. The idea, it is presumed, being that the chemical action would be confined to this strainer, and so save the blading. How far this may have been successful there is no data yet to hand, at least the writer has not heard of any. In our opinion the most prevalent initial cause is steam leaking through the blading of machines while they are standing idle.

The majority of engineers know of the great difficulty there is in keeping valves tight where super-heated steam is used. After trying various makes of valves and seats, which may be all right for a short time, eventually the leaking steam again makes its appearance and finds its way through the blading of the turbine with the usual result.

In this connection, some years ago, the

writer suggested that the steam pipe to the turbine be drained to a trap and taken back to the feed water heater, this drain being kept open when the machine was standing idle.

The leaking steam would then take the easiest path in preference to the more tortuous path through the blading of the machine. Recently this has been done in our own plant, but the good results which we anticipated from this alteration will not be apparent until a certain length of time has elapsed.

Follow Leaking Steam

If we follow this leaking steam with its alleged metal attacking properties, it will eventually find its way to the condenser, and here an interesting state of affairs appears to exist, which, I am afraid, will take an abler pen than mine to describe.

Here we have on one side of the tubes a vapor which is supposed to have an affinity for certain metals, and on the other side of the same tubes we have perhaps salty water, which also has the same properties, and the result is, we say perhaps, condenser tube corrosion. We have a pet theory of our own which may help to explain blade corrosion from this point, but of that, as the dramatists say, "More anon."

The writer of these notes hopes that they may prove interesting to engineers who are in daily touch with this class of work. The samples given are purely hypothetical and are not intended to refer to any particular condition, but they probably are what would obtain in a medium sized plant. There are, I know, many engineers who know this subject thoroughly, and the data given may appear to them to be "old stuff." This article is intended, however, for the young fellow who is probably just looking for something along these lines to help him out in his own plant, and if the writer has succeeded in giving him a new angle on the subject, the object of the article will have been fulfilled.

BOILER FEED PIPING

By Robert Larsen

While the general principle of a feed water layout is the same regardless of the size of the plant, the introduction of heaters, condensers, hot-wells, pumps, traps and injectors complicates the matter to such an extent that the necessary details are often confusing. It is proposed in the present article to give a couple of diagrams covering the usual conditions, together with rules for determining pipe sizes, and other practical data relating to the subject.

It is always important for the engineer to know something of what lies beyond the opening with which he connects a pipe, and for this reason a little time has been devoted to the internal feed arrangements and the conditions necessary for introducing water without damage to the boiler.

Feed Piping Divided

Feed piping may, in a general way, be divided into two parts, **internal** and **external**. The first of these includes that portion within the boiler shell, and its construction is of great importance, both as regards safety and also efficiency of operation. The conditions sought in the design and construction of internal feed pipes are, first, to raise the temperature of the entering feed water as nearly as possible to that of the contents of the boiler; second, to discharge it so as to assist and not retard the natural circulation; and third, to avoid directing it so as to impinge at once upon the hot plates of the shell, drums or tubes.

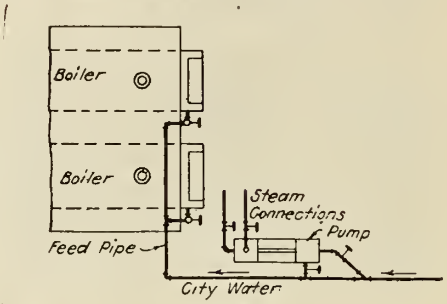


Fig. 1

The older practice of feeding boilers at the bottom, either through the blow-off pipe or by means of special connections, has now been practically done away with in new installations. The only condition where this should ever be considered is in the case of low-pressure heating boilers where the condensation is returned at a fairly high temperature and where there is a tendency for the blow-off pipe to become clogged with sediment. Even in cases of this kind it is generally considered better practice to provide a circulation pipe in connection with the blow-off and admit the feed water through a special connection properly located.

The water fed into a boiler is always colder than that already inside, the difference running all the way up to 100 degrees or more, depending upon the pressure carried and the conditions of operation.

How to Supply Water

Water at lower temperature introduced at bottom of boiler cannot rise with the natural circulation until it is sufficiently heated to reduce its density to that with which it is surrounded. From this it is evident that the feed water must first spread out on the lowest part of the boiler surface while being heated to the necessary temperature for circulation. This naturally cools the plates and sets up strains which are much larger than is commonly supposed.

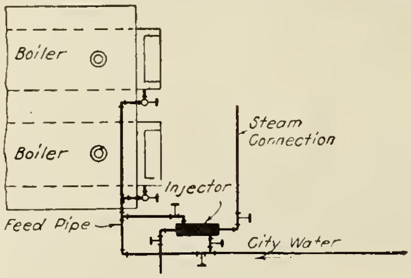


Fig. 2

As the rapidity of heat transfer from the metal to the water depends upon the temperature difference, it is evident that the cooler the water the more rapid will be the cooling effect. The amount of cooling for a given weight of water is proportionately large because it takes much more heat to raise the temperature of one pound of water 1 degree than is given up by the cooling of a pound of steel or iron through a like temperature range.

Furthermore, since the heating is so rapid, by far the greater portion of the heat given to the cold feed must come from the store of heat already in the metal and not from the heat transferred from the furnace gases through the shell or tubes. Hence, the plates are cooled through a considerable range of temperature with each admission of fresh feed water.

Personals

George W. Beardmore, president, Beardmore Belting Co., 37 Front Street East, Toronto, is seriously ill with pneumonia. Mr. Beardmore is known nation wide as one of the most prominent manufacturers of belting.

H. J. Heasley, sales manager for Sadler & Haworth of Montreal, has just returned from an extensive trip throughout the Canadian West. Mr. Heasley found business conditions are showing a decided improvement over last year.

Geo. Callard, builder and contractor, of Montreal who is well known throughout the province as a specialist in furnace and boiler settings is ill at the Royal Victoria Hospital, Montreal. It will probably be several weeks before Mr. Callard will be able to resume business.

Wm. Carter, assistant general sales manager, Canadian Ingersoll-Rand Co., Montreal, was a visitor at the Industrial Paper Show in New York. The above company in association with their American principals had a booth at the show, showing pulp mill machinery.

Hamilton Chamber of Commerce held its election of officers last week, and the following have been appointed to the executive: W. H. Cooper, president; W. J. Westaway, first vice.; George R. Kerr, second vice.; E. V. Illsey, treasurer; Benson Johnston, chairman of committee on committees, and G. E. F. Smith, chairman, finance committee.

M. L. (Bob) Kane, manager for the past six years of the gas department of the Winnipeg Electric Railway has left to assume the management of the gas business of the Georgia Railway and Power Company at Atlanta. Prior to coming to Winnipeg in 1917, Mr. Kane, was in charge of the gas department of of the Continental Gas and Electric Corporation at Cleveland. On the occasion of his departure from Winnipeg he was the recipient of several valuable gifts, both from his associates in the company and from his many friends in the clubs to which he belonged.

Odd Questions and Their Answers

Queries are invited on the every-day problems of engineers in all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped a fellow engineer and a pleasure for us to pass on the data.

POWER TO PUMP WATER

There are two methods of figuring the power required to pump a given amount of water per minute against a stated head or pressure. The first of these is based on the weight of water discharged per minute and the head pumped against.

If the water is merely drawn from one open tank and pumped into another open tank at a higher level through piping without appreciable friction, the head is the difference in level of the water in the two tanks. Where there is a pressure gauge just beyond the pump discharge, the head in feet at that point is equal to the reading of the gauge in pounds per square inch multiplied by 2.3. To this should be added the distance in feet from the center of this gauge down to the level of the suction water. Where the suction water is at a higher level than the pressure gauge, this difference in elevation is subtracted. The total head and weight of water discharged per minute being known, the horsepower is figured in the manner illustrated by the following example:

Suppose that 2,000 lb. of water per minute is being delivered against a total head of 50 ft. The net work done per minute is 2,000 × 50 = 100,000 foot-pounds.

Since one horsepower is equal to 33,000 ft.-lb. per min., the theoretical power required is equal to 100,000 ÷ 33 000 = 3.03 h. p. This is the power that would be required by a perfect pump. If the pump used has an efficiency of 60 per cent., the actual power required will be equal to 3.03 ÷ 0.60 = 5.05 horsepower.

Another way to figure the work done in pumping water is to multiply the cubic feet of water delivered by the total pressure worked against in pounds per square foot. If the total head in feet has already been figured as previously described, it can be reduced to pounds per square foot pressure by multiplying by 62.4, the weight of a cubic foot of water. On the other hand, pressure in pounds per square inch may be changed to pounds per square foot by multiplying by 144, since there are 144 sq. in. in one square foot.

Suppose, for example, that a pump works with an inlet suction of 2 lb. per sq. in. and a discharge pressure of 70 lb. per sq. in., the inlet and discharge being on the same level. Then the total pressure worked against is 72 lb. per sq. in or 72 × 144 = 10.368 lb. per sq. ft. If the discharge is 40 cu. ft. per min. the theoretical power will be

$$\frac{40 \times 10{,}368}{33{,}000} = 12.6 \text{ h. p.}$$

* * * *

BOILER INTERIOR

When setting the interior of a boiler what are the most common defects to look for?

Answer:—Corrosion and pitting at the water-line, grooving at the seams, loose stays and braces and thin plates, using the hammer test to detect the last two, also see that the feed pipe and dry pipe are secure.

* * * *

CROSS-EXHAUSTS

What is the real purpose of the so-called cross-exhaust connection in compound direct-acting steam pumps?

Answer:—The purpose of the cross-exhaust is to maintain a more uniform pressure in the low pressure steam chests; without its use there is a diminishing pressure in the L. P. steam chest as the piston moves along, creating a tendency to short stroke; the purpose of cross exhaust connection, is to admit exhaust steam from the opposite side of the pump at the correct time, thus forcing the piston the full length of its stroke.

* * * *

GENERATOR POWER NEEDS

Can you tell me what power must be developed by a direct-connected engine to run an electric generator so that it will develop 85 electrical horse power?

Answer:—The indicated horsepower required to be developed by the engine would depend on the efficiency of the generator and the engine. The efficiency of the generator would be about 90 per cent. and the mechanical efficiency of a suitable engine would be about 88 per cent., and therefore an engine suitable for the purpose would be required to develop about 85 ÷ (0.90 × 0.88) = 107.3 indicated horsepower.

* * * *

LEAKY TUBES

I am handfiring a return tubular boiler that gives much trouble from leakage around the tube ends when I use soft coal although there is little leakage when firing hard coal. How can this condition be remedied.

Answer:—The trouble when burning soft coal undoubtedly results from incompletion of combustion before the gases reach the back connection of the combustion chamber, due to insufficient height of the boilers above the grates. Better results would be obtained by having the boilers set higher above the grates and by firing lighter and oftener. If the tube ends are beaded over, they will be better protected from fire.

* * * *

BELT TROUBLE

Why does a belt always run to the outside of a 2 in. pulley on two shafts running parallel to each other and about four feet apart. The pulleys are of wood, with a flat surface and the belt generally overlaps the pulleys about half an inch? T. G. Lowe, Winnipeg.

Answer: It would appear that your chief trouble lies in the alignment of the two shafts on which the pulleys are mounted. This should be checked by means of a straight edge, placed alongside the pulley edges and should touch the two pulleys at four points, that is, the rim and centre of each. If the shafts are not in alignment, nothing can be done to prevent belts running off.

If, however, the shafts are properly aligned and the trouble still occurs, it is in all probability in the pulley faces. If the face of the pulley is perfectly flat, as you say, it would seem that the belt is slipping over until the pulley edge is used for a crown.

Check the pulley faces by means of a steel straight edge. If this is the case, the only solution is the replacement of the pulleys by a set with a properly crowned surface.

* * * *

DIFFERENT ELEVATIONS

A condensing-steam power plant at sea level is a duplicate of one installed on a mountain. Both plants are operated with steam at 150 lb. boiler pressure and carry the same load. The vacuum at the sea-level plant is 28½ in., while that at the other is 27½ in. Which plant should operate with better steam economy?

Answer:—The absolute pressure in a condenser, expressed in inches of mercury, is the difference between the barometer of the place and the number of inches of vacuum. Hence if the same difference were 1 in., the absolute back pressure in the condensers would be 1 in. of mercury column pressure in each instance. However, as the absolute initial pressure of the steam is gauge pressure plus the pressure of the atmosphere at the place, the plant at sea level is operated from a slightly higher absolute pressure. But the greater amount of work available would be less than 1/10 of 1 per cent. and therefore, for all practical purposes, the steam economy of the plants should be the same.

* * * *

PHASE AND CYCLE

Will you explain the terms, "cycle" and "phase" in connection with a D. C. Generator. W. R. E.

Answer: These terms have no application in discussing D. C. generators or circuits, but are applied to A. C. only. In reference to an Alternator, a cycle is the building up of the current from zero to maximum strength, returning to zero, and then going through the same procedure in the opposite direction. By phase, is meant the angle turned through by the armature, reckoning from a given instant. Various types of alternating current are known as single phase, two phase, three phase, etc.

* * * *

STEAM EXPANSION

A steam-engine cylinder is 33⅛ in. diameter, and the piston has a stroke of 3 ft. 3 in. The engine develops 600 I. H. P. at 100 revs. per min. Assuming a diagram factor of 0.82, what is the ratio of expansion if the initial steam pressure is 155 lb. per sq. in. absolute, and the back pressure 21 lb. per sq. in. absolute? (2) In a turbine the nozzles are inclined at 20 de. to plane of rotation, and the velocity of the blades is 400-ft./sec. There are three rings of rotating blades and two fixed blades. Determine the angles of the blades and work done per pound of steam, assuming the velocity of the steam leaving the nozzles is 2,800-ft./sec.—V. B.

Answer:—Let R be the ratio of expansion required; pm the mean effective pressure; p_1 the initial pressure; p_2 the back pressure; and c the diagram factor. Then—

$$\text{pm} = c\left\{p_1 \frac{(1 + \log^{\epsilon} R)}{R} - p_2\right\}$$

—i e.,

$$\text{pm} = 0.82\left\{155 \frac{(1 + \log^{\epsilon} R)}{R} - p_2\right\}$$

$$= 127\left(\frac{1 + \log^{\epsilon} R}{R}\right) - 1.64 \ldots.(1)$$

Also— $$\text{H. P.} = \frac{\text{pm l A n}}{33{,}000},$$

where l, A, and n have their usual significance, That is—

$$\text{pm} = \frac{33{,}000 \times 60}{3.25 \times 0.785 \times 33.125^2 \times 200}$$

$$= 35.38 \text{ lb. per sq. in.} \ldots\ldots\ldots (2)$$

Thus expressions (1) and (2) must be equal.

$$\therefore 127\left(\frac{1 + \log^{\epsilon} R}{R}\right) - 1.64 = 35.38$$

—i e., $$127 \frac{(1 + \log^{\epsilon} R)}{R} \times 37.02;$$

or, $$1 \log^{\epsilon} R = 0.292 R$$

—i.e., $$0.292 R - \log^{\epsilon} R - 1 = 0.$$

This equation can be solved by giving R various values and evaluating the left-hand side. The best method of doing this is to tabulate as follows:—

R.	0.292R.	Log^ε	Y.
5	1.460	1.6077	— 1.1477
6	1.752	1.7899	— 1.0379
8	2.336	2.0771	— 0.7411
10	2.92	2.3	— 0.38
12	3.504	2.482	+ 0.024
14	4.088	2.366	+ 0.452

$$Y = 0.292 R - \log^{\epsilon} R - 1.$$

Plot the values of R and Y on squared paper (see Fig. 1). The value of R when Y=0 can be read off the graph fairly accurately. The writer's value, obtained in this way, is—

$$R = 11.85$$

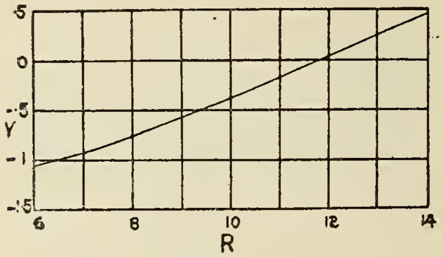


FIG. 1

To determine the angles of the turbine blades, proceed as follows: Referring to Fig. 2, set out V equal to the speed of the steam leaving the nozzles, and making an angle of 20 deg. with U, the direction and speed blades. Complete the triangle by drawing R, the speed of the steam relative to the blades. Then the angle between R and the horizontal is the angle of entry for the first set of moving blades. This is 23 deg. These blades are usually made symmetrical, so that the angle of exit is also 23 deg. Neglecting friction, the speed of the steam relative to the blades will be the same at exit as at entry. Thus make R_1 = R, and let it make an angle of 23 deg. with the horizontal. Combining R_1 with U, we obtain A, the absolute velocity of the steam as it leaves the first ring of moving blades. Thus the angle made by A with the horizontal is the angle of entry for the first ring of fixed blades. This is 27.2 deg. As the blades are symmetrical, this is also the angle of exit for the first ring of fixed blades. The other angles required are obtained in the same way, and are—

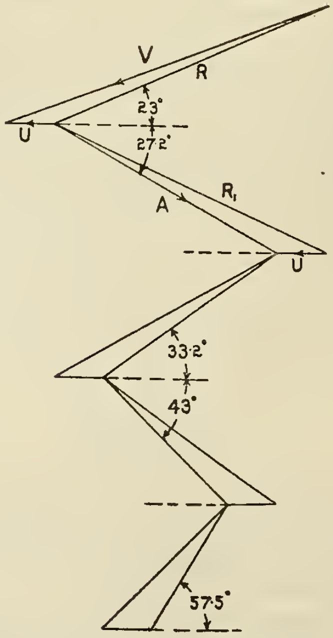


FIG. 2

Angle for second ring of moving blades = 33.2 deg.

Angle for second ring of fixed blades = 43 deg.

Angle for third ring of moving blades = 57.5 deg.

The work done per pound of steam entering per second for first ring

$$= \frac{1 \times 2}{g} (V \cos 20 \text{ deg.} - U)\, U$$

$$= \frac{2\,U}{g} R \cos 23 \text{ deg.}$$

$$= \frac{2\,U}{g} \times 2231 \text{ ft.-lb.}$$

Similarly, for second ring, work done

$$= \frac{2\,U}{g} \times 1737 \cos 33.2 \text{ deg.}$$

$$= \frac{2\,U}{g} \times 1452;$$

and for the third ring, work done

$$= \frac{2\,U}{g} \times 638.$$

Therefore total work done per second per pound of steam

$$= \frac{2\,U}{g} \times 4320$$

$$= \frac{800}{32\,2} \times 4320$$

$$= 107\,500 \text{ ft.-lb.}$$

In practice the friction of the steam on the blades causes a modification of the relative velocity of the steam such that R_1 would probably be equal to only 0.9 R, and so on throughout the calculation.

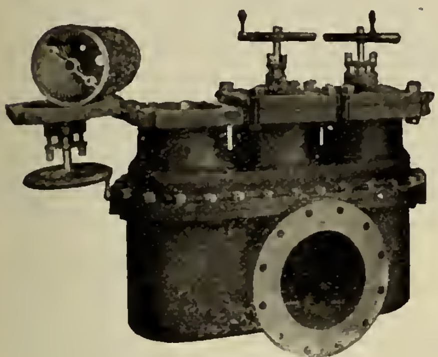
Trade Catalogs

Republic Flow Meters Co. has issued a 16-page bulletin which is entitled "Operation and Construction of the Republic Flow Meter."

Westinghouse Electric & Mfg. Co., has issued leaflet 1867, which describes electrical equipment for coke plant machinery.

We Supply
Automatic Water Softeners

For the purpose of removing by chemical means the scale-forming matter from water.



Three Basket Filter

These filters have from one to six baskets and can be arranged to remove foreign matter to any degree of fineness.

Lagonda Water Driven Cleaner for Curved Tubes

Lagonda Air Driven Cleaner for Straight Water Tubes

Cleaner Removing Scale from Outside of Fire Tube

ALL natural waters contain some impurities, which, when introduced into a boiler, may appear as solids deposited on the heating surface. No matter what the substance consists of, it must be removed at frequent intervals or it will decrease the capacity and efficiency of the boiler and may cause it to be badly damaged by over-heating.

Some waters, notably well waters, deposit such quantities of scale that it should be purified before going into the boiler, thereby preventing an accumulation of incrustation and consequent damage to boiler parts, and at the same time effecting a large saving in fuel by keeping all parts of the heating surface in a clean and efficient condition. If you have bad feed water it is a case for the chemist, for the scale is probably composed of several substances which must be known before the exact treatments necessary to get rid of them can be determined upon. The use of treatment without technical advice is poor policy.

Stony and vegetable matter in suspension can be removed by FILTERS, which we supply in various sizes and designs to suit all requirements. In most Canadian plants, lake or river water is used for feed, and these waters seldom carry large quantities of scale-forming materials in solution. Scale can be allowed to form in the boiler for a considerable period. Experience in each individual plant determines the limit at which tube difficulties will begin or a perceptible falling off in efficiency will take place. With such a limit of scale formation fixed, and the danger of allowing it to be exceeded, well understood, probably the most economical and efficient method of keeping the heating surfaces clean is by the use of the LAGONDA TUBE CLEANERS.

The cleaners are designed and so constructed as to thoroughly remove all the scale, in the shortest possible time, at the lowest cost of operation, and they require a minimum amount of repairs, reducing both the waste boiler time and labor cost of cleaning.

They are made to operate by either water, air or steam, and electricity. In every case a swing head is furnished so designed that three sets of cutters are thrown out by centrifugal force against the scale in such a manner that they make straight line contact with the tube and they do the work without damage to it.

You can be supplied with LAGONDA tools for cleaning Economizers, Condensers, Evaporators and other tubular plant.

Catalog and full particulars for the asking.

Babcock & Wilcox, Limited

Head Office for Canada: St. Henry, Montreal
Branch Office: Bank of Hamilton Bldg., TORONTO

Progress in New Power Equipment

METHODS OF REMOVING SOOT

Engineers who are delving into new methods of doing work around the power house now claim that one of their most disagreeable problems—soot handling—has been solved.

By soot handling, let it be understood, is not meant the cleaning of soot from the tubes, but the handling of soot after it has been cleaned from the tubes and has been deposited by gravity or otherwise in the combustion chamber. It is a problem of removal.

There are a number of very efficient and economically operating soot cleaners on the market. Whatever may be their respective methods of operation, the general results are the same—the soot removed from the tubes drops to the bottom of the combustion chamber, or it is carried on to the stack, where a certain amount is deposited in the stack base.

Removing this soot from combustion chamber or stack base is a necessary, but dirty job. If the soot is removed in the time honored way, a wheel barrow is backed up to a clean-out door and a long-handled shovel is put to work. Little need be said about the results. The soot is finally removed—but in a costly and unsatisfactory manner.

And now the steam jet method of soot handling has come to light.

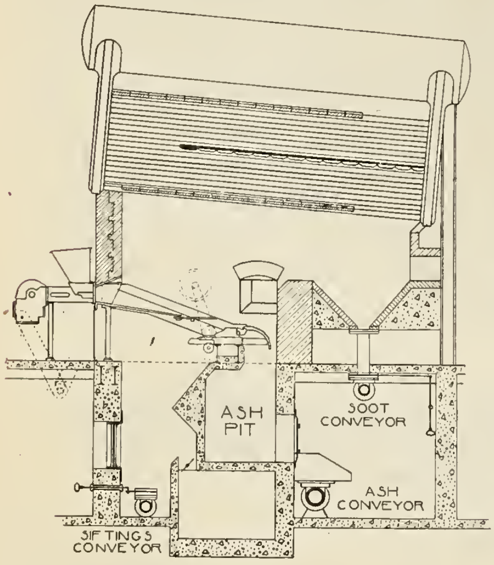


Figure 1

The steam jet method of ash handling has been employed by progressve power plants for many years. The soot handling equipment is but a logical adoption of the steam jet conveyor, indeed the design of equipment and the method of handling are similar.

A line of hard metal pipe (either 4 or 6 inches in diameter, depending on engineering conditions) is laid in a trench in the boiler room floor. Intakes are so located that the soot can easily be withdrawn through the clean-out doors and fed into the conveyor line. A jet of high pressure steam entering the system just beyond the last intake creates a vacuum in the pipe line, which, in turn, creates a suction. The current of air carries the soot to the jet, from which point the soot is ejected through the discharge line to the tank or receiving receptacle. Like the tanks used for receiving ashes, those of section cast iron design are to be preferred. They should be equipped with water sprays or wash vents to clean the steam of all dust as it emerges.

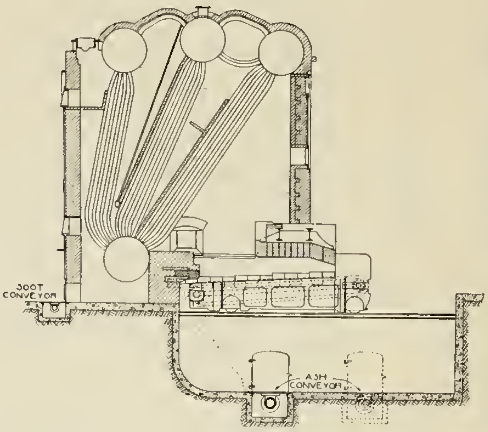


Figure 5

Figure 1 shows a soot conveyor located in the rear of a water-tube boiler, over a chain grate stoker. An ash conveyor with optional location is indicated in the diagram. In this installation, the soot is hoed or raked through the clean-out door and fed into the conveyor intake. No shovelling or wheeling is necessary.

Another type of installation is indicated in Figure II. Here we have the soot conveyor located under a soot hopper; the flow of materials from the combustion chamber to the conveyor being controlled by the operation of a slide.

In operating this installation, the steam valve is opened and the slide removed. The soot feeds automatically into the conveyor, and when the accumulation is removed, the slide is closed and the steam valve closed.

Peek holes or inspection doors are not necessary, as the operation of the conveyor may be determined by sound. When the conveyor line is running empty, a loud, harsh roaring is heard. As the soot is fed into it, the sound is deadened into a low, muffled rumble.

This type of soot conveyor can easily be applied to stack bases and economisers. Coal siftings, too fine for the grates, can also be handled by means of a steam jet conveyor.

It must not be supposed that conveyors of this type are in a preliminary stage. They are in actual use and are satisfactorily doing their work.

Chief engineers who are interested in removal of soot by the steam jet method can receive information from Mr. R. E. Cleaton, of the Cleaton Company (Canada) Ltd., Montreal, who are Canadian representatives and engineers for the Conveyors Corporation of America, the manufacturer of this type of equipment.

PREVENTS BUTTON LOSS

An improvement recently made in the button which hold the chart on recording thermometers and gauges will be welcomed by users of these instruments. Not only does the latest innovation do away with the trouble of unscrewing and removing the button and then replacing it every time a new chart is to be put on the instrument, but it eliminates all possibility of losing the button.

On the recorders now being placed on the market by the Schaeffer & Budenberg Mfg. Co., and the American Steam Gauge and Valve Co., there is a patented chart holder which cannot be removed.

A simple quarter turn draws in the little metal clips, or fingers, and permits chart to be removed. Another slight turn in the opposite direction pushes out the clips again and they grip the new chart firmly.

Announcements

Engineering and Machine Works, St. Catharines, have been awarded the contract for two 54 x 14 horizontal return tubular boilers for the new Coca-Cola building, Toronto.

Arthur S. Leitch Co., Toronto, heating and ventilating engineers, report the following contracts recently placed: For Jarvis Collegiate Institute, Toronto c Nash, size C, Jennings hytor-vacuum duplex pump 52,000 feet direct radiating capacity, also a type C single pump of 26,000 feet capacity. For Silverthorn School, a Nash C-type pump; Galt Collegiate, a duplex C-type; Reg. N. Boxer Co., Toronto, a single C-type; Phoenix Ave. School, duplex B-type, 32,000 feet capacity; Wyandotte School, Windsor, M-type, 500 square feet; Robert Reford Building, Toronto, A-type, 8,000 square feet; Coca-Cola Bldg., Toronto, C-type, duplex; Dovercourt Road church, A-type. Western University, London, C-type, duplex. Sims heaters are being installed in Jarvis Collegiate,

Test this sheet packing

—try it where others have failed

Pick the meanest sheet packing condition in your plant and try Service Sheet on it—that's the engineering way to prove facts.

Thousands of engineers have tested Service Sheet on almost everything from mercury vapor to molasses—and with this result:

—that Service Sheet will stand up under more conditions, and stand up better, than any other sheet packing on the market.

Service Sheet meets practically every sheet packing need of the average plant. It replaces numerous "special" styles, simplifying your packing stock, reducing the investment, preventing mistakes, and eliminating deterioration.

Service Sheet is so dense and resilient that it can be used half as thick as other packings—a direct saving of material.

And remember, Service Sheet is absolutely reliable as well as economical.

CANADIAN JOHNS-MANVILLE CO. Ltd.
Toronto Montreal Winnipeg Vancouver
Ottawa

Johns Manville Service
Covers the Continent
Through
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials

Toronto; Toronto Transportation Co.'s building, Coca-Cola building, and a Sims garbage burner in Hotel Dieu, Windsor, while the Canadian Salt Co., Windsor are installing a No. 3 Nash hytor chlorine compressor.

Irving Iron Works Co. of Long Island City, N. Y., who some time ago established a sales branch in Montreal with L. Gomes in charge, have changed their address from No. 64 Decelles Street to 304 Coristine Building, Montreal.

The Canadian Clothel Refrigeration Co., have temporarily closed their Montreal offices and, until further arrangement has been made, are being represented by A. G. Kidston & Co., 17 St. John Street.

Annual Banquet of the Quebec branch of the Canadian Manufacturers' Association will be held in the Windsor Hotel, Montreal, on May 15. Sir Auckland Geddes, British Ambassador to Washington, will be extended an invitation as guest of honor.

The Voorhees Rubber Company of Jersey City, N. J., who are well known to Canadian jobbers as manufacturers of belting and hose, have recently established a Canadian branch. The Canadian company will be known as The Voorhees Rubber Manufacturing Company of Canada. Head Office, 10 Victoria Street, Montreal. This office will be under the management of E. R. Fenwick.

The Devoe Electric Switch Company, of Montreal and Toronto, have just been awarded the contract for the panels and switch boards for the new T. Eaton Company store in Toronto.

Lighting safety panels will be installed throughout. These panels are built on one solid base of "bakelite." This contract was awarded because of the general rugged construction of this style of panel and will amount to upwards of $15,000 exclusive of installation costs.

This is the firm who supplied all panels and switch boards installed in the King Edward Annex, the Royal Bank Building and the Union Station, all three of Toronto as well as the Mount Royal Hotel in the City of Montreal.

E. A. Barnes, of the Semet-Solvay Co. has made some interesting announcements regarding the new plant that his company is constructing in Hamilton for the Hamilton By-Products Coke Ovens Company. The complete project will cost $2,500,000; the approximate cost of the buildings and equipment, $2,000,000 and at least 90 per cent. of this amount, or roughly speaking, $1,800,000, will be spent in Canada. Contracts for electrical equipment have not yet been awarded. The new plant will be in operation by November this year. The plant will also have a minimum capacity of 5,000,000 cubic feet of gas per day, and a maximum of 7,000,000. In addition, the company will manufacture from 300 tons to 350 tons of coke per day.

Monday, April 30, marked the removal of the Toronto Branch of Crane, Ltd., to their new establishment at 306 Front St., W., recently completed for them by Anglin Norcross, Ltd. The new building is one of the best examples of modern construction in Toronto, being fireproof throughout and embodying in its design, the results of years of experience in the particular work required.

A feature of the new building, which combines, the offices, showrooms, and warehouse, is the attention which has been given to lighting, and to the comfort of the employees. Among the exceptional features are, a shower bath for the male employees and a completely equipped rest room for the office staff. It is planned to add a cafeteria to the plant at an early date.

During the time of the removal from the old location at 526 Bay St., not a delivery was missed by the company, due largely to the provision made by the installation of a special siding at the rear of the new warehouse.

Construction

St. Vincent de Paul Hospital, Sherbrooke, contemplate a $600,000 addition. J. W. Gregoire, 16 Wellington Street South, Sherbrooke, is the architect.

Toronto Board of Control voted $5,000,000 last week to the Toronto Transportation Commission for its program of rehabilitation and construction.

Belleville City Council have passed a by-law for a $15,000 improvement to the civic gas plant. A new gasification system will be installed with the object of lowering the cost of production.

Kilgour Bros., 21 Wellington Street West, Toronto, will shortly call for tenders for the erection of a factory costing about $100,000. D. C. Cotton, 54 Adelaide Street West, is the architect.

Bank of Montreal will build a new structure on King Street, Kingston, to cost about $125,000. A. Terenent, superintendent of the John V. Gray Construction Co., Toronto, general contractors, will handle the work.

Brown Corporation, La Tuque, Que., contemplate the erection of a paper mill at St. Angele de Laval. Geo. Boswell, 19 St. Genevieve Street, Quebec, is the manager of the company. The mill when completed will cost about $5,000,000.

Canada Life Assurance Co. will shortly erect a $300,000 office building on the south-east corner of Gerrard and Yonge Streets, Toronto. The new building will be three storeys in height and will be built where the Forum Building now stands.

Yolles & Rottenberg, Ltd., 366 Adelaide Street West, Toronto, are having plans prepared for the erection of a ten-storey textile manufacturing building at the corner of York and Front Streets, at an estimated cost of $1,000,000.

Dominion Iron & Steel Co., North Sydney, N. S., will shortly instal an electrically operated belt conveyor, 75 feet long and return, also an endless haulage wire for handling coal cars on piers.

Building Committee of the Toronto Board of Education has called for tenders for the work of adding eight class-rooms to the Riverdale Collegiate, to cost $120,000; a six-room addition to the Ogden Street school, to cost $53,000, and a six-room addition to the Lansdowne school.

Robert Simpson Co., Toronto, will commence construction work on the addition to their store, which will cost about $1,000,000, the middle of next week. There will be an entrance on Queen Street opposite the City Hall, also one on Richmond Street, which will lead direct to the basement.

Construction work on the new St. Andrews College at York Mills, Ont., will commence this fall. The new group of buildings, when completed, will be among the finest in Canada, and will cost about $400,000. The site comprises about 135 acres. Sproatt and Rolph are the architects.

Linde Canadian Refrigeration Co., Vancouver, have received contracts for the erection of a pre-cooling plant for the United Growers' Association of Chilliwack, B. C., costing $13,000, and for a similar plant to be erected for the Maple Ridge Growers Association at Port Haney, B. C., costing the same amount.

Memorial Hall will be built in Montreal by the Imperial Order of Daughters of the Empire, of that city. The total cost of the structure is estimated at $500,000. The new hall will have a seating capacity of 4,000. A suitable site has been offered by the McGill University. Headquarters of the Order are located in the Ogilvy Building, Montreal.

Plans for the erection of a pulp and paper mill in North Vancouver, at a cost of $8,000,000, are nearing completion in the offices of the Seamon Paper Co., Chicago. The company is already interested in the British Columbia paper industry, as its president for years was a director of the Whalen Pulp & Paper Co. 50,000 h.p. will be used in the mill when completed. The mill will employ about 1,000 hands, and will have a capacity of 250 tons per day.

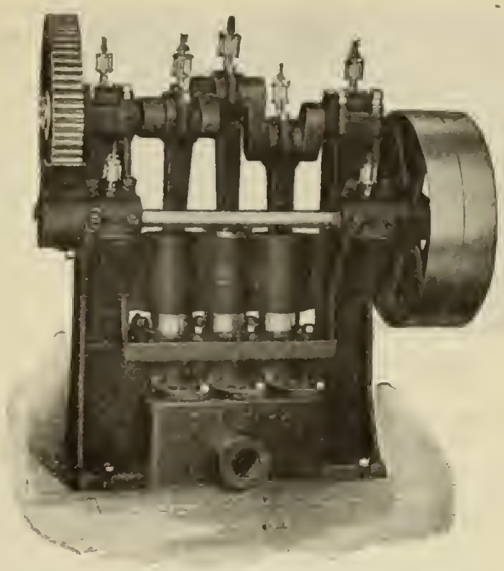
Contracts have been awarded for the erection of the new Ottawa Auditorium on O'Connor Street. General contract has been let to T. C. James, Ottawa, and structural steel contract to Dominion Bridge Co., Lachine, Que. Work will be started and it is expected the structure will be completed by November 1. The building is to cost about $335,000. Contract for the ice-making plant has not yet been awarded. Tenders for this are now being received, and Major R. Percy Sims, Montreal, will suggest to the Board of Directors, which tender should be accepted. Richards & Abra, Ottawa, are the architects.

Heavy Pumping Equipment

This Single Acting Triplex Power Pump is used to a large extent in supplying boiler feed in mines, paper mills, and elsewhere. It is a strong, well built pump for working pressures up to 150 pounds per square inch.

Steel crank shafts, fine cut gears and deep stuffing boxes make this one one of Smart-Turner's dependable pumps — sturdily strong.

Foot Valves and Strainers.
Steel Barrels.
Fisher Steam Specialties.



We illustrate Fig. E 182—and extend to you our engineering service to build what you need.

Smart-Turner Machine Co. Limited

Hamilton - Ont.

WHY FLUE GAS ANALYSIS TALKS FURNACE EFFICIENCY

(Continued from page 31)

when and how, the losses occur and will suggest the remedies that may be applied if we have parallel lines of information upon the draft, the fuel bed thickness in the case of coal, and the uptake temperature. You do not guess at the height of the water in the boiler or at the steam pressure, so why should you guess at the draft and the analysis of the flue gases?

Early Methods

When the importance and dividend-paying value of analyzing waste gases from boiler furnaces, internal combustion engines, kilns, etc., (as well as the valuable gases from gas producers, gas benches, water gas sets, bee-hive ovens, by-product coke ovens and the like), had become established, operating engineers and consultants looked for the best means of making accurate analyses rapidly. Orsat, a French chemist, devised a laboratory instrument for making volumetric analyses a good many years ago and his method having been found to be the correct one, numerous styles of "Orsat" gas analyzers were offered for sale. These instruments were constructed almost entirely of hand-blown glass parts and owing to their fragility, cumbersomeness and other undesirable features, were not well suited to engineering work. What is needed is a compact, rugged, portable, "fast," accurate analyzer which can be handled by ordinary workmen.

Principle of Gas Analysis

If you wished to know how much chaff, by volume, there might be in a bushel of wheat you would first carefully measure out an exact bushel by volume of the mixed chaff and wheat. You would probably take a bushel measure, fill it heaping full and run a straight edge across the top of it. You would remove the chaff and carefully measure the wheat; the shrinkage would be the volume of the chaff. The steps you take in making a gas analysis with an Orsat type analyzer are analogous, but you cannot handle gas as you would handle wheat or any solid substance. Gases have the property of elasticity, and unless you confine them they will get away from you. Moreover, the volume of any gas is affected by pressure and by temperature, and we must have means of controlling both within the limits of accuracy required by the work.

A mixture of gases is analyzed by the "Volumetric Method"—that is, a measured volume of the mixture is taken and one of the gases is removed by absorption. The volume remaining is then measured and the shrinkage indicates the percentage of the gas absorbed. The residue volume is then exposed to another absorber which removes another gas. On re-measuring, the volume of that gas becomes known, and so on until all of the gases have been determined. The "volumetric method" is employed because it is exceeding difficult to weigh gases. If the weights are desired these can be easily computed when the percentages by volume are known.

Apparatus Employed

The illustration shows a standard three-chamber gas analyzer used to test for carbon dioxide (CO_2), oxygen (O_2) and carbon monoxide (CO). This instrument is marked by several features worthy of particular mention.

Special metal valves are used instead of frail glass stop cocks or troublesome pinch clamps on rubber connections. The advantage is obvious to any practical engineer but best known by those who have had a glass cock break or stick at the time of an important test, or who have had a rubber connection "set," or show a leak while being carried in a suit case. The metal valves with their renewable seats and packing nut connections are easy to manipulate; they are far from fragile, and when closed after a test they allow the analyzer to be carried in any position. The stems and seats are constructed of non-corrosive metals and so are not affected by the absorbed chemicals or the gases.

The use of fibrous material in the absorption chambers serves the dual purpose of breaking up the gas sample and presenting a very large exposed, wet surface for absorption.

Pounding Plibrico into place to form a front door arch.

What is PLIBRICO? JOINTLESS

FURNACE LINING

PLIBRICO is a plastic furnace lining in unbaked form that meets all furnace requirements and that can be installed by anyone who can use a mallet and trowel. When baked, it forms a one-piece, jointless furnace lining that is resistant to temperatures to 3100 degrees F. Plibrico outlasts ordinary fire brick two to four times. It eliminates the joints—the root of all furnace trouble—and so gives a lining that will not crack, spall off or bag.

Plibrico is stocked in warehouses for immediate delivery in 52 principal cities throughout the United States and Canada. **It is delivered only in steel containers of distinctive appearance as shown below.** This container keeps Plibrico fresh and plastic and identifies the original.

Write for your copy of the new book—"Modern Furnace Building."

JOINTLESS FIRE BRICK Co

1142 Clay St. Chicago, Ill.

Steam Jet Conveyor Economy

Discharge of Modern Type of Equipment No Longer Productive of Excessive Dust

*BY GUY S. HAMILTON

THE power plant engineer who is about to purchase ash handling equipment for his plant has before him a wide variety of conveyors from which to choose.

Where more than one method of ash handling is under consideration, logic compels the adoption of that type which combines in itself the greatest number of advantages for the conditions for which it is required.

The usual argument against the use of the steam jet conveyor is that it requires a large number of boiler horse power when in operation. This is true, comparatively speaking, when considered in comparison with a 5, 10 or 15 H. P. motor. But the action of this type of conveyor being extremely rapid, with great capacity, necessitating usage for only a very short period of time, this apparently large consumption of power becomes nominal and low it is claimed by the manufacturer.

Laud Soot Blowers

Most engineers are thoroughly familiar with soot blowers and will almost invariably be found to be enthusiastic advocates of their installation. They never regard them as a drain on their boilers nor do they make accusations of extravagance in their use of steam, but the rate of flow of steam for the soot blower per minute is no less at any time than for the steam jet conveyor and in some instances may be found to be more.

The steam soot blower is an accepted piece of equipment. It has found its place and by sheer merit has held it. Engineers regard it favorably because they know what it will do, but not being familiar with ash conveyors they hastily jump to conclusions.

Refute Objections

Two other arguments are frequently advanced against the use of steam jet ash conveyors:

It will pack ashes in a bin or tank where it is necessary to store for a period of time.

The discharge of the conveyor is productive of a great deal of dust.

These arguments were true in earlier types of steam jet ash conveyors but they no longer are true to-day with modern designed equipment.

Another important feature claimed for the steam jet ash conveyor lies in the fact that it can be operated by labor devoid of any mechanical ability.

Interruptions Costly

Interruptions of service, what are usually considered solely from the inconvenience and annoyance involved should and can be translated into a tangible value of dollars and cents.

The steam jet conveyor from its simplicity of construction does not require an extensive supply of repair parts, consequently a very small amount of money is tied up in parts.

With the steam conveyor, in the event that a repair part should not be on hand, an emergency repair can be made which will tide over until a part can be procured from the factory.

---

*Conveyors Corporation of America.

* * *

In changing the speed of a Corliss engine the governor should be pulleyed so that it will run at the speed for which it was intended. A little departure from this speed will keep it against one or the other of its stops.

* * *

Cement of value in filling up small leaks such as blow holes in a casting is composed of 5 lb. paris white, 5 lb. yellow ochre, 10 lb. litharge, 5 lb. red lead, and 4 lb. black oxide manganese. Mix these materials thoroughly and add a small quantity of asbestos and boiled oil This cement will set hard in from two to five hours and will not be subject to expansion and contraction to an extent sufficient to cause leakage afterwards.

Construction

(Continued from page 42)

British Empire Steel Corporation are spending $30,000 on an enlargement to the electric plant at New Waterford, N. S.

Canadian Atlas Crucible Steel Co., Welland, Ont., are in the market for a 500 h.p., 750 r.p.m., 4,400 volts, 25 cycle, 3 phase, wound rotor or slip ring, 40 deg. rating motor.

J. & J. Cash, Inc., of South Norwalk, Conn., and of Coventry, England, will establish a branch plant at Belleville. The company conducts an extensive textile industry.

Bridge River Power Co., Seton, B. C., are having plans prepared for a $12,000,000 power development, including gravity dam, power house and transmission lines. H. Holgate is the engineer.

Y. W. C. A., Toronto, will rebuild their headquarters on McGill Street. A campaign has been launched with an objective of $350,000. Construction work is expected to start some time this summer.

Hawkesbury Industrial Corporation, Hawkesbury, Ont., have been incorporated to build and operate electric plants, industrial plants, etc., with a capital of $100,000.

Residents of Hamilton Mountain have applied to the city for additional water supply. Equipment necessary will be pumps of larger capacity, replacing the two one-million gallon centrifugal pumps now in operation. The estimated increase in cost is $15,000.

Toronto, Ont.—The Toronto Hydro-Electric System, Yonge and Shuter Sts., will construct extensions and improvements to its lighting and power system, including poles, transformers, conduit, wire, cable, switches, etc. Estimated cost $2,000,000.

* * *

E. Gordon has been appointed sales manager for the Bull-Dog Belt Lacer Co., 85 Cannon Street West, Hamilton. Mr. Thompson, also connected with the above concern, states that they are very busy at present, and enquiries are coming in from quite a scattered territory, ranging from the Maritime provinces to British Columbia.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES — $1 A MONTH
8754 ILLUSTRATIONS — $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator--Lubrication--PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers.--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference Index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ______
Occupation ______
Employed by ______
Residence ______
Reference ______

See
Buyers' Guide
Pages
50, 52, 54

POSITION WANTED

FACTORY SUPERINTENDENT OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1¼-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order. Apply Box, 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

SAWMILL MACHINERY—MODERN DESIGN—most satisfactory to operate. Apply Box 105, Power House.

SAWMILLS—PORTABLE — DOUBLE EDGES; also all kinds sawmill machinery. Apply Box 106, Power House.

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

WELDING

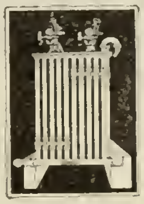
ELECTRIC AND ACETYLENE WELDING of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

BELTING BARGAIN

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

VICTORIA FOUNDRY COMPANY
LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations
Write for our latest catalogue
Patterns Machine Work

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W



New Fuel Economies

Efficient and economical operation follow the installation of a Sturtevant Fuel Economizer.

Folder 609 will be of particular interest to you.

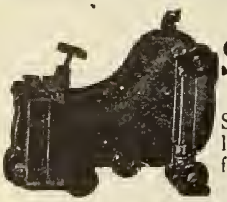
B. F. Sturtevant Co. of Canada, Ltd.
Montreal Galt Toronto

When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*

HINTS TO BUYERS

McDaniel Improved

STEAM TRAP



FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

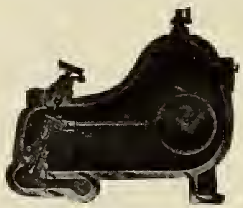
May We Send One on Trial ?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

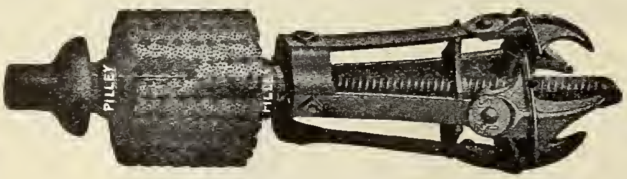
Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over
A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo
Eastern Office: 71 Fulton St., New York.

"Featherweight"

MAGNESIA
KEASBEY & MATTISON CO.
FEATHER WEIGHT
85%
AMBLER, PA.
SECTIONAL COVERINGS

Save Coal

by using

85% Magnesia

Sectional Covering

The extra saving in coal (power) and dryness of your steam should decide you in favor of K. & M. "Featherweight" 85 per cent. Magnesia Pipe and Boiler Covering. Would you like to know just why this widely used boiler covering is the most durable and most efficient fuel conserver of all pipe and boiler coverings? Then send for free booklet. It contains much valuable information for engineers.

Keasbey & Mattison Co., 25 Front St. E., Toronto.

FUEL OIL BURNING

for

HEATING and POWER PLANTS

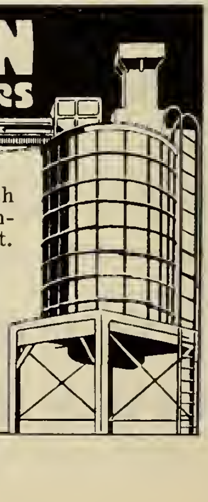
Correspondence Invited

ENGINEERING & CONTRACTING

The T.J. CUNERTY Company
Room 240 17, Queen St, East Toronto

AMERICAN

STEAM ASH CONVEYORS



Give lowest costs per ton of ash handled. Satisfactory performance guaranteed. Ask for booklet.

CANADIAN REPRESENTATIVES:
CLEATON CO., (Canada) Ltd., Montreal.
GORMANS, LTD., Calgary, Edmonton, Vancouver.
WM. A. GOOLD, Winnipeg.

Conveyors Corporation of America
326 W. Madison Street, Chicago, Ill.

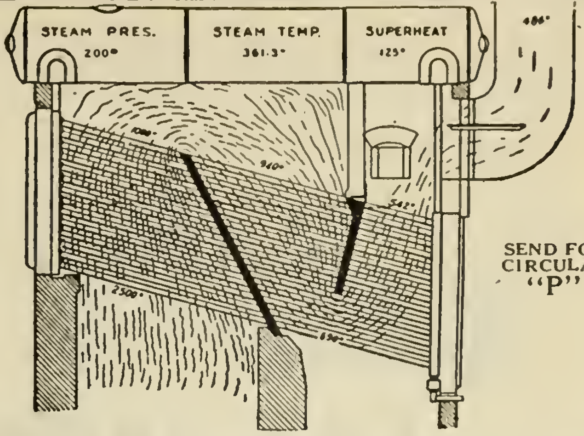
"MONO" TRADE MARK REG. U.S. PAT OFF. BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE

AND ARE NOT DAMAGED WHEN TUBES ARE WITHDRAWN, REPLACED OR BY THE USE OF A TURBINE CLEANER. OUR ENGINEERS ARE AT YOUR SERVICE TO HELP YOU SOLVE YOUR COMBUSTION PROBLEMS. THE CUT ON THE RIGHT IS AN EXAMPLE OF WHAT WE CAN DO FOR YOU.

KING REFRACTORIES CO.

Sole Canadian Representatives:

GRANT E. COLE CO.
21-23 River St., Toronto, Canada
Represented in Vancouver, Winnipeg, Montreal, Halifax.



SEND FOR CIRCULAR "P"

EDWARD VALVES

Valves for high pressures and superheated steam. Write for catalogue.

THE EDWARD VALVE & MFG. CO.

Main Office and Works: East Chicago, Indiana.
CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal; Valve Engineering Co., Toronto.

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING

Oil Burning Systems Installed

Full line of Power Plant Equipment and Supplies.

LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL

Jardine's Self-feeding Tube Expanders

REGISTERED J TRADE MARK

All have properly casehardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co., Ltd.
Hespeler, Ont.

NORTHERN

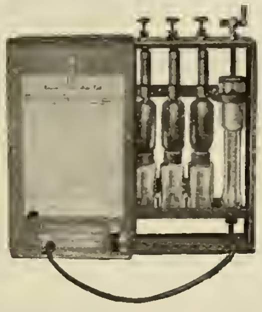
CRANES
NORTHERN CRANE WORKS, LTD
Walkerville, Ont.

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE MEANS ECONOMY

Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.



Hays Improved Gas Analyzer.

Hays Improved Gas Analyzer

compact — rugged--accurate, employs the Hays patented steel wool method of breaking up the gas and presenting a large absorption surface—the most accurate and rapid known. CO2 analysis can be made in 30 seconds, complete analysis for CO2 O2 and CO in 4 minutes.

No troublesome pinch clamps and rubber connections, no glass cocks to stick. We use a special needle valve with renewable seat.

Neat leather carrying cases for Consulting and service engineers.

Better send for Literature.

P. A. Goepel, Vancouver, B.C.; Wm. A. Goold, Winnipeg, Man.; The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
1034 E. Eighth Street
MICHIGAN CITY, INDIANA

BOICO BOILER COMPOUND Gets the Results!

Anti-Clinker Shell Bar Grates—Maximum air space ensures the last bit of heat from the last bit of fuel.

One-Piece Jointless Furnace Lining—Line your furnace with PLIBRICO. More efficient, less costly, lasts longer, easier to instal.

Tip-It Patent Welding Process. Gives you tools with shanks of carbon and tips of high-speed steel.

SHELL-BAR BOICO SUPPLY, Limited
1-15 Saunders Ave., Toronto.

SALES AGENTS: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot, Reg'd., Quebec; Adam Davis, Cobalt, Ont.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

Annual Convention

of the

CANADIAN ASSOCIATION
of
STATIONARY ENGINEERS

OF THE DOMINION OF CANADA, INC.,

will be held in conjunction with

Annual Exhibition of Power Plant Equipment

June 25, 26, 27, 28

in the

Central Technical School
Toronto, Ontario

Remember it! *Boost it!* *Come to it!*

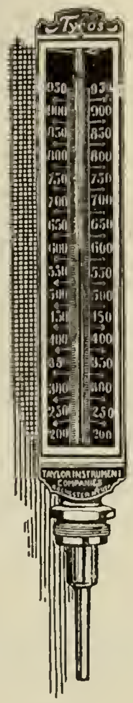
For further particulars write

George J. Soucy, Chairman, 48 Moore Avenue
TORONTO

Tycos and Superheat

A *Tycos* Superheated Thermometer installed on both ends of the superheated steam line will indicate the temperature performances and losses due to pipe radiation.

A *Tycos* Bi-Record Recording Thermometer at the power unit gives accurate records of both temperature and pressure of the superheated steam as it is delivered. These records are made on one chart simultaneously. These charts are invaluable in determining the costs of producing superheated steam and for determining power plant efficiency.



Taylor Instrument Companies

110-112 Church Street,
Tycos Bldg., Toronto

There is a Tycos or Taylor Temperature Instrument for every purpose.

Indicating, Recording Tycos ROCHESTER N.Y. **and Controlling.**

875

SONDERGLASS

"The Unbreakable Boiler Gauge Glass"

Two Glass Tubes in One

The different metals used allow for expansion and changes of temperature to which the glass is subjected, and add greatly to its pressure-resisting qualities, as each of these metals has different degrees of expansion. The inside of the tube expands in proportion to the temperature of the steam or hot water and the outside according to the temperature of the air.

There are no others "Just as Good"

LYTLE ENGINEERING CO. LIMITED

404-406 St. James Street, Montreal

VALVE ENGINEERING COMPANY

174 King Street West, Toronto

Power House

is a dominating factor in maintaining power plant efficiency in equipment and service

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge. Every issue is full of real worth while ideas.

Two Issues per Month

24 Issues (one year) $2.00

Special Offer

48 Issues (two years) $3.00

CURTIS ENGINEERING SPECIALTIES

Comprise a line of devices that have stood the test of years for the utmost in efficiency. They are built for dependable and enduring service. Scrupulous care in the selection of material and in construction, with adherence to the highest engineering standards, have won them a commanding position. The

CURTIS WATER-PRESSURE REGULATOR

will deliver water into service pipes at any desired pressure, regardless of any fluctuations of outside pressure.

Trouble with rust or clogging with sediment is prevented. Waste of water in domestic use by flying or spattering is avoided by the reduced pressure. This also prevents water hammer or concussion and prevents wear and tear on all packings and seats in valves and faucets, thus eliminating frequent plumbing bills. Adapted for use in pulp and paper mills, hotels, public buildings and dwelling houses. For ¾ in. to 2½ in. pipe, screwed. For 3 in. to 8 in. pipe flanged.

The Curtis Line of Steam Specialties contains many other notable devices. They are fully described in our No. 50 catalogue. Write for a copy.

JULIAN D'ESTE COMPANY

26 Canal Street, Boston, 14, Mass.

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co. Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

ASBESTOS SPECIALTIES
Can. Johns-Manville Co., Ltd., Toronto,
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited. Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited. Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd,, Windsor, Ont

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd,, Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto. Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co, Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co,, Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont,

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal,
Waterous Engine Works Co., Brantford,

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis. Mo
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING. MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville,. Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

"SAFETY"

Plastic Metallic Packing

Packing in Cotton Tubes.

For steam, water, air, gas, etc., is practically indestructible and may be used over and over again. It is

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL

Packing in Bulk.

It is made of an alloy of the finest anti-friction metals, just hard enough for long service but not hard enough to damage any rod.

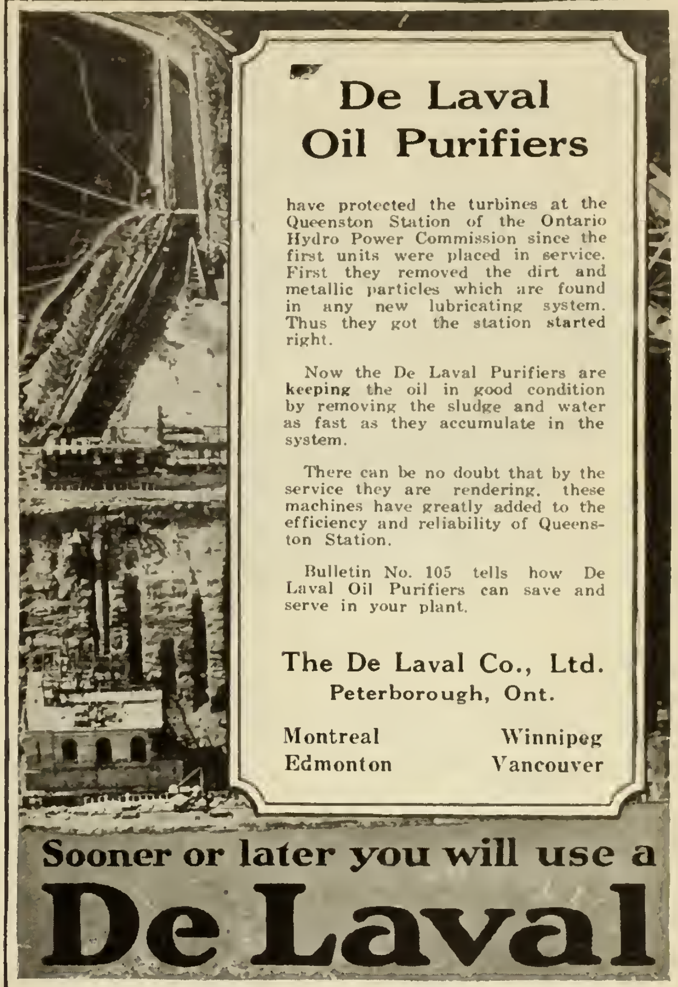
The metal is combined with the best lubricating material, making it practically SELF-LUBRICATING AND FRICTIONLESS.

Send for full particulars also about our "Safety" Superheat Sheet Packing.

STEEL MILL PACKING Company

Windsor *EST. 1899* Ontario

AGENTS WANTED



De Laval Oil Purifiers

have protected the turbines at the Queenston Station of the Ontario Hydro Power Commission since the first units were placed in service. First they removed the dirt and metallic particles which are found in any new lubricating system. Thus they got the station started right.

Now the De Laval Purifiers are keeping the oil in good condition by removing the sludge and water as fast as they accumulate in the system.

There can be no doubt that by the service they are rendering, these machines have greatly added to the efficiency and reliability of Queenston Station.

Bulletin No. 105 tells how De Laval Oil Purifiers can save and serve in your plant.

The De Laval Co., Ltd.
Peterborough, Ont.

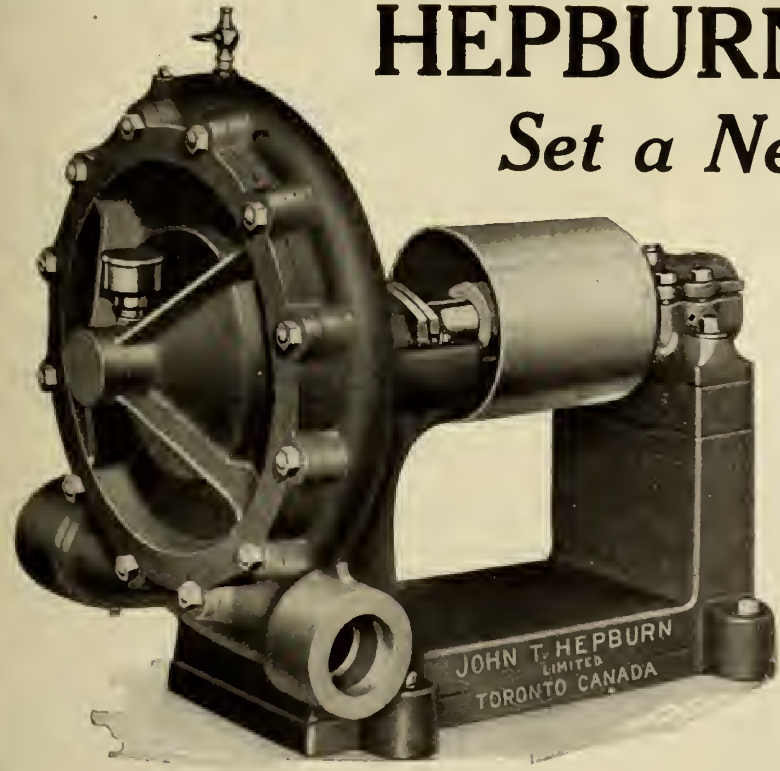
Montreal Winnipeg
Edmonton Vancouver

Sooner or later you will use a

De Laval

HEPBURN CANADIAN MADE **PUMPS**

Set a New Standard



The Hepburn Centrifugal Pump is not one of those "Old Stagers" which was designed 20 years ago and is still the same. It is, on the contrary, a Pump of modern design and up-to-date in every respect.

We also make Simplex and Duplex Pumps, Hand and Electric Overhead Cranes, Vertical Engines, Castings and Forgings.

JOHN T. HEPBURN, LTD. ENGINEERS AND IRON FOUNDERS **18-40 Van Horne St., TORONTO**

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal

EJECTORS
Jas. Morrison Brass Mfg, Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boeton.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Wateroue Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Wateroue Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto,
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N. Y.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Graver Corp., East Chicago, Ind.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Out.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johne-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gariock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
W. J. Wail, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div- Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto. land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Moutreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Canadian General Electric Co., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mase.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn N. Y.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto. Ont.
Northern Crane Works, Walkerville, Ont
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Gariock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gariock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke. P. Q
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal,
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murpby Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

Building a one-piece furnace lining without special forms.

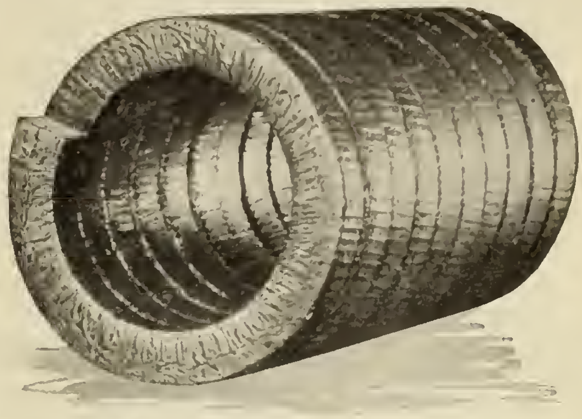
BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

Makes practicable, solid, one-piece furnace linings, including front and back arches, side walls and baffles. It costs but little to install in any make or type of boiler. It saves fuel, annoying shut-downs, costly repairs, and increases the amount of power from the fuel used.

Complete details of the many uses, methods of installing, how to order, measurement blanks, etc., are contained in a booklet of information which we will gladly send you. Tell us the individual to whom it should be addressed.

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6, Rome, N.Y.
Canadian Distributors
INTERNATIONAL CHEMICAL CO.
26-6 Adelaide St., Toronto, Ontario, Canada.

A COMPLETE SERVICE IN
"John Crane"
FLEXIBLE METALLIC PACKING



Style 100. Spirally wound Babbitt foil impregnated with purest graphite. Minimum expansion.

On Centrifugal Pumps

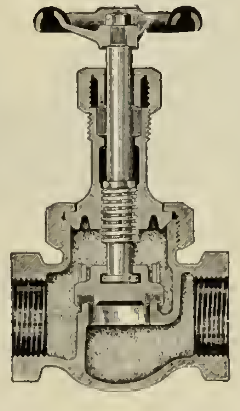
Positively will not score, burn or sever rods. Is non-abrasive and scales without squeezing rod, giving perfect service of extraordinary duration. This service is only one of many on rods, valves, and shafts where John Crane Style 100 is producing unexcelled results.

1923 Edition of our Text "Metallic Packing" now ready. Send for your copy.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, B. C.

PRATT & CADY VALVES

P&C CO TRADE MARK

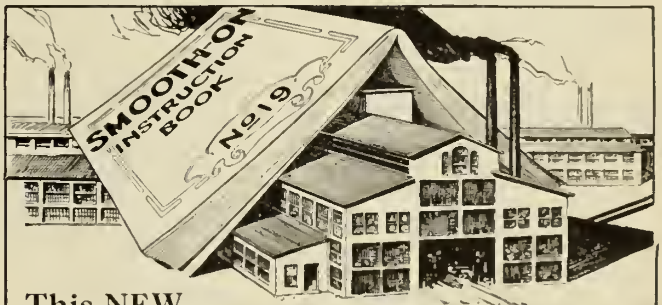


P&C CO TRADE MARK

It is real economy to install Pratt & Cady Bronze Union Bonnet Renewable Disc globe and angle valves. It is so easy to replace parts subject to wear that you are sure to take advantage of this feature.

P. & C. Folder No. 2 describes this valve in detail. May we send you a copy?

Reading Steel Casting Co., Inc.
Pratt & Cady Division
General Sales Office: Bridgeport, Conn.
CANADIAN REPRESENTATIVES:--CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.



This NEW
Instruction Book will Cover Your Plant Repairs

From making leaky flanged and screw-thread joints tight to repairing a crack—minor repairs and some of the most serious—are illustrated and described alike in the pages of this NEW Smooth-On Instruction Book No. 19, just off the press.

Every page illustrates and describes a different power plant repair—and the descriptions are written by the engineers who did the work.

Some engineers tell how they saved hundreds of dollars through the use of Smooth-On Cements; others how they made repairs with Smooth-On which at first seemed impossible; and still others how they restored to peak load capacity, power plant parts that seemed ready for the scrap heap. Send for your copy of this NEW Edition No. 19 today—it's FREE—a postal will do.

Smooth-On Cements are sold by Supply Houses in 5-lb., 10-lb. and 25-lb. tins; also in larger sizes.

The Canadian Asbestos Company
Dept. 52-E Montreal, Que.

Do it with SMOOTH-ON

PACKING, AMMONIA, STEAM AND WATER
Beveridge Suppy Co., Montrea.l
Csnadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Jenkins Bros., Limited, Montreal, Que.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Bolco Supply Ltd., Toronto.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Bolco Supply Ltd., Toronto, Ont.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCullooh Co., Galt.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Mon'real.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. - Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg, Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS
Shell Bar Bolco Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co. Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)
Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham,- Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM TRAPS
Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE
Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING
Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Shell Bar Bolco Supply, Ld., Toronto.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Underfeed Stoker Co., Toronto, Ont.

WALKWAYS, (Irving Subway)
Irving Iron Works Co., Long Island City, N. Y.

Re-Use Your Waste Oil

The amount of oil that can be collected in drip cans, properly located beneath the engine or machinery, is surprising. This oil, usually wasted, can be refined by running it through

The ANDERSON Pressure Oil Filter

and clean, usable oil, equal to the original article obtained. The operation can be repeated over and over again, cutting oil bills almost in half. It's a saving you should investigate.

Write for Catalogue.

The V. D. Anderson Co.

1935 W. 96th St. - Cleveland, Ohio

The Longer the Experience, The Better the Babbitt

It took 37 years of progressive development to bring Magnolia Anti-Friction Metal to the supremacy which has been proven repeatedly by United States and foreign government tests. We've done all the experimenting so that the users of Magnolia Anti-Friction Metal take no chances.

To experienced power users who know good service and realize that it can be had only by taking proper precautions, Magnolia Anti-Friction Metal offers a real opportunity.

If you wish to take advantage of all possibilities in putting your power delivery and bearing maintenance costs well on the safe side, write us for performance data, etc.

Magnolia Metal Company

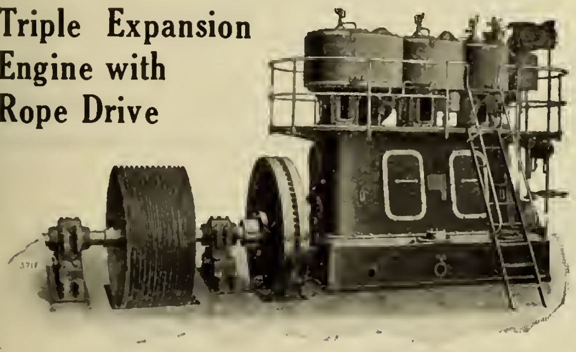
113 Bank St., New York

Chicago Fisher Bldg. San Francisco Pacific Bldg. Montreal 37 Shannon St.

MAGNOLIA ANTI-FRICTION METAL

TRADE MARK

Triple Expansion Engine with Rope Drive



Belliss & Morcom Ltd.

Birmingham, England

Builders of:

STEAM ENGINES
AIR COMPRESSORS
STEAM TURBINES
CONDENSERS
CRUDE OIL ENGINES

Packing for Centrifugal Pump Spindles will not cut

Maxim Silencers

for Air Compressor Suction, Gas Engine Exhausts, etc.

Welldeck Steam Traps

do not get out of order

AGENTS:

LAURIE & LAMB, Board of Trade Bldg., **MONTREAL**

Established 1907

POWER HOUSE

Member A.B.C.

B. G. NEWTON, Manager

S. S. MOORE, Advertising Manager

CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740. Montreal: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. Winnipeg: 810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—New York: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. Chicago: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. Boston: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—London: The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

American Steam Pump Co. 4
Anderson Co., V. D. 55
Armstrong Cork and Insulation Co., Ltd. 11
Audel Co., Theo 45

Babcock & Wilcox 39
Bailey Meter Co. 14
Betson Plastic Fire Brick Co. .. 53
Bristol Co., The 4
Builders' Iron Foundry 41
Buyers' Directory 50, 52, 54

Can. Fairbanks-Morse Co. 16
Canadian Ingersoll-Rand Co. ... 9
Can. Johns-Manville Co. 41
Classified Adv. Section 45
Cole Co., Grant E. 47
Conveyors Corp. of America .. 46
Counerty, T. J. 46
Crane Packing Co. 53
Can. Sirocco Co. 17
Canadian Link-Belt Co., Inside Front Cover

DeLaval Steam Turbine Co. ... 14
DeLaval Co., Ltd., The 51
Dart Union Co. 56
D'Este Co., Julian 49
Diamond Specialty Ltd. 19
Durabla Mfg. Co. 16

Elk Fire Brick Co. 47
Engineering & Machine Works of Canada 6

Edward Valve Mfg. Co. 47

Foxboro Co. 15
Flexible Metallic Packing Co. . 53
Frick Company 12

Garlock Packing Co. 5
Garth Co., The 46
Goldie & McCulloch Co. 20
Greene, Tweed & Co. 7
Gutta Percha & Rubber, Ltd. ... 3

Hints to Buyers 46
Hepburn, John T. Co. 51
Hays Co., Jos. W. 47

Jardine, A. B. 47
Jenkins Bros., Inside Back Cover
Jointless Firebrick Co. 44

Kerr Engine Co. 11
Keasbey & Mattison Co. 46

Laurie Engine Co. 47
Laurie & Lamb 55
Linde Can. Refrig. Co. 2
Lunkenheimer Co. 2
Lytle Engineering Co. 49

McLaren, D. K. Co., Front Cover
McGowan Co., John H. 8
Magnolia Metal Co. 55
Moncrieff Ltd., John 47
Morrison Brass Mfg. Co., Jas., Outside Back Cover

Mueller Mfg. Co. 18
Northern Crane Works 47
Pilley Packing & Flue Brush Mfg. 46
Pratt & Cady Co. 53

Reading Steel Casting Co. 53
Refrigeration Dept. 10
Refinite Co. of Canada 46

Schaffer & Budenberg Mfg. Company 8
Smooth-On Mfg. Co. 53
Superheater Co. 56
Sturtevant & Co., Ltd., B. F. .. 45
Steel Mill Packing Co. 49
Shell Bar Boiler Co. 47
Smart-Turner Machine Co. 43

Taylor Instrument Co. 49

Underfeed Stoker Co. of Canada, The 13

Victoria Foundry Co. 45
Vilter Mfg. Co. 10
Valve Engineering Co. 49

Wall, W. J. 47
Waterous Engine Works Co. ... 1
Watson, M. Barry 45
Watson & McDaniel Co. 46

Yarnall-Waring Co. 19
York Mfg. Co. 12

Bronze to Bronze **DART** **At the Joints**

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

SUPERHEATERS ELESCO

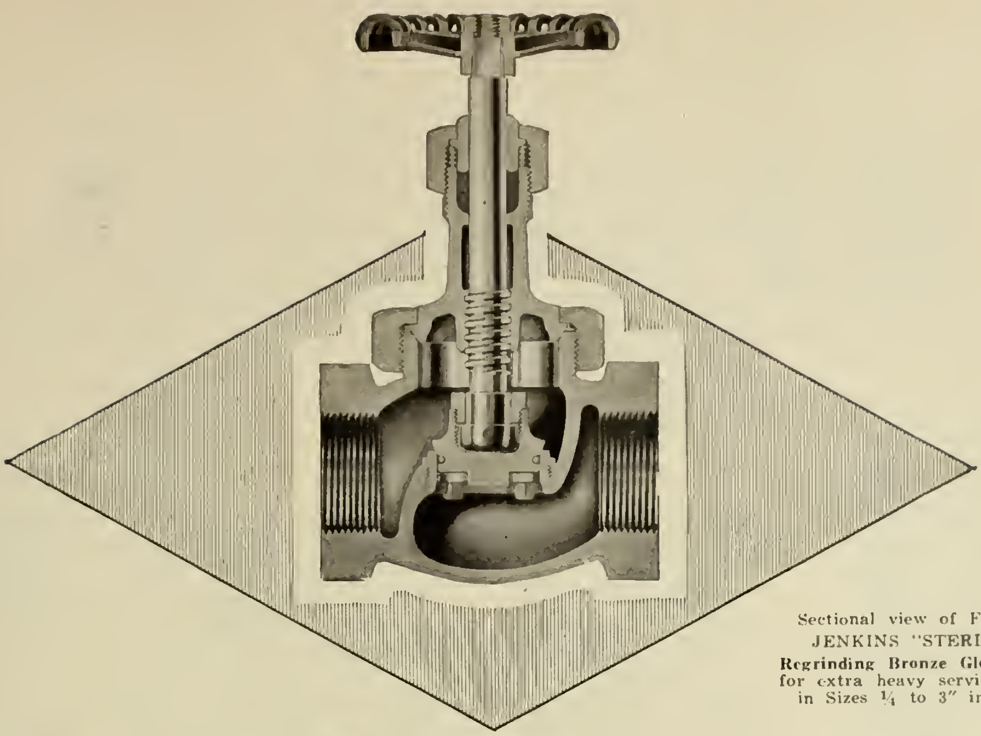
DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.



Sectional view of Fig. 500.
JENKINS "STERLING"
Regrinding Bronze Globe Valve
for extra heavy service. Made in Sizes ¼ to 3" inclusive.

Be Free From Repair and Replacement Costs

You can bring **true** valve economy into your plant by using a "Jenkins" wherever a valve is needed.

Jenkins Valves are the least expensive because they free you from costly repair and replacement charges.

Years of experience in valve manufacturing contribute to the perfection of Jenkins design—close inspection and rigid factory tests assure the valve quality that never fails.

Jenkins Valves for every service are pictured and described in Catalog No. 9. It will be mailed you free and without obligation. Send for it to-day.

TRADE
JENKINS
MARK

Jenkins Bros

Every JENKINS VALVE carries this sign—our guarantee of service.

JENKINS BROS. LIMITED
Head Office:
103 St. Remi St., Montreal
Sales Offices: Toronto and Vancouver
European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, Eng.
Factories at: Montreal, Bridgeport, Elizabeth.

Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

MORRISON'S

TRADE MARK J.M.T. REGISTERED
A GUARANTEE OF QUALITY

Morrison Improved Marine Safety Valve Approved by Lloyd's Survey and Canadian Marine Department. For pressures up to 250 lbs.

J. M. T. Twin Safety Valve Iron Body, Bronze Mounted. For pressures up to 200 lbs.

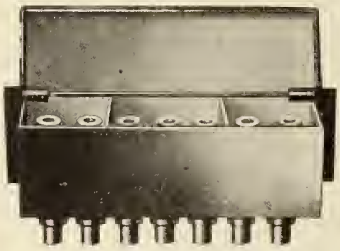
BUY SAFE

Steam Specialties, perhaps more so than any other commodity, stand or fall upon their reputation for absolute and unvarying quality.

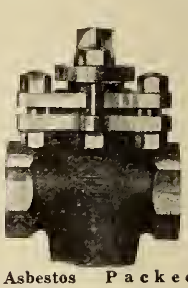
The confidence and good-will built up by the Morrison line is a natural sequence of a conscientious effort to apply, to their manufacture, the skill and knowledge secured by over sixty years' experience.

So, while this asset is a natural product of service, it stands equally as an essential for the continued security of users of the Morrison line — users who prefer to "buy safe."

Are you getting our monthly bulletin? If not, let us put your name on our mailing list.

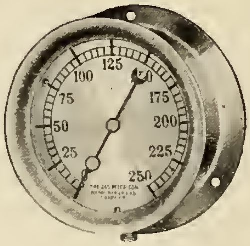


Multiple Feed Oil Box Marine Pattern.

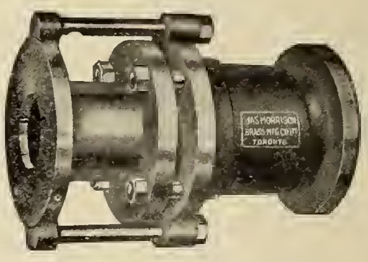


Asbestos Packed Cocks Screwed or flanged. Working pressures up to 250 lbs.

Haines' Steam Trap Starts wide open. Is compact, needs no attention and can be installed in inaccessible places. Will not freeze.



Morrison Pressure Gauges.



Extra Heavy Expansion Joints. Furnished in all styles and sizes to meet every requirement of any plant.

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Fostering Economy in the Development of Power for All Industries

Vol. XVI—No. 10.
Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.
May 20, 1923

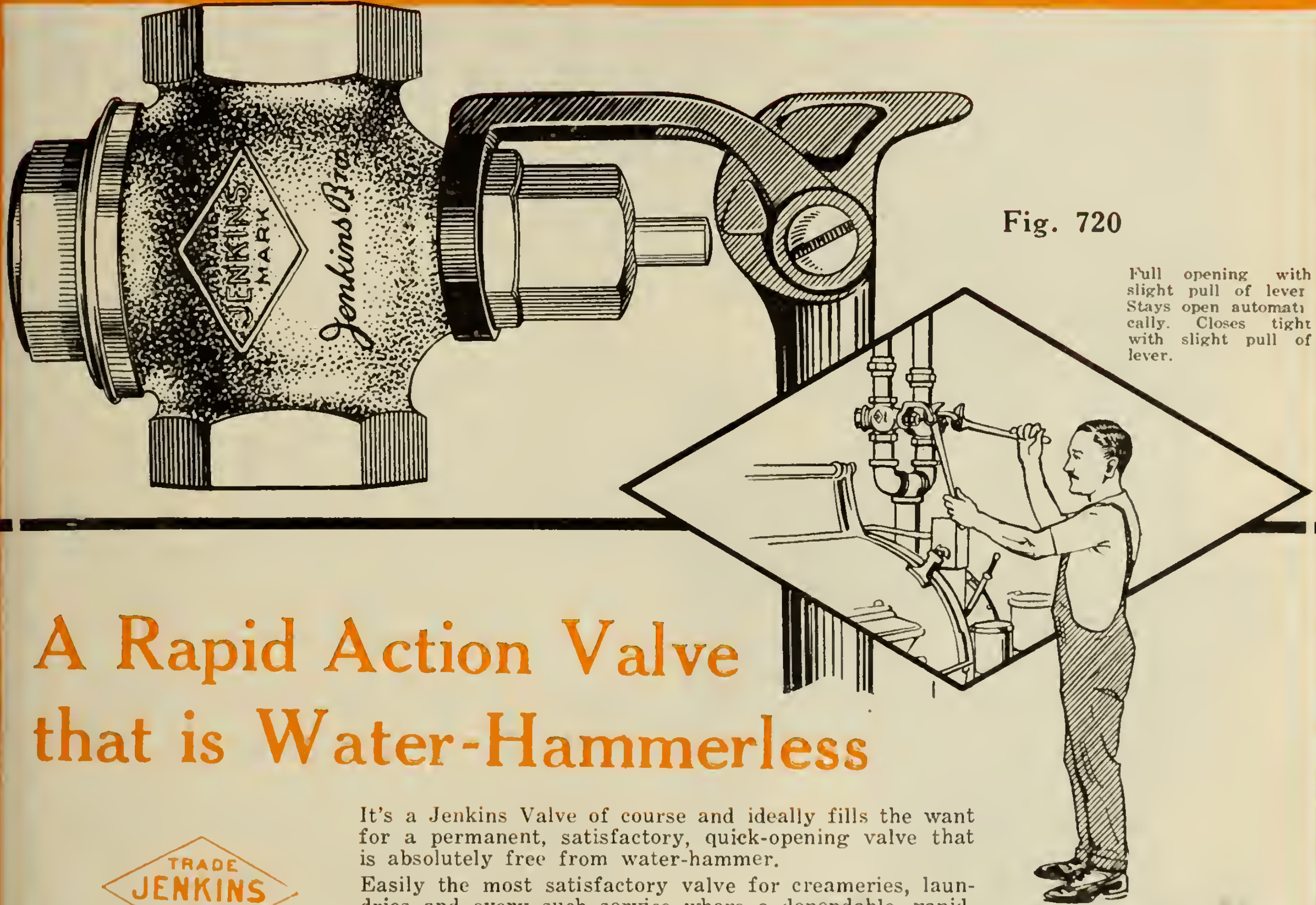


Fig. 720

Full opening with slight pull of lever. Stays open automatically. Closes tight with slight pull of lever.

A Rapid Action Valve that is Water-Hammerless

It's a Jenkins Valve of course and ideally fills the want for a permanent, satisfactory, quick-opening valve that is absolutely free from water-hammer.

Easily the most satisfactory valve for creameries, laundries and every such service where a dependable, rapid-action valve is required.

Made in sizes ½" to 2½" inclusive.

TRADE JENKINS MARK
Jenkins Bros
The Mark of Valve Quality

Write for Catalog No. 9 and illustrated literature describing this Jenkins Valve in detail.

JENKINS BROS. LIMITED
HEAD OFFICE and FACTORY: 103 St. Remi St., Montreal.
SALES OFFICES—Toronto and Vancouver.
EUROPEAN BRANCH—6 Great Queen St., Kingsway, London, W. C. 2 England.
FACTORIES—Montreal, Bridgeport, Elizabeth.

Always marked with the "Diamond"
Jenkins Valves
SINCE 1864

WORD PICTURES SOLVING PROBLEMS OF STATIONARY ENGINEERS

Stop that waste!

Leakage through the blow-off line causes heat waste and reduces the efficiency of the boiler.

LUNKENHEIMER Blow-off Valves

remain tight under the most extreme operating conditions because their design guards against the CAUSES of leakage by automatically cleansing the seating surfaces before the disc becomes seated and by minimizing wire drawing of the water across the seating surfaces.

Their construction permits of only a very gradual release of the water, and the danger incident to undue agitation of the water within the boiler and severe shock in the discharge line caused by sudden release, are eliminated.

Lunkenheimer Blow-off Valves embody all the requisites essential for durability, service and economy.

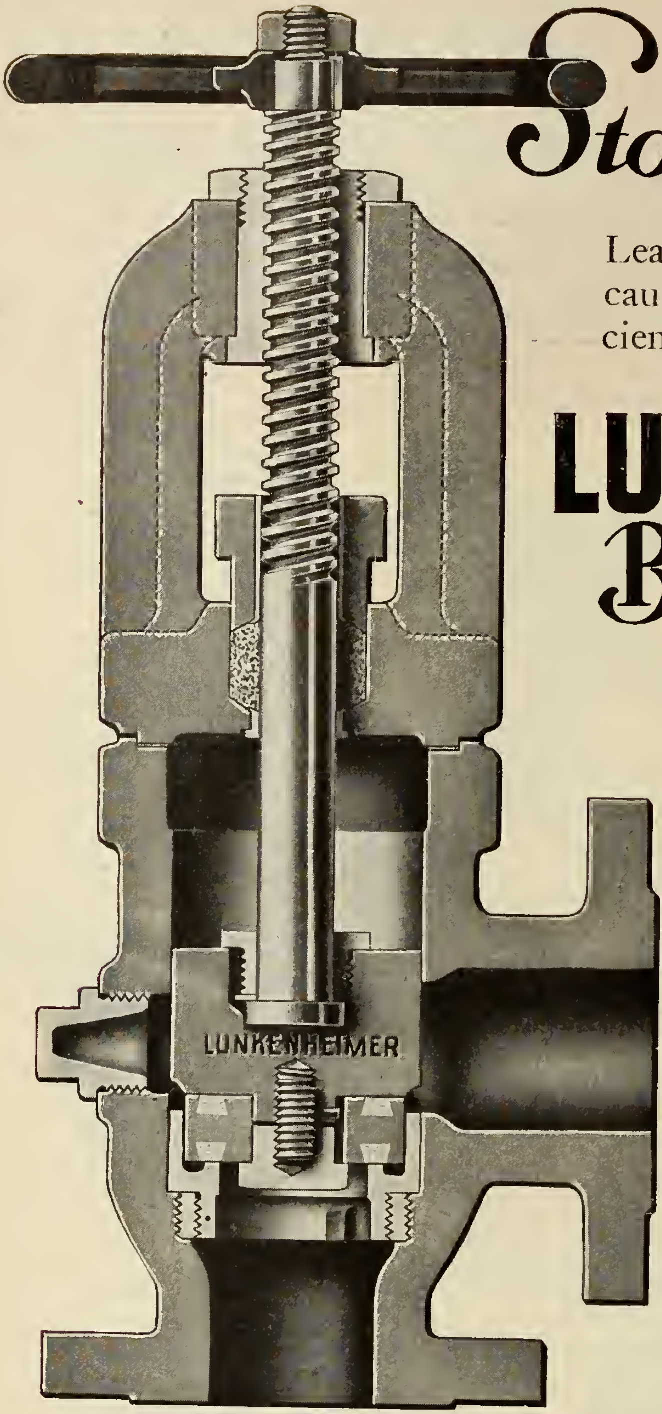


Fig. 897

Booklet 515-DC
Describes the complete line.
Write for a copy.

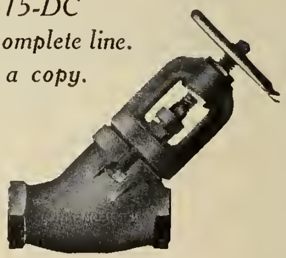
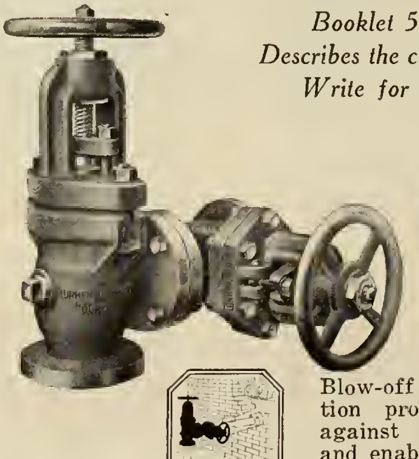


Fig. 935

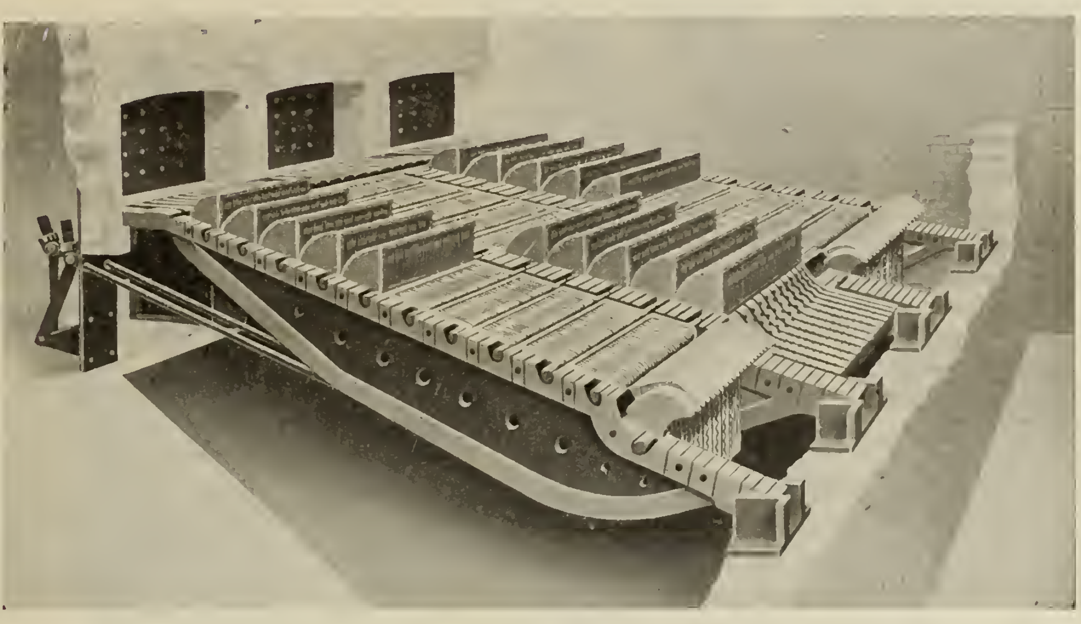


Blow-off and Gate Valve Combination providing double assurance against leakage, greater safety, and enables blow-off valve repairs while boiler is under pressure.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO CINCINNATI, U.S.A. LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

16-26-43

"America's Best since 1862"



THE FILES STOKER

Pays for Itself in One Year

Below is a copy of one of the many letters we have received, telling of the efficiency and economy of the Files Hand-Operated Stoker

Re FILES HAND STOKERS

Gentlemen:—

Frequently we receive letters from manufacturers, asking for information and our experience with the "Files Hand Stokers"— the most economical and efficient system of burning coal with the utmost conservation of labor.

As these inquiries are becoming more and more frequent, our better plan will be to furnish you with a letter to pass on, outlining our experience and satisfaction.

In September, 1920, we placed an order with you for two 150 H.P. Tubular Boilers, specifying our desire to have them equipped with "Files Hand Stokers." This we did on the recommendation of our United States Engineering Department, who had installed "Files Hand Stokers" in some seventeen plants, finding in them a decided saving and advantage over flat or shaking grates.

Speaking for ourselves, we have found them most satisfactory and economical, particularly so in regard to the elimination of smoke, rapid disposal of ash and clinker, thorough cleaning of fires without disturbing the active fire, and in maintaining an even bed of fuel.

We are able to keep a clean fire at all times; we have no cleaning period, for with the "Files Hand Stoker" the grate can be cleaned at peak load. It is only a matter of working one rod on each section, which can be done in less than two minutes.

The better the coal the better the result, but almost any kind of coal that will burn free can be used. With good coal, however, it is an easy matter to procure 150% boiler rating, which in reality is 12½ lbs. evaporation per pound of coal. Generally speaking, evaporation is around 7 or 8 lbs., and often as low as 5 or 6 lbs.

Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel.

And what we have done and are doing with them others can do.

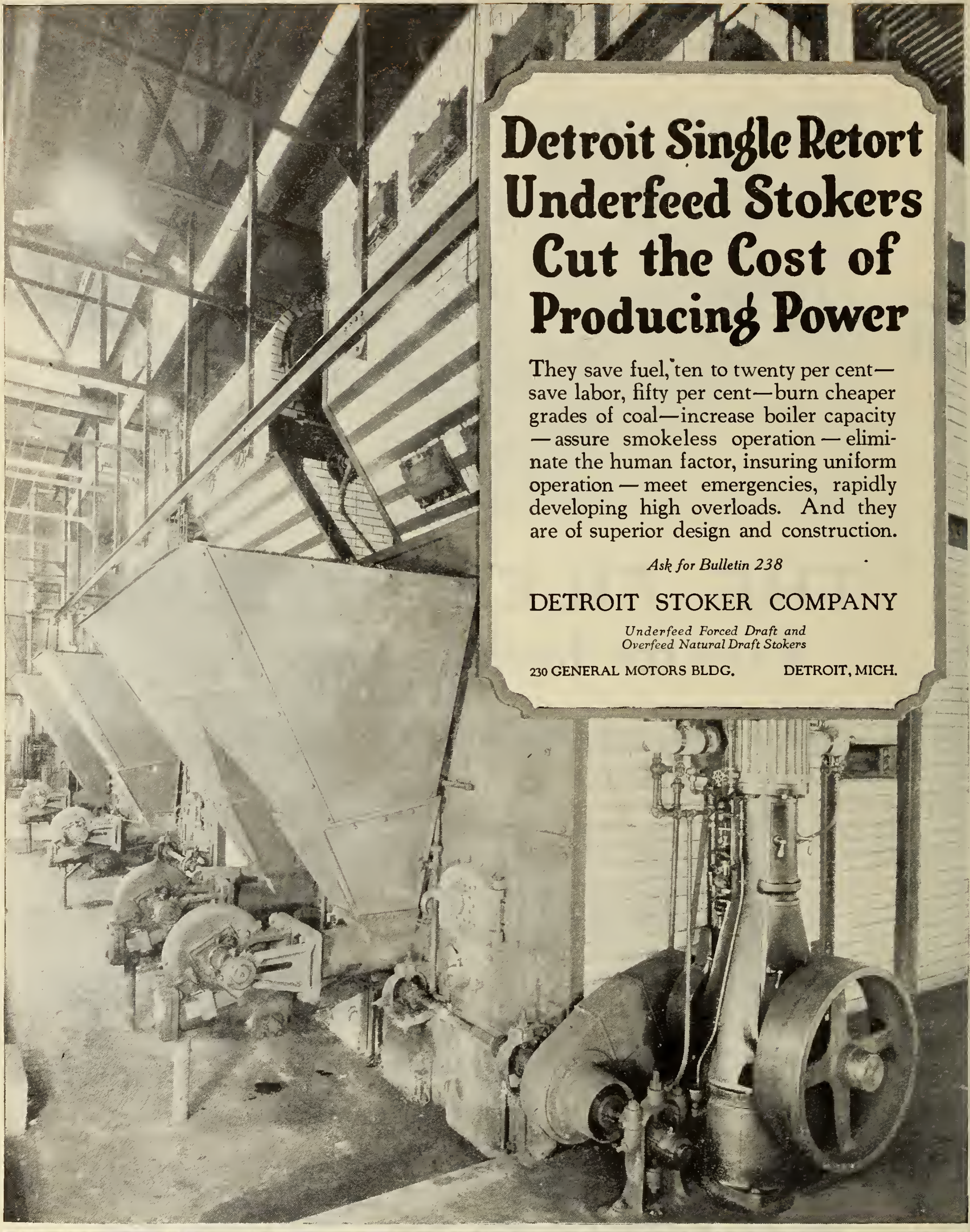
We know they effect a saving; we know they are a convenience; they have proved satisfactory in every particular, and we have no hesitation in recommending them.

Yours very truly,
THE MERIDEN BRITANNIA CO., LIMITED.

Why not Profit by others Experience?

Waterous

BRANTFORD, ONTARIO, CANADA



Detroit Single Retort Underfeed Stokers Cut the Cost of Producing Power

They save fuel, ten to twenty per cent—save labor, fifty per cent—burn cheaper grades of coal—increase boiler capacity—assure smokeless operation—eliminate the human factor, insuring uniform operation—meet emergencies, rapidly developing high overloads. And they are of superior design and construction.

Ask for Bulletin 238

DETROIT STOKER COMPANY

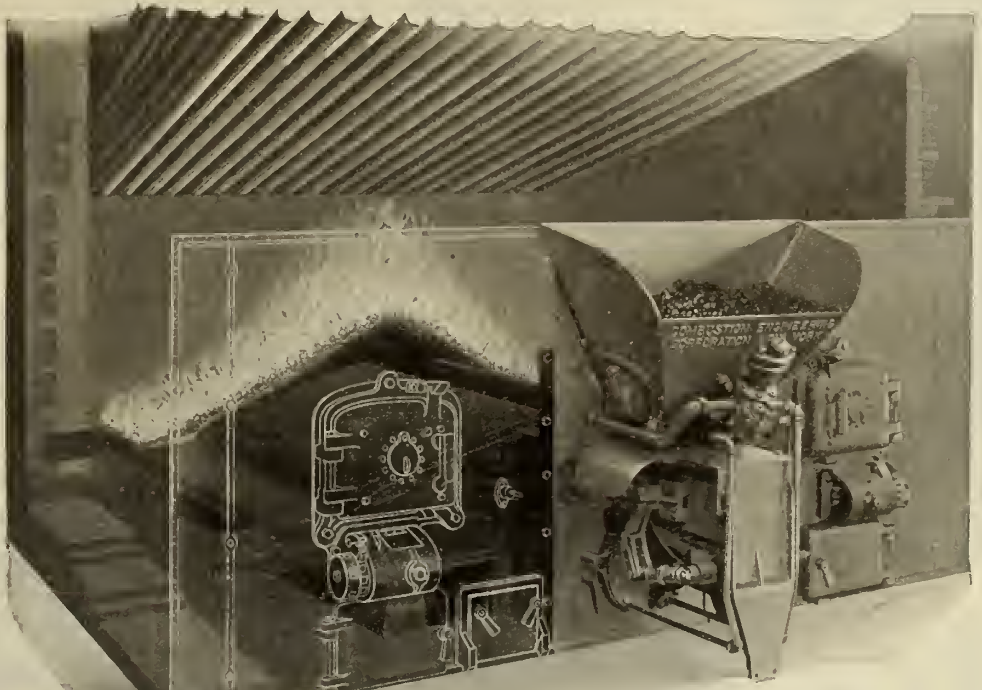
Underfeed Forced Draft and
Overfeed Natural Draft Stokers

230 GENERAL MOTORS BLDG. DETROIT, MICH.

DETROIT UNDERFEED STOKERS

CHANGE OVER
TO
TYPE "E"

Type "E" Stokers may be installed under existing hand-fired Boilers with but little change in Boiler Settings. Ashes may be removed from boiler room floor level.



This is a decided advantage when installing Stokers. Let us send you further details.

We also manufacture and supply

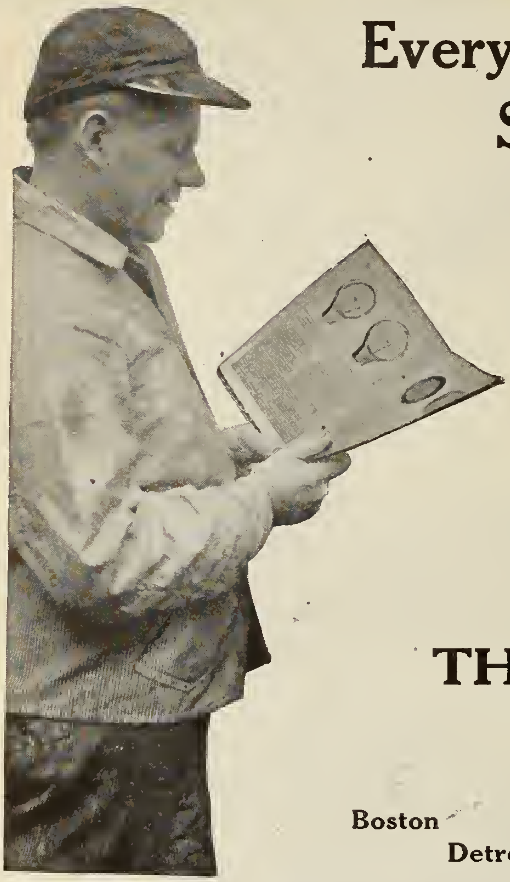
Type "E" Stokers
Self-contained Stokers
Flat Furnace Arches
Uehling Recording Instruments
Combusco Ash Conveyors
Type "K" Stokers
Lopulco Pulverized Fuel Systems
Quinn Oil Burning Equipment
Custodis Radial Brick Chimneys
Economisers and Air Heaters

Everything in the boiler room except the boilers

COMBUSTION ENGINEERING CORPORATION
LIMITED

A. J. T. Taylor, President
John T. Farmer, Chief Engineer

MAIN OFFICE : TORONTO
VANCOUVER
MONTREAL
WINNIPEG



Every "Power Plant Engineer" Should Have—

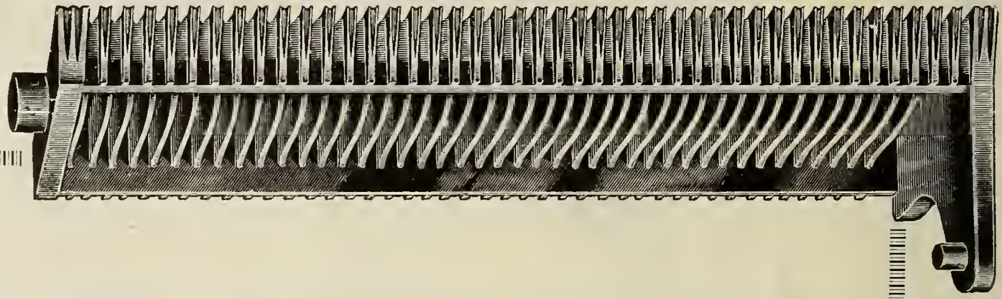
in his possession a copy of our new 84-page Catalog, 1006, Recording Gauges for Pressure and Vacuum. It is the biggest and most complete of its kind ever published.

It illustrates and tells about all the latest developments. It gives information you as an engineer should know about.

Send us your address—refer to this advertisement, and your copy will be mailed.

THE BRISTOL COMPANY
Waterbury, Conn.

Branch Offices:
Boston New York Philadelphia Pittsburgh
Detroit Chicago St. Louis San Francisco



Is Your Grate Surface Properly Proportioned?

Unless it is—that is, unless the surface of your grate bars is properly proportioned to the load—you are not getting the maximum of combustion efficiency, you are burning but wasting fuel.

TWENTIETH CENTURY SHAKING and DUMPING GRATE BARS

are specially designed to give the highest combustion efficiency possible. Clogged air spaces or chipped grate bars are unknown where they are installed. Correctly designed, not too heavy and not too light, they are **guaranteed to save from 2½ to 5 per cent. more fuel than any other make of grate bar.** Let us make you an estimate.

EXPERT SERVICE—Our 35 year's experience in constructing and repairing boilers, furnaces, grate bars, etc., means that you can depend on every job we handle being done RIGHT and at a minimum cost. Emergency repair work night, day or week ends.

BOILER REPAIR and GRATE BAR COMPANY
84 CHURCH STREET, TORONTO

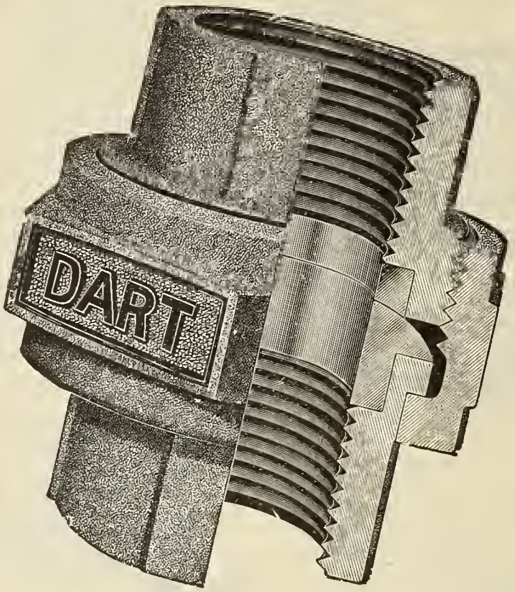
GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Scientifically Constructed!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

DART UNIONS



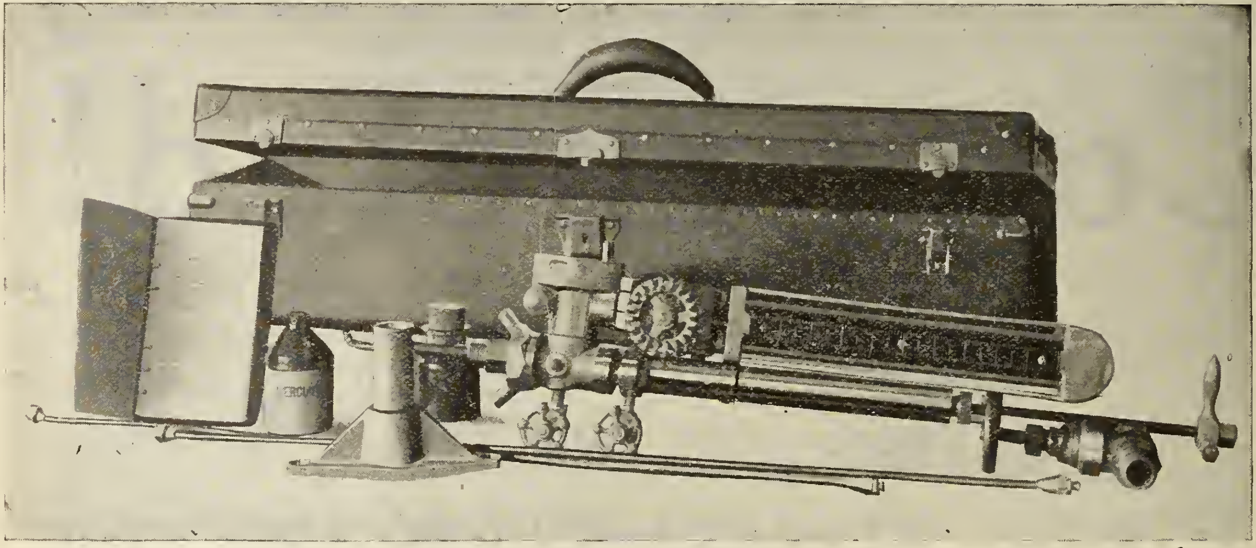
Stay Tight Permanently

No Upkeep Cost
No Replacement Cost
No Loss from Leaks

Because—THEY ARE BRONZE TO BRONZE AT THE JOINT

Your Jobber Sells Them

Manufactured by
DART UNION CO., LIMITED, TORONTO, ONT.



Cory-Royer Flow Indicator
Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

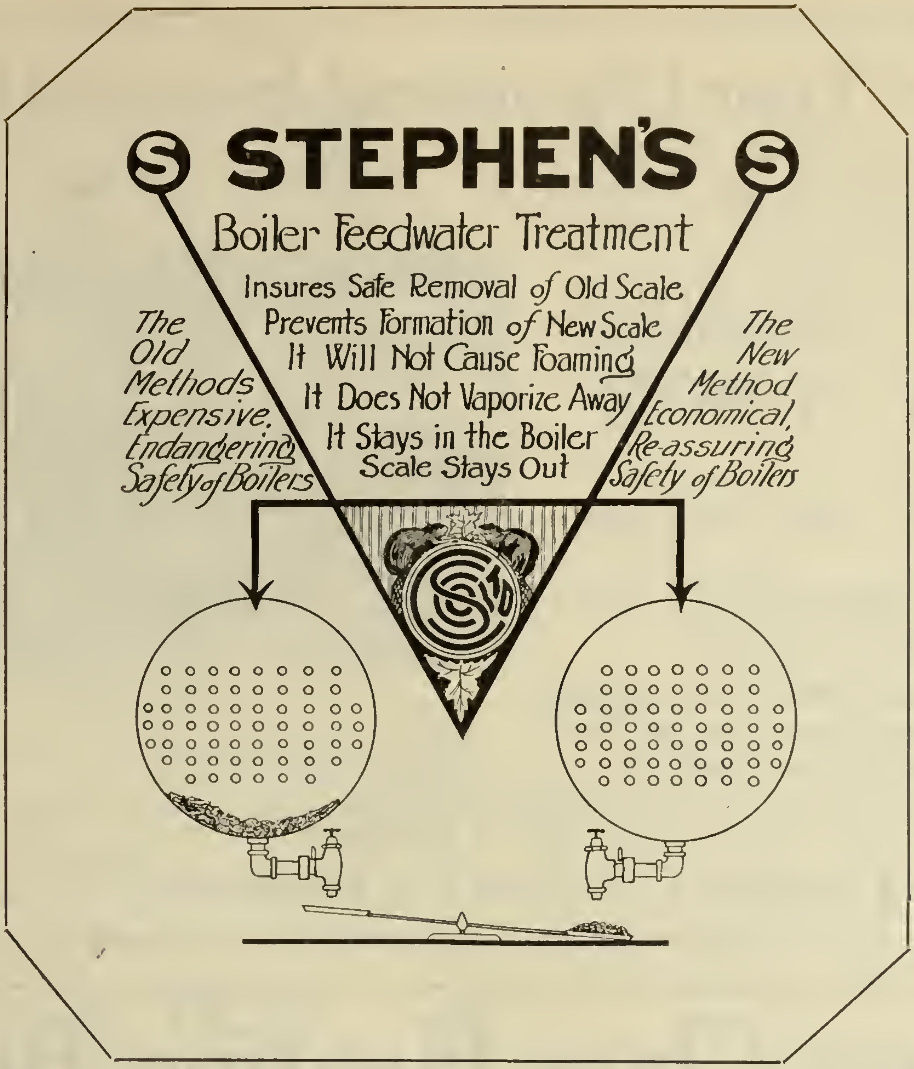
CHAS. CORY & SON INC.

183-7 VARICK STREET - - NEW YORK CITY

VANCOUVER
P. A. Goepel,
525 Pender St. W.

Est. CORY 1845

TORONTO
The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers


STEPHEN'S
Boiler Feedwater Treatment
Insures Safe Removal of Old Scale
Prevents Formation of New Scale
It Will Not Cause Foaming
It Does Not Vaporize Away
It Stays in the Boiler
Scale Stays Out
The Old Methods Expensive, Endangering Safety of Boilers
The New Method Economical, Re-assuring Safety of Boilers

If You Want to Save Coal Bills

Save Repair Bills, Prevent Shutdowns, Lengthen Life of Boilers and Reduce Your Power Costs

Then Scale Formation. Must be Stopped.

One-eighth of an inch of scale increases coal consumption 36%. The cost of keeping scale is expensive. STEPHEN'S FEEDWATER TREATMENT is a specific cure for scale formation in boilers. It does not merely remove scale from tubes—it removes all old scale; it prevents new scale from forming and it will not cause foaming.

Stephen's engineers are men of practical experience. They can discuss your boiler feedwater problems in a practical way. Consult them freely at any time.

We don't manufacture all the feed-water treatments—BUT we manufacture the best.

STEPHENS CHEMICAL & MANUFACTURING CO., LIMITED

2004 Dundas Street West, Toronto, Canada.

Protect Your City against Fire and Crime

With power off because of some mechanical trouble or coal shortage, your streets dark, your citizens fearful, apprehensive; do you know that well lighted streets add to their security? Why not investigate

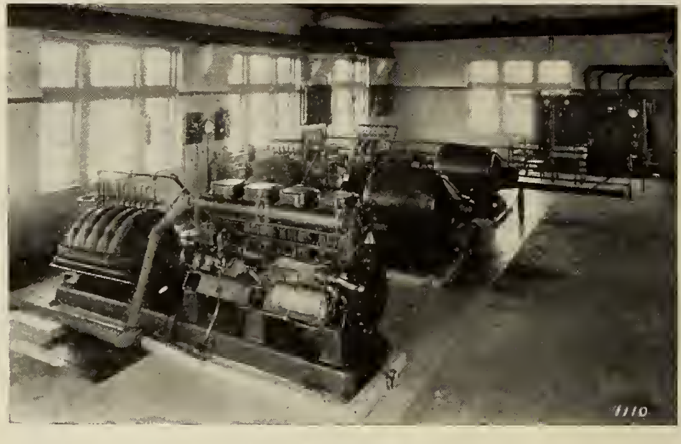
Sterling
THE ENGINE OF REFINEMENT

STANDBY POWER

for driving

Electric generators, and centrifugal pumps?

For emergency lighting, for fire protection or domestic water supply?



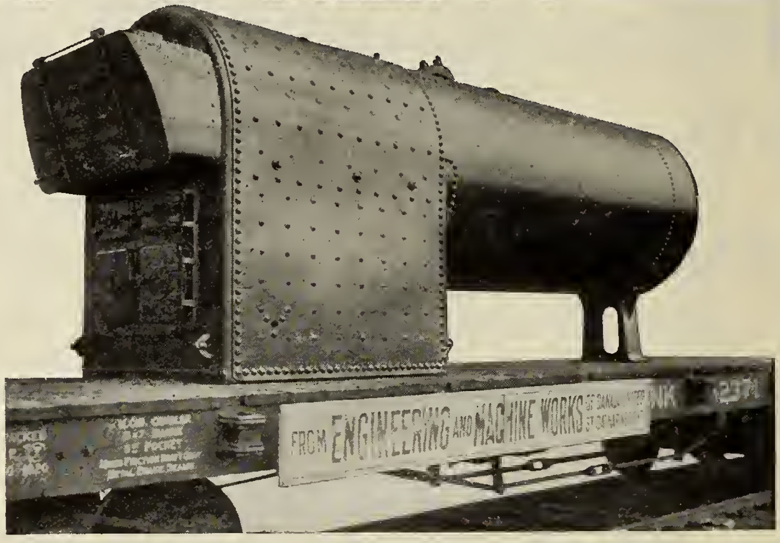
8 cylinder 240 H.P., 1200 R.P.M. STERLING on five stage Lecourtenay, centrifugal pump, 1050 G.P.M., 650 ft. head at Ironwood, Michigan. On one occasion run 9 days constantly, supplying town with water. Specifications by Alvord, Burdick & Howson, Consulting Engineers, Chicago, Illinois.

Further particulars on request. 50 to 300 h.p. in single units. 600 to 1,500 r.p.m.—centrifugal pump and electric generator speeds.

Sterling Engine Co. (Dept. C4) **Buffalo, N.Y., U.S.A.**

A First Class Heating Boiler

The Keystone Heating Boilers we make are built to give the best results with the inferior grades of coal now so often met with. Smoke-consuming device included when wanted. Thirty-five years of experience behind our products. Satisfaction!



Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: HALL MACHINERY CO., Sherbrooke, Que., and Birks Bldg., Montreal

Don't turn Your Factory into a Store!

Most plants that use ordinary traps are virtually compelled to "keep a store" in order to maintain a supply of extra parts sufficient to take care of repairs. For some bucket traps have as many as 43 parts that may require replacement. This not only means a lot of money tied up, but it means that you are paying someone **to make the repairs!**

The Steam Trap Sarco, on the other hand, has but five parts, and only one that moves. Consequently there is practically nothing to wear out and require replacement in the simple

STEAM TRAP SARCO

Another thing, most concerns keep a few extra traps on hand for emergencies. Here again the Sarco saves money as it costs about one-third the price of bucket traps.

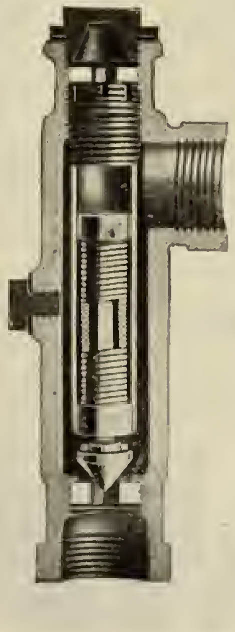
The next time you have a steam trap breakdown remember **that it costs less to install a new Sarco than to repair a worn out bucket type trap.**

Hence, in most cases, you actually save money by scrapping your old trap and replacing it with a brand new Sarco.

The Sarco drains the condensate as quickly as it forms, with minimum loss of heat, instead of permitting it to collect in volume and cool off. Saves valuable heat units.

Made in sizes from ⅜ in. to 3 in., for pressures up to 200 lbs.

Write for Booklet J-32 and particulars of our 30-day Free Trial Offer.



SARCO CO. INC.
239 Broadway, New York City.
PEACOCK BROS., LTD., Montreal.

"Always in Action"— Since 1893

How long do you think a pump governor should last and give satisfactory service?

Actually, we don't know what is the service life of Fisher Pump Governors. We do know of many that are going on doing their work, after a third of a century of duty.

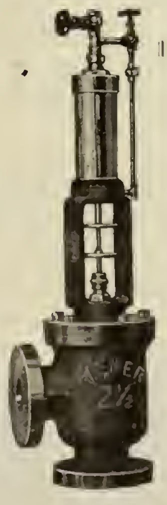
Here is an unusual instance. Read what the owners have to say;

> "The Governor we are using of your make has been in constant use on our sprinkler pump (purchased Nov. 27, 1893). This pump is always in action, *as we have no pressure tank, the pump performing that work.*
>
> Barring minor repairs, the governor *has never given us any trouble and considering its age this is a remarkable record.*"
>
> AMERICAN LINSEED OIL CO.
> St. Paul, Minn.

When you buy a Fisher specialty, you buy a lifetime of service.

Let us send you our book, "Power Plant Specialties" about Fisher Pump Governors and other power plant specialties.

The Fisher Governor Company
945 Fisher Avenue Marshalltown, Iowa, U.S.A



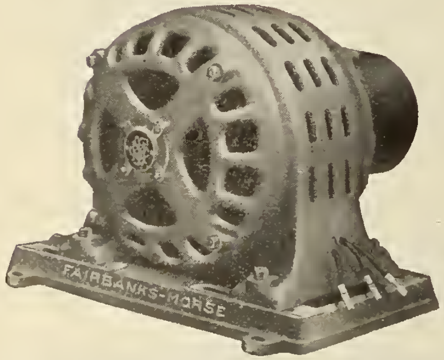
FISHER Pump Governor

(Type No. 1)

Tested, approved and listed as standard by the National Underwriters' Laboratories.

Why

Fairbanks Morse Ball Bearing MOTORS



1. They reduce friction—therefore save current.
2. They require lubrication but once a year—therefore save lubricant and maintenance charges.
3. The one-piece rotor winding means no loose joints, flashing or sparking.
4. They outlast any sleeve-type bearing motor.

A full explanation of these and other points of superiority is contained in our booklets. Prudent executives will ask our nearest branch for them.

The Canadian
Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg,
Regina, Calgary, Vancouver, Victoria.

100

Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.

DURABLA

TRADE MARK REGISTERED

Strength; Goodness; Quality—these features distinguish durable Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

DURABLA is not affected by vibration or condensation. It will not burn out, blow out or pulp at the points. Let us send you a trial sample. Made in stock sizes 36 in. wide x 144 in. long, and 48 in. wide x 144 in. long, in thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Orders Filled Promptly.

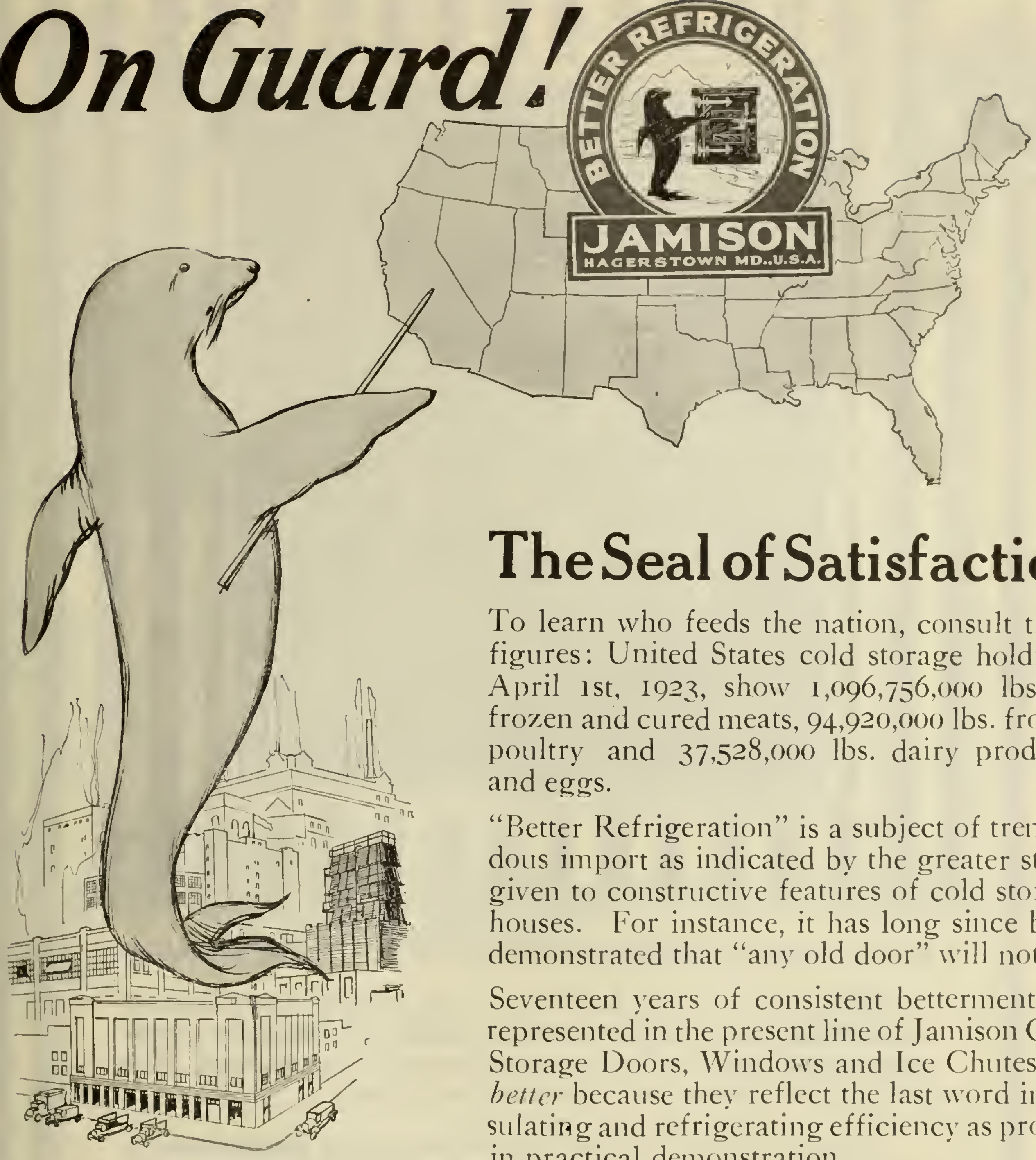
CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

On Guard!



The Seal of Satisfaction

To learn who feeds the nation, consult these figures: United States cold storage holdings April 1st, 1923, show 1,096,756,000 lbs. of frozen and cured meats, 94,920,000 lbs. frozen poultry and 37,528,000 lbs. dairy products and eggs.

"Better Refrigeration" is a subject of tremendous import as indicated by the greater study given to constructive features of cold storage houses. For instance, it has long since been demonstrated that "any old door" will not do.

Seventeen years of consistent betterment are represented in the present line of Jamison Cold Storage Doors, Windows and Ice Chutes; — *better* because they reflect the last word in insulating and refrigerating efficiency as proven in practical demonstration.

Architects, engineers, owners and superintendents are invited to write us in regard to these items. Always a full line of standard doors in stock ready for immediate shipment.

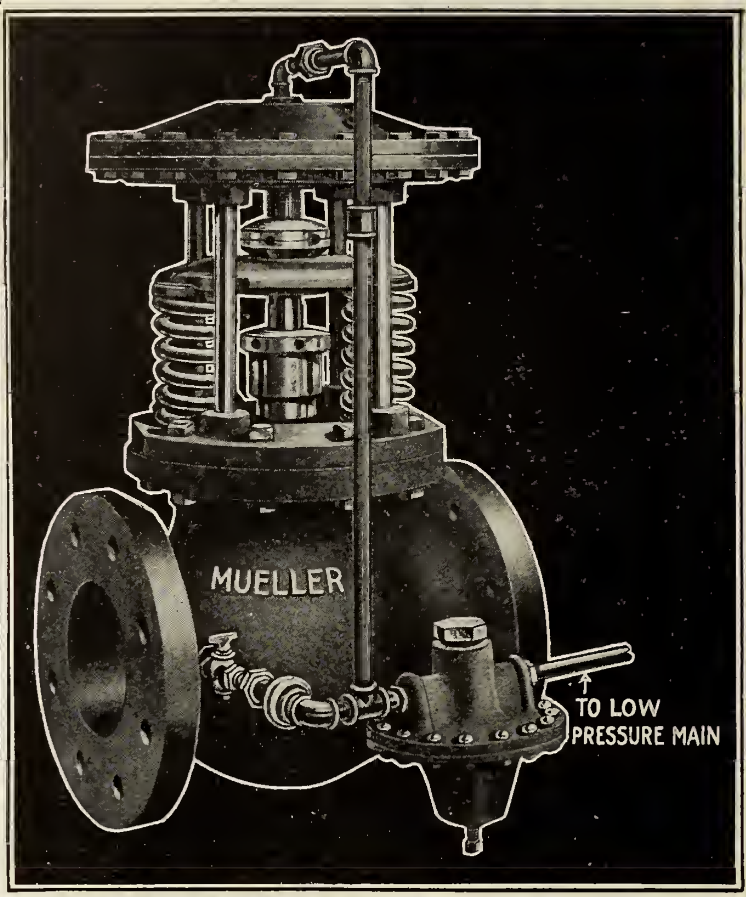
Architects and Engineers

Aside from a large stock of standard size doors ready for shipment, we build refrigerator fronts to specifications for use in any built-in refrigerator.

Send a request addressed to "Desk" please, and we will forward a catalog you ought to read.

JAMISON COLD STORAGE DOOR CO.
HAGERSTOWN, MD., U.S.A.

Make
Canada
Prosperous
by
Buying
Canadian
Products



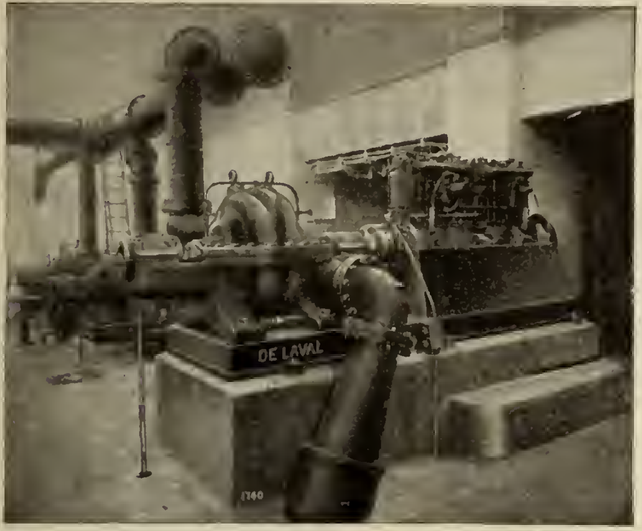
MUELLER Reducing and Regulating Valves

This valve — No. A-5030 — will make any desired reduction and will maintain a constant delivery pressure regardless of fluctuations in initial pressure. For water, air, steam or oil, it has no equal.

When valves are installed under our supervision, we fully warrant their performance. There is a MUELLER stock valve to meet practically every need. Tell us your problems—and we will help solve them.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Ill., U. S. A. Branches, New York and San Francisco
Mueller Metals Co., Pt. Huron, Mich., Makers of "Red Tip" Brass Rod: Brass and Copper Tubing: Forgings and Castings in Brass, Bronze and Aluminum: ; also Screw Machined Products.

Orillia, Ont., Selects De Laval Pumps *for* Safety and Economy



THREE DE LAVAL centrifugal pumps installed in the water works pumping station of the City of Orillia, Ont., are shown herewith. The two-stage 8-in. pump in the foreground is driven by a gasoline engine, and has a capacity of 1,440 gal. per min. against 325 ft. head. The two De Laval pumps in the background are driven by electric motors. Where cheap electric power is available, this type of plant combines low cost, simplicity, and insurance against shut-down. The amount of attention required is very small, and practically no supplies are used.

The De Laval centrifugal pump is ideally adapted for both electric motor and gasoline engine drive. The starting torque is low and the power characteristic permits the size of motor to be selected to suit the normal capacity, resulting in lower power factor and higher efficiency in the driving motor. In many instances De Laval pumps are driven by self-starting synchronous motors, which can be used to correct the power factor.

State pumping requirements and ask for special publication B100

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

244

"Burn All" NONPAREIL

SHAKING AND DUMPING GRATES

A Child Can Operate It

Get *All* the Heat from *All* the Fuel

There's no sense in paying good money for fuel unless you get out of it all that's in it. To do that you've got to burn it right and you can't do that unless your Grate Bars are properly made for the job.

NONPAREIL Grates are designed and built with this one end in view. Under perfect working conditions, their 65% air space and 95% underdraft means that you can get every bit of heat out of the last bit of fuel—any grade fuel at that.

FIRE BRICK WORK You Can Depend Upon

Sexton Boiler Settings can be seen in some of the most important plants around Toronto. You can depend upon the work Sexton does, he has a reputation for doing it RIGHT and without waste of time.

Whether it's building-in boilers or just repair work of any kind, it will pay you to call in "Safety-First" Sexton. His work lasts longer, it's more efficient and it's SAFER.

AGENTS: Mr. C. Berry, Ottawa, Ont. Mr. A. McTaggart, Leamington, Ont. W. Green, Church St., Smith Falls, Ont.

THE W. R. SEXTON BOILER SETTING CO.

Established 1900 114 GRENADIER ROAD, TORONTO, ONT. Junction 2765W

FLAME BRAND

HIGH TEMPERATURE CEMENTS

RED FLAME
PLASTIC CEMENT
WHITE FLAME
INSULATING CEMENT
BLUE FLAME
FIRE BRICK CEMENT

"MONO" TRADE MARK
REG U.S. PAT. OFF.
BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE

FLAME BRAND

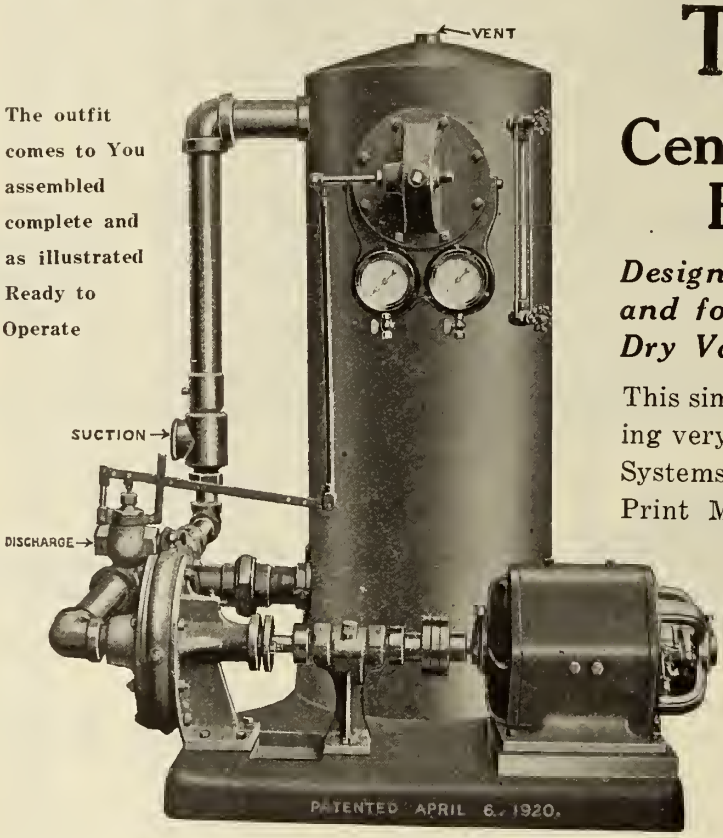
KING REFRACTORIES CO. INC.

Represented in
VANCOUVER, WINNIPEG,
MONTREAL, HALIFAX

SOLE CANADIAN REPRESENTATIVES:
GRANT E. COLE CO.

21-23 River St.
TORONTO, CANADA

The outfit comes to You assembled complete and as illustrated Ready to Operate



The YOUNG

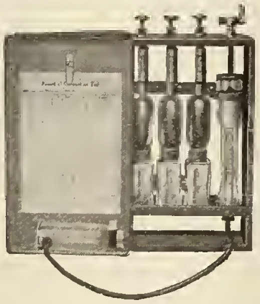
Centrifugal Vacuum and Boiler Feed Outfit

Designed for Vacuum Heating Systems and for All Conditions Where a Wet or Dry Vacuum is Desired—Highly Efficient

This simple, inexpensive and noiseless outfit is giving very satisfactory results with Vacuum Heating Systems, Dry Kilns, Paper Driers, Feed Driers, Print Mills, Cooking Apparatus, Vacuum Pans, etc., for the purpose of effecting a saving by returning the condensate for boiler feed.

Manufactured in Canada by

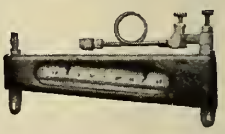
Young Pump Co. of Canada
96 Mary Street
HAMILTON, ONT.



Hays Improved Gas Analyzer.

Are You Wasting Fuel?

Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO_2, O_2 and CO; 1-chamber Analyzer for CO_2 only. Stocked by Canadian Agents listed below.



HAYS DRAFT GAGES, "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts and Draft Regulation."

P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
Michigan City, Indiana

General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.

Trade-Mark

Single retort simplicity —multiple retort efficiency

THE *"Lateral Retort"* construction opens the many decided advantages of multiple retort stoker firing to a large number of plants that formerly would have been compelled to install a stoker of far lower capacity and efficiency.

The *"Lateral Retort"* Stoker possesses the self-cleaning feature and the general simplicity, ease of installation, and low maintenance of the simple side dumping stoker—and adds to these advantages the fuel burning effect found in the larger and more expensive multiple retort stokers.

The construction of the *lateral retorts* is clearly shown by the illustration below. Note that from the time the fuel enters the large central retort, until it is deposited on the side dump plates as ash, it is always *underfed* insuring maximum combustion efficiency.

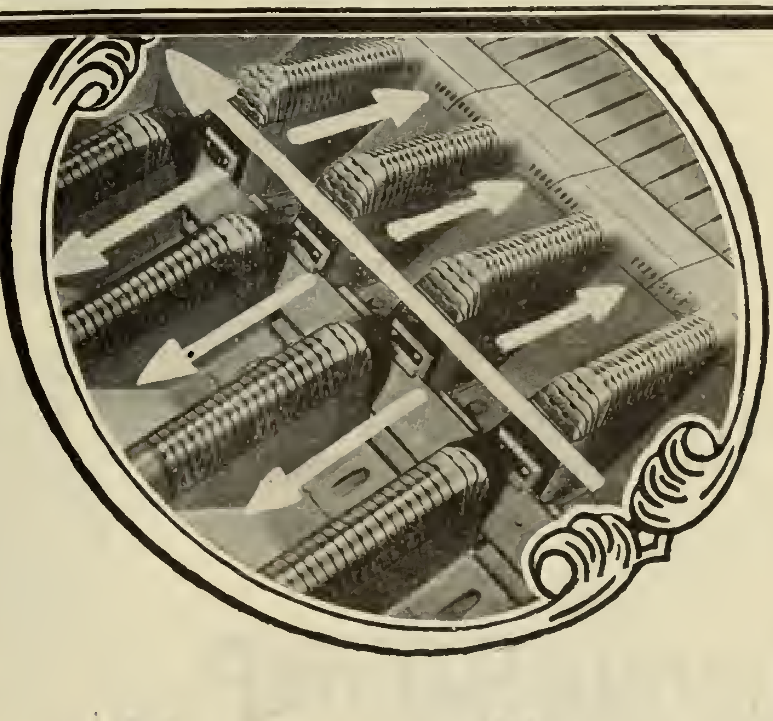
Isn't your plant among the hundreds that this stoker principle can benefit? The operating records of many plants now using the *"Lateral Retort"* Stoker will convince you. Write for the new bulletin—8½x11", standard filing size.

RILEY JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

The Under-Feed Stoker Co. of Canada, Ltd., 146 King St. W., Toronto

Jones Underfeed Stokers Riley Underfeed Stokers Murphy Automatic Furnaces

Alta. & West Sask:	Man. & East Sask.:	British Columbia:	Quebec:
Mr. J. Twomey, Camrose, Alberta.	W. W. Hicks & Co., Winnipeg.	E. A. Earle, Ltd., Vancouver, B.C.	The Cleaton Co. (Canada), Ltd., Montreal, Que.



In design—

a simple side-cleaning stoker — moderate in first cost—economically installed.

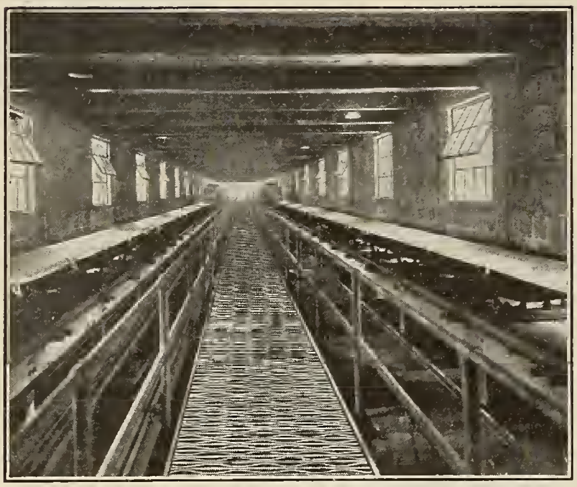
In effect—

a multiple retort stoker with high capacity and efficiency.

The Lateral Retort Stoker

TRADE MARK

IRVING SUBWAY TRADE MARK (PATENTED) THE FIREPROOF VENTILATING FLOORING



IRVING SUBWAY TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

An all-steel, general-purpose flooring for any and every industrial purpose, indoors or out—that's what **Irving Subway** is. A cool, smooth, safe, non-slipping surface to walk or work or wheel upon, with light and ventilation in plenty—that's what its adoption brings to any industrial plant. And its life is the life of steel—its purchase is a permanent investment in foot comfort, under-foot safety, and flooring efficiency. Send us your layouts—get our quotations on your flooring requirements. Write for Catalog 3A50.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Canadian Agents:
Montreal, P.Q., 304 Coristine Bldg. (St. Laurent).
Winnipeg, Man., 141 Bannatyne Ave.
Welland, Ont., Standard Steel Cons. Co.

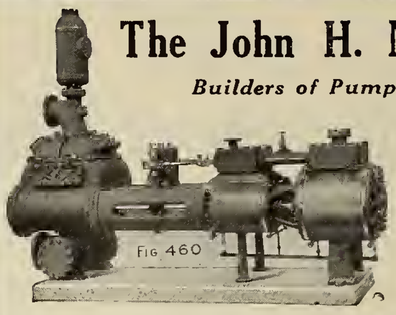
Manufacturers of

IRVING SAFSTEP TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS

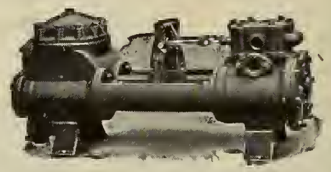
The John H. McGowan Co.

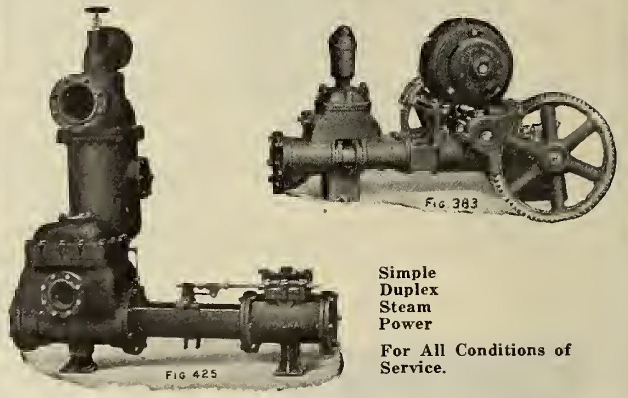
Builders of Pumping Machinery

CINCINNATI, OHIO
U.S.A.



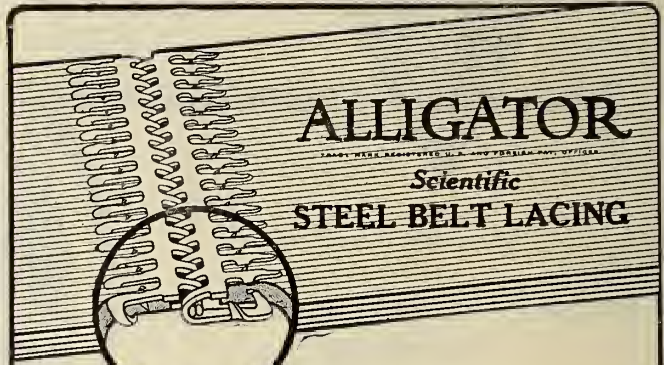
The consumer whose service is interrupted "Can hear no excuse." Reduce complaints by using McGowan Duplex Steam or Power Pumps to handle your water service.





Simple
Duplex
Steam
Power

For All Conditions of Service.


ALLIGATOR
TRADE MARK REGISTERED U. S. AND FOREIGN PAT. OFFICES
Scientific
STEEL BELT LACING

Practically and Scientifically Correct

BELTS give longer uninterrupted service when laced with Alligator Steel Belt Lacing, for Alligator is the strongest and most durable of all belt lacings. It is setting new standards in belting performances.

Every Alligator tooth is a vise, clinching around the belt fibers, holding them in equal permanent service.

Practically all authorities on belt transmission recommend Alligator. It is in use every day on millions of belts of every type and size and in every service.

Just a Hammer to Apply It
"Never Lets Go"

Sold at Wholesale and Retail the World Over

Flexible Steel Lacing Company
4667 **Lexington Street, Chicago**
In England at 135 Finsbury Pavement, London, E.C.2

The name and the trade mark protect you

Genuine
British Oak Tanned
Leather Belting

D. K. McLAREN

All
Shoulders
Necks
AND
Bellies

go into the discard so far as D. K. McLAREN'S BELTING is concerned. Only the BACK portions of the specially selected hides are used.

The Genuine British Oak Tanning Process adds considerably to the original toughness of these portions and is reflected in the unusual gripping power of the finished belting.

It is only after every inch of belting has been put to the severest tests that the Oak Leaf is stamped upon it as the D. K. McLaren Guarantee of efficiency, even under the most adverse conditions—your assurance of Belting with a grip that never slips.

D. K. McLAREN
LIMITED

Head Office and Factory :
351 St. James St., Montreal, P.Q.

BRANCHES:
ST. JOHN, N.B.
90 Germain Street
TORONTO
194 King Street, W.

STOCK DEPOTS:
VANCOUVER, B.C.
Gormans, Ltd.,
1158 Homer St.
CALGARY
Gormans, Ltd.
EDMONTON
Gormans, Ltd.

D. K. McLAREN, LIMITED
TRADE MARK
MONTREAL

Is Canada To Become an Archipelago ?

Are we provincially insular

Do we know anything of the problems of our sister provinces

John Nelson's

"The Problems of Our Provinces"

is a series of ten articles which will appear during the next six months, commencing May 15, in MACLEAN'S MAGAZINE. John Nelson, a Canadian journalist of distinction, a publicist of authority, a writer with an unusually forceful and trenchant pen, has been assigned to visit every province and record what he discovers during his travels, without fear or favor.

Canada's Three Great Prairie Provinces

will be the subject of John Nelson's first article, and of the triumphs, the trials and tribulations of our great growing provinces, he will write. In his interesting, readable style he will give you the point of view of the farmer, the small prairie town dweller, the rich man, the poor man and his wife, the hired man. In fact no one has been overlooked in the author's careful search for facts and impressions.

There is a great big vital message for every Canadian in this fine series and every politician, every public man and every layman, his wife and his grown children should follow this series.

Other Features of the May 15th Issue Include:

"THE KICK"—Wallace Irwin.

This is a fine "long" short story by an author who has made a big reputation for himself as a regular contributor to the Saturday Evening Post.

"PUSSYFOOTING AT OTTAWA."

Grattan O'Leary in an interesting revelation of how politicians supply the public with "news." After reading this you will read between the lines of the press reports from Ottawa.

"THE BOOK"—Benge Atlee.

A fine human document by an author who has the gift of word painting. The story of a small country town doctor who holds Death at bay by strange remedies.

"THE SAND-DIVINER"—Kathlyn Rhodes.

A really startling play upon popular interest in the spirit world. Staged in Egypt, ever mysterious and ever restless, an ideal setting for the strange tale Kathlyn Rhodes has given us.

All our regular departments and
THE REVIEW OF REVIEWS

NOW ON SALE 15 CENTS

MACLEAN'S
"CANADA'S NATIONAL MAGAZINE"

At All News Stands 15 CENTS

Investigate the Advantages of the

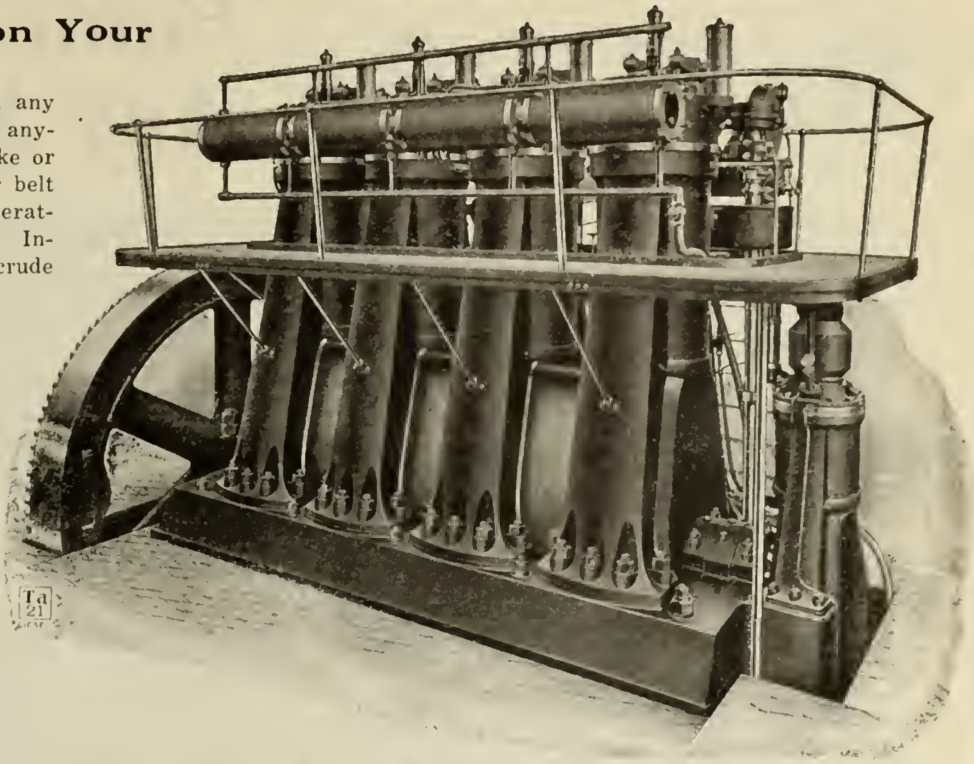
POLAR DIESEL ENGINE

Before Deciding on Your Power Plant

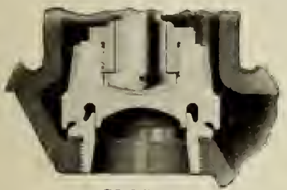
Lower operating cost than with any other system. Can be erected anywhere. No risk of fire, no smoke or smell, silent running. Built for belt drive or direct coupling to Generators, Pumps or Air Compressors. Instantaneous starting. Cheapest crude oils may be used as fuel.

Types	Sizes	Fuel Consumption
BW	670 & 1000 B.H.P	0.390 lbs. per B.H.P. hour
T	50 to 550 B.H.P.	0.396 to 0.418 lbs. B.H.P. hour
Z	12 to 75 B.H.P.	0.440 to 0.484 lbs. B.H.P. hour

Write us for particulars, we shall be pleased to submit proposals regarding power plants of any description.



LAMMERS & MAASE
LIMITED
170 McGill Street
Montreal, P.Q.



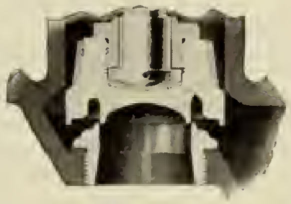
CLOSED

EDWARD Protected Type Seat and Disc

In the "cracked" position, the erosive action of the steam is greatest due to the fact that the steam is being wire drawn through a very small orifice and its velocity thus greatly increased. The illustrations show the positive protection which the Edward Protected Seat and Disc affords against this cutting action.

Note that in the "cracked" position the seating surfaces are widely separated and protected from the direct flow of steam and that the velocity across the seating surfaces is greatly reduced.

Send for Catalogue.



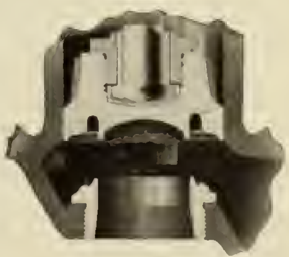
CRACKED

Unless positive means of prevention is provided, the cutting from wire drawing between the seat and disc of a valve will rapidly destroy the seating surface. This is especially true under high pressures and temperatures, where very small leaks will rapidly grow on account of the terrific erosive action, making the life of the valve very short and increasing the upkeep cost due to frequent repairs and renewals.

The Edward Valve & Manufacturing Co.

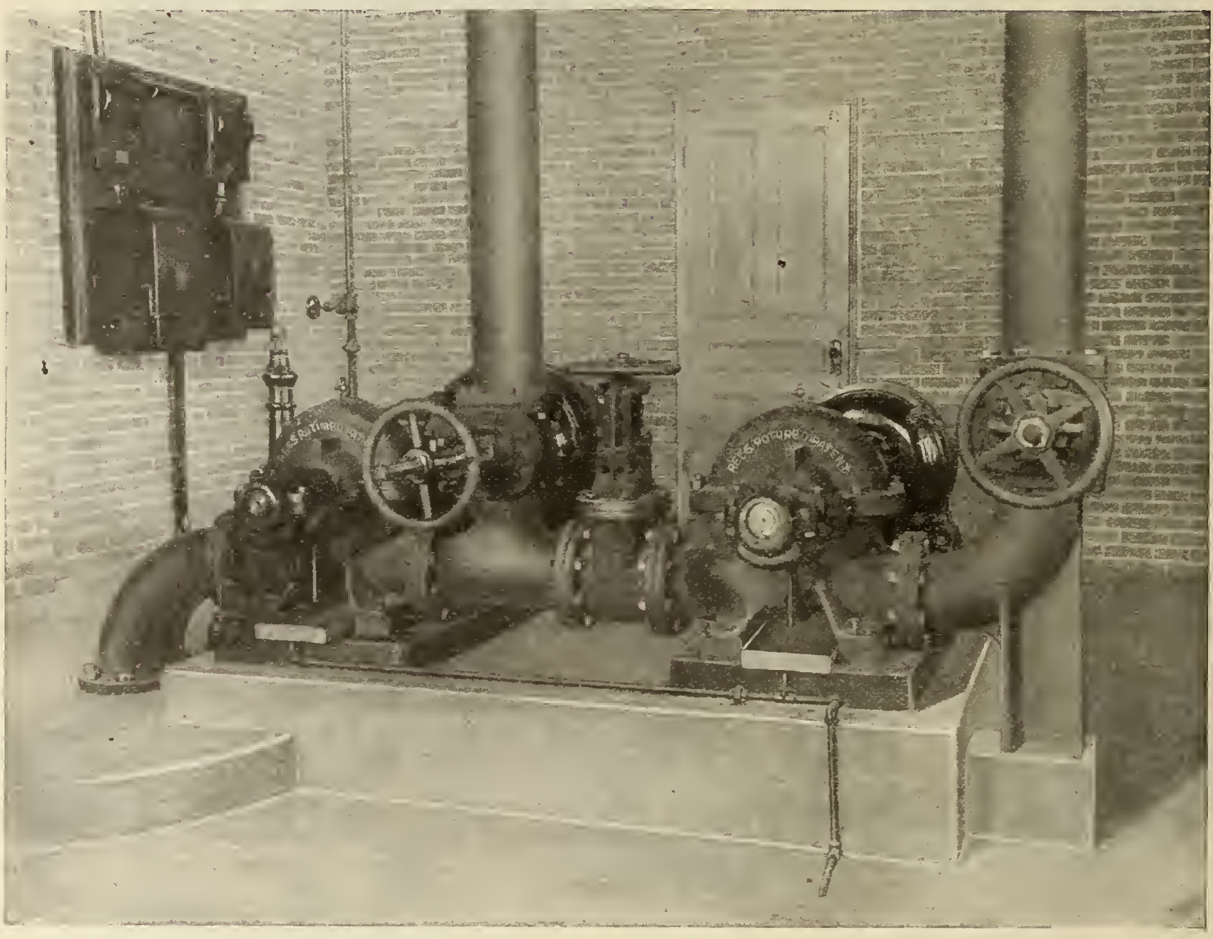
General Office and Works: East Chicago, Indiana

Canadian Agents: LYTLE ENGINEERING CO., LIMITED, Montreal.
VALVE ENGINEERING CO., Toronto.



OPEN

THE REES RoTURBo *A Centrifugal Pump for Any Service*



Showing two REES RoTURBo Pumps at the Waterworks Pumping Station, Carleton Place, Ont.

REES RoTURBo PUMPS ARE SELF REGULATING

They automatically adjust themselves to sudden Drop or Overload without injury to themselves or the prime mover, and they assure a high and constant efficiency over a wide range of duties.
Municipal and Industrial Plants all over Canada are installing REES RoTURBo PUMPS.

The above installation has been so satisfactory that a third pump of the same make has since been installed.

Catalogs and further information on request

The GOLDIE & McCULLOCH CO. Limited
Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2
Bank of Hamilton Bldg.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Grieg,
400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B. C.

POWER HOUSE

ESTABLISHED 1907 *Toronto, May 20th, 1923* A SEMI-MONTHLY NEWSPAPER

Storage Solves Fuel Problems of Power Plants

A Brief Outline of Precautions Essential in Handling Coal and Fuel Oils in Large Quantities With a Description of Various Types of Equipment for Economical Disposal

By ARTHUR MURPHY*

POWER plants in all parts of Canada continually face the problem of fuel supply and with each recurring shortage it is made apparent that whether coal or oil be utilized, storage in large quantities is essential; indeed the safe storage of bituminous coal is advanced by economic experts as the final solution of stabilizing the coal industry.

As long as the peaks of demand react upon the mines the coal industry must be a seasonable one but if, on the other hand, some system can be devised whereby coal can be stored economically with little deterioration or danger of spontaneous combustion the mines may be operated practically the whole year —or at least 300 days instead of 180 or 250 as at present.

Production under such operation would then be uniform with correspondingly lower costs.

Although the oil industry is more stabilized with production practically uniform throughout the whole year, the demand for the lighter fractions such as gasoline and kerosene is seasonable. During the summer months large quantities of crude oil are distilled with the result that large amounts of fuel oils are produced to meet the consumption of the winter months.

Limits Fuel Storage

In the average plant available space limits the amount of fuel it is possible to store but if economy in operation is of prime importance, sufficient storage must be provided in some way for several months' supply, although if the purpose of storage is only to insure continuity of supply much less space will be needed.

As the use of oil as a fuel is making slow headway in the larger plants of the Dominion the storage of coal is at present of greater importance and presents greater difficulties.

Large power plants in the neighborhood of cities usually have facilities for the storage of sufficient coal for their needs but plants located within a city are usually not so fortunate, space being limited and costly.

Under present day conditions only twenty per cent. of the coal recovered from the ground is actually used at the point of application. Losses in recovery, cleaning, handling, storage and methods of combustion account for this seemingly appalling loss of four tons out of every five. Experts claim that in the sub-average plant one-quarter of the coal actually fired under the boilers is wasted. Operating engineers are, however, well aware that when this condition exists there is usually some single thing which, when remedied, eliminates the bulk of this waste.

It is sometimes necessary to store coal outside a city and truck it to the plant, at best a costly procedure and one which is not improved any if when it reaches the plant the equipment necessary to place it at the boiler is obsolete in type.

There are many different types and sizes of coal handling devices on the market, but for use in handling large quantities of coal they may be generally summarized as belt conveyors, chain buckets, clam shell buckets, skip hoists and drag lines.

Offer Varying Types

Continuous conveying types vary from the endless type, used to elevate coal from under the hopper of a car, to elaborate systems with long trestles, pulleys, rollers, etc. They are used largely within power plants to convey the coal from the crushers to the coal bunkers but they also find a place in unloading cars directly into large overhead buckets.

The clam shell bucket with a locomotive type of crane, on the other hand, is used widely for unloading coal from cars and placing it in large piles. By laying a rough track as large a pile as desired may be made.

This type of equipment is also useful in reclaiming operations, especially where the coal is to be reloaded on coal cars or motor trucks.

A clamshell operated from an overhead trestle is often preferable for unloading coal from barges as well as for reclaiming the coal in the bunkers.

A cable drag scraper is useful for spreading coal in a large yard, especially when used in conjunction with a skip hoist or other form of elevating machinery. Its great advantage lies in its flexibility and simplicity. In a large yard it is only necessary to anchor posts at convenient places to which the tail blocks are fastened. The scraper spreads the coal and when reversed reclaims it to the elevating equipment.

Quickly Expose Fire

Clam shell buckets and drag scrapers are very useful if the coal pile should fire spontaneously; they will quickly dig down and expose the fire so that it can be quenched.

In comparison with the equipment necessary to handle coal, fuel oils require little equipment, a pump or pumps and a pipe line being the essentials. Pumps for fuel oil may be of several types. For large volumes and low heads centrifugal pumps are generally used; for higher heads and small quantities a gear or a reciprocating type usually finds favor.

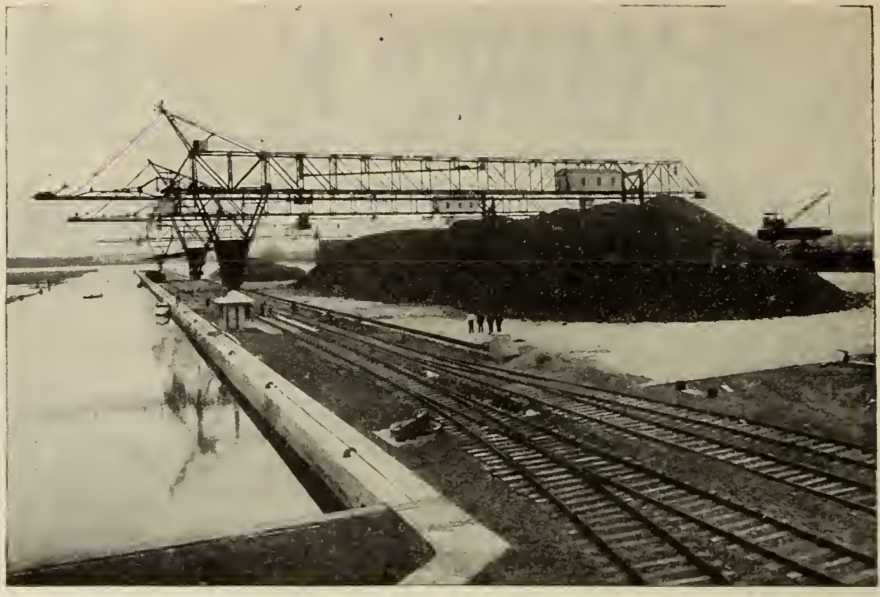
The reciprocating type, it is charged by some engineers, has one disadvantage, the difficulty of keeping the stuffing boxes tight to prevent oil dripping.

For heavy oils, in order that they may be sufficiently fluid to flow through the pump and pipe line without excessive friction losses, a steam coil is placed in the tank for heating purposes.

In storing coal the risk of spontaneous combustion is really not so great. It is extremely rare that in the smaller operations involving only a few tons there is any heating, the chief danger

---

*Associate Editor, Power House.



Traversing bridge tramway with 5½ ton grab bucket.

lying in the large piles needed as reserves for public utilities and industries.

All coals have a tendency to deterioration in storage, but the loss at ordinary temperatures is small. The tendency to fire spontaneously differs with various coals and their age, the younger coals being the more dangerous.

No case has ever been recorded in which anthracite coal has fired spontaneously, even with the finest screenings. Lignite, on the other hand, cannot be stored, even in lumps, except under water.

The degree of fineness has an important bearing on the tendency to fire, the finer the coal the greater the tendency to fire. The presence of fines in the coal pile should be avoided.

Heating a Phenomenon

The heating of coal is believed to be a surface phenomenon. If a ton of bituminous coal could be delivered in a cube, each dimension of the cube would be about 2.8 ft. When coal heats, it is due to something that goes on at the surface and not something that happens inside the piece. If the cube, having originally an area of about 47 sq. ft., be continuously divided until all the pieces are fine enough to pass through a 16 mesh screen, the area of exposed surface in one ton of coal becomes one acre.

This explains why trouble from spontaneous combustion originates in fine coal, because the great increase in area does not begin until one gets below 1½ in. or nut size. If fine coal is kept out of the pile the heating surface is so small as to remove the cause of spontaneous combustion.

Another important factor is the freshness of the broken coal surface. The freshly broken surface is much more active in uniting with oxygen than it is later, thus more heat is produced. Coal should be handled as little as possible before storing to avoid freshly broken surfaces and fine coal. For the same reason it is not advisable to crush coal before storing.

Cooling Coal Piles

Cooling a pile of coal by artificial ventilation is almost impossible on account of its low conductivity, unless the air reaches every part of the pile. A better method is the exclusion of air in order to stop oxidation, rather than attempting to dissipate the heat by artificial ventilation.

Moist air gives a lower spontaneous temperature than dry air, therefore wetting coal is not good practice unless the coal be completely immersed.

Partly oxidized coal, when mixed with fresh coal tends to inhibit spontaneous combustion; on the other hand, a mixture of two kinds of coal will heat more readily than the poorer of the two. In recent experiments with artificial mixtures of coal and pyrite in various proportions, it was found that the mixture gave a critical temperature no lower than coal alone, while pure pyrite had a critical temperature 26° C higher than the coal. Therefore, pyrite or brass lumps are not dangerous in a coal pile.

Anthracite stores best. Lignite cannot be stored except under water.

Store largest sizes possible.

Keep fines out of the pile.

Do not crush before storing.

Handle coal as little as possible.

Do not wet coal unless completely immersed.

Do not mix different kinds.

Do not ventilate coal pile.

Oils, while free from the danger of spontaneous combustion in storage are not wholly free from hazard. Tanks must be constructed and placed in compliance with underwriters and municipal regulations.

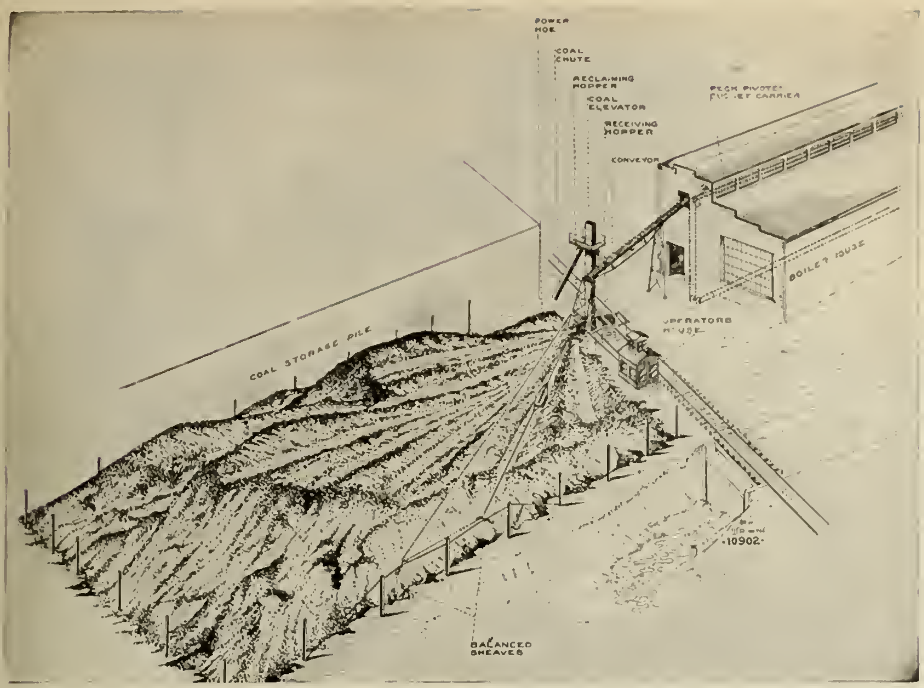
Heat Small Portion

Normally, fuel oil at ordinary temperature, is a heavy, inert, non-explosive fluid; crude oil may, however, contain a fair percentage of the lighter fractions which may vaporize and form an explosive mixture. Another danger arises from the use of steam coils to heat the heavier oils. These coils should be placed near the suction pipe so as to heat as small a portion of the tanks as possible. In any event, oil should never be heated above 140° F. Serious hazard sometimes arises from leaks due to careless handling, faulty tanks or piping.

A small leak allowed to continue may result in the formation and accumulation of explosive vapor in low levels, since it is heavier than air and subject to ignition by sparks, naked flames, smoking, etc. Spilled oil should be wiped up at once and drip pans emptied regularly. Leaky piping is especially dangerous as the oil is usually heated and under pressure. Such leaks may occur in the form of a spray which will have a greater tendency to mix with the surrounding air.

In fighting oil fires water must never

Crane with clamshell bucket.



Typical layout of storage using scraper and skip-hoist

be used as it will only tend to spread the burning oil over a greater area. Oil fires can be extinguished only by sand, steam smothering or chemical means. Tanks should be permanently equipped with steam or foam smothering connections.

Concrete Untried

Steel plate tanks are usually recommended to meet insurance and municipal regulations for the storage of oils in large quantities. Lately there has been considerable interest shown in the possibility of concrete as a material for tanks, due largely to the ease of construction and facility in obtaining raw materials.

A well developed fuel handling and storage system, in which both the coal and ash bunkers are located outside the building, was recently installed in an electric lighting plant. Skip hoists are used throughout, and a coal weigh larry carries the coal from the bunkers to the stokers. A cable drag scraper is used for coal storage.

Machinery is reduced to its simplest form, the equipment consisting of only a few self-contained units. Three winding machines are used, one for the coal skip, one for the ash skip, and one for the drag scraper. These are placed side by side in a clean, well lighted room in the coal house.

Coal is received at the plant in railroad cars and dropped into the track hoppers. From these hoppers the skip hoist is loaded by a loader of the self-damming type. By the use of this type of loader the skip bucket cannot be flooded or underloaded, insuring the skip hoist working at maximum capacity.

Opened by Bucket

The loader consists of a fixed chute or body bolted direct to the underside of the hopper. The chute has cast iron sides and a heavy steel plate bottom. To it is suspended a pivoted undercut gate built with cast steel sides and a heavy steel plate top and bottom. This pivoted gate is opened by the descending skip bucket coming in contact with, and pulling down, a spring hook attached to the chute, and is closed by the ascending skip bucket.

Counterweights are attached to the pivoted chute to assist in closing and keep it closed.

A balanced skip hoist is used in which one bucket acts as counterweight for the other, alternately loading, ascending, discharging and descending. The bucket is a simple, rectangular steel box, open at the top and fitted with flanged wheels and hoist bale. It is discharged by inverting on dump rails.

The entire operation of the skip hoist is automatic. The operator pushes a "starting" button, and the bucket ascends, accelerates to 250 ft. per minute, slows down and discharges at the top, lowers and reloads automatically and again ascends. This cycle is repeated entirely automatically and alternately by the two skip buckets until the "stop" button is pushed. The skip bucket discharges to a hopper which passes the coal into a feeder to be delivered to the crusher.

Passes Into Bunker

From the crusher the coal passes into the bunker, until the bunker is filled, after which it is chuted outside for storage. A 1,000-ton steel suspended bunker is used, with the outlet gates spaced close together to minimize "dead" coal.

From the bunker the coal is drawn into a ½-ton coal weigh larry, weighed and then discharged to the stokers as needed. The gates are spaced close together and the larry travels the full length of the bunker. By means of a recorder the larry operator is enabled to keep an accurate check on all coal consumed.

The coal which has been chuted for storage is stored out and reclaimed by a cable drag scraper at the rate of 80 tons per hour. The scraper is dragged back and forth over the coal, it being quickly detachable so it can be turned around to reclaim the coal. Around the edge of the yard are steel posts. To store coal at any portion of the storage yard, the tail blocks are changed from one post to another.

When reclaiming, the scraper is reversed on the cable and the coal is scraped back to the reclaiming hopper, and delivered to the skip hoist which will elevate the coal to the bunker. This system is used to store 10,000 tons at a depth of 6 feet.

Has Wide Field

Turning to the continuous conveying type, the belt conveyor is one of the oldest known devices and has a wide field of usefulness. It is practical to run these conveyors at relatively high speeds which adapts them well for conveying long distances. The three most important elements of a belt conveyor are the supporting idlers, the belt and the drive.

The earliest idlers were flat rollers but to-day the rollers are generally trough-shaped with a central horizontal roll and inclined side-rolls. The speed of these rolls is from 200 to 400 r. p. m.

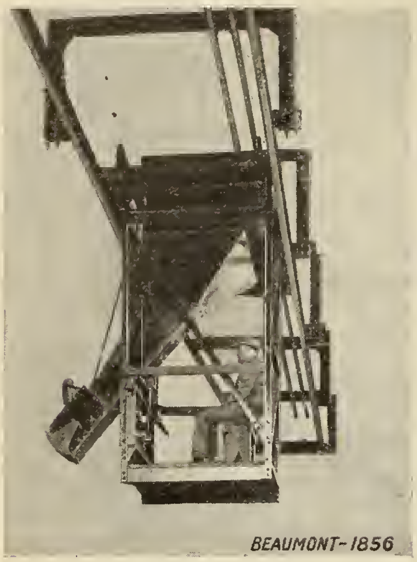
Belts for conveyors may be canvas or rubber. The belt should be flexible enough to conform to the trough by its own weight to get the guiding action of the central part of idler.

Belt conveyors are commonly driven at the head or discharge end; however,

500,000 ton storage plant

under some conditions they may have to be driven at the tail end, or intermediate point. Belt conveyors work best when the angle of inclination is less than 20°.

Another widely used type of continuous conveyor is the pivoted-bucket carrier. On horizontal or inclined runs, the rollers on the bucket-chain move along on standard T rails; on vertical runs they are confined to their path by double T rails for each chain. The buckets, usually of heavy steel although sometimes of cast iron, are pivoted and swing freely on rods, their weight with that of the material serving to keep them always in an upright or load carrying position. The material is discharged from the buckets by an automatic tripping device which may be fixed or movable.

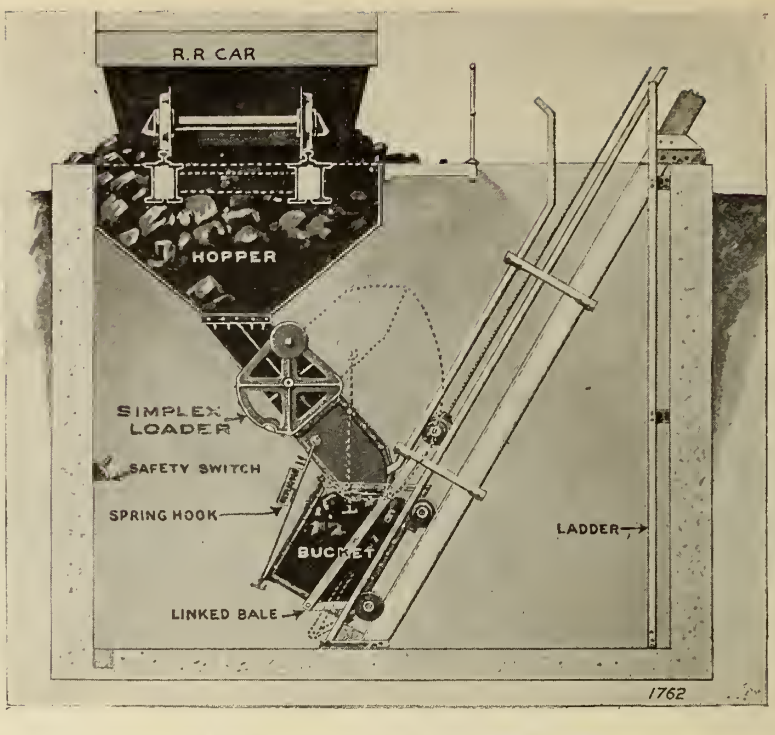


Coal Weighing Larry.

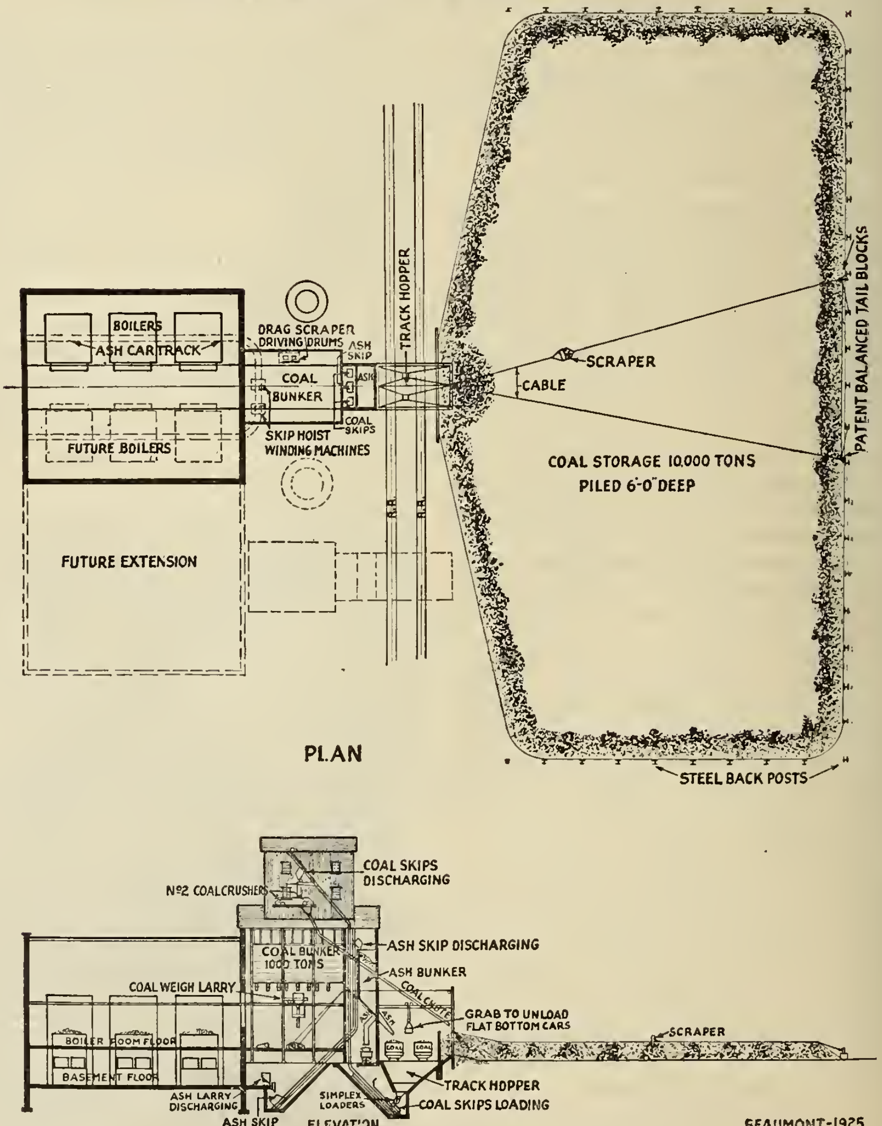
The speed of the buckets is slow, from 40 to 50 feet per minute. This type of conveyor is built in capacities of 15 to 300 tons per hour, the commonest type having a capacity of 40 to 100 tons per hour.

A small single-phase motor will continue to run in the direction in which it is started. If a split-phase winding is supplied for starting the connections of either the starting winding or the main field winding may be interchanged to reverse the direction of rotation.

Mechanical efficiency is a term intended to express the ratio of indicated horsepower to that available for doing work. Brake horsepower divided by indicated horsepower gives the mechanical efficiency. For small single-cylinder engines the mechanical efficiency may be as high as 4 per cent., or the friction 6 per cent. of the indicated power. For large compound engines the mechanical efficiency is sometimes as low as 80 per cent., or the friction 20 per cent. of the indicated power.



Coal Hopper and Automatic Skip-hoist Loader.



Typical Layout for Electric Lighting Plant.

Pulverized Fuel in Action in a Sugar Refinery

Officials of British Columbia Plant Desire Longer "Try Out" Before Giving an Opinion on the Economy in Operation and Maintenance of This Type of Fuel

By Geo. R. Archdeacon, A.M.I.E.E.

DISTINGUISHED as the largest sugar refinery in Western Canada, the B. C. Sugar Refining Co. also possesses a power plant unique in its application to the problems of combustion in so far at least as the Dominion is concerned.

Here the quest for cheap fuel has been persistent, for the plant has in turn burned coal, with hand firing and mechanical stokers, then oil fuel, and now a brave experiment is being made with pulverized coal.

The economy of the last method is of course a debatable matter, as engineers are by no means unanimous either in their praise or in their condemnation of the results obtained.

Await Longer "Try Out"

E. T. Rogers, the vice-president of the company, is quite non-committal on this point, and preferred to refrain from giving any opinion until he had had a longer period of "try out." The system has been in service scarcely three years, and as one of the determining factors is the cost of operation and maintenance, Mr. Rogers did not consider it would be quite fair to either side to express an opinion until enough time had elapsed to represent a reasonable amount of wear and tear on the machinery incidental to the preparation of the fuel before it can be burned.

There were two points, however, upon which Mr. Rogers was emphatic:

> That pulverized fuel is uneconomical in a small or medium size plant, and that pulverized fuel is uneconomical in the furnace of a return tube boiler.

Seven Separate Stages

The process of operation of the pulverized fuel system may be divided into separate stages as follows:

Storage of the "raw" coal.

Transporting the "raw" coal to the crusher and drier.

Transporting the partly dried fuel to the 2nd stage grinder.

From the grinder to a considerable height over the boilers.

Distributing to each boiler as required.

Methods of blowing through a nozzle with air mixture.

Ignition.

The fuel employed in this plant is a very low grade, fine slack, possessing a calorific value of about 10,000 B.t.u. This is landed from barges and dumped into a large coal bunker with a capacity of about 1,400 tons.

In the flooring of the bunker are a number of slots about 12 inches square. The coal falls through these slots to a conveyor, consisting of a high grade rubber belt about 24 inches wide and ½ an inch thick. This belt runs over a series of small "idler" pulleys inclined at an angle, so as to hollow out its contour and prevent excessive spillage.

View of boiler room and fuel feed control.

Carry Coal 500 Feet

The coal is conveyed in this manner a distance of about 500 ft., and elevated about 35 ft. It then makes its entrance to the drying building, a solid brick structure about 75 ft. long, 45 ft. wide, and 40 ft. high.

At one end, at an elevation of some 35 ft., is a platform running parallel to the belt conveyor. This permits of close inspection of the coal as it makes its way toward the crusher and drier.

It will be apparent that it is quite possible for metals or other foreign bodies to be mixed with the coal and conveyed with it. In the case of a piece of iron or steel having fallen in the coal during its progress from the mine to the crushing plant, it is important that its further progress should be arrested, as in the event of its finding its way into the crusher it would doubtless result in the destruction of the crusher, or at least in a stoppage of the process of crushing.

An Ingenious Device

To eliminate this contingency a most ingenious device has been provided.

At the end of the run of the conveyor, the belt passes over an end pulley and the contents of the belt are deposited into a bell-mouthed orifice, which leads into the crusher.

This end pulley is 3 ft. in diameter, and its surface is made of brass.

The pulley is hollow, and contains a powerful electro-magnet. There are two collector rings mounted on the spindle of this pulley, and through the brushes on these collector rings, is conveyed a supply of direct current at 110 volts which energizes the electro-magnet.

Should pieces of iron or steel accidentally be carried along the belt the electro-magnet attracts them and prevents them from falling into the crusher.

The coal is then free to pass into the grinder, falling out of the mesh into a rotary drier.

Motor-Driven Drier

This drier is 5 ft. in internal diameter and approximately 50 ft. long. It is supported on 2 sets of steel tires shrunk around its outer surface. The whole is rotated about 25 revolutions per minute, being driven by a 10 h.p. Canadian General Electric induction motor.

In the rotary drier are a number of narrow projections upon which the coal that has been crushed rests, until the position of the ledges is so changed as to dump the coal on to another ledge, when the operation is repeated.

A screw conveyor passes through the inside of the rotary drier, and as the partly dried coal is thrown from one ledge to another portions of it fall into this conveyor.

The middle section of this rotary drier, which occupies about 50% of its total length, passes through a furnace and, as the crushed coal is slowly tossed about inside the drier, the heat rapidly gains access to the coal, which is soon reduced to a dry powder.

The furnace used for this purpose is itself fired with pulverized fuel.

As the dry fuel leaves the drier it passes through an enclosed tunnel to the dry coal elevator, where it is dropped into a bucket elevator and taken from the drying building into an adjacent building, being elevated to a height of 60 ft., and distributed through two gates into 3 enclosed bins of 15 tons capacity each.

There are three pulverizers arranged on a platform about 10 ft. apart. Each can handle 4 tons of fuel per hour.

There are 6 boilers, and the screw conveyor is laid across the whole width of the tops of the boilers. The fuel is deposited into large "chutes," which are connected by a 4-inch pipe to the special mixing chamber, where the pulverized fuel and the air are mixed. From this mixing chamber the fuel is propelled by an air blast through a nozzle, in the form of a "spray" of coal—powder and air.

Ignited by Waste

This "spray" is ignited by the application of a piece of cotton waste soaked in oil.

With pulverized fuel it is necessary to provide a very large combustion chamber, and in this plant one sees the unusual spectacle of a boiler possessing two fire doors, one at the front end and the other at the back. This is necessary on account of the combustion chamber being so large that it is inconvenient to rake out the ashes from one end only.

In this particular installation it was found necessary to raise all the boilers from their former setting. This involved considerable expense and made the cost of the installation excessive.

It is important that this point should be borne in mind, as much structural alterations are unnecessary in the case of a new plant being installed.

In this plant the combustion chamber is 12 ft. x 20 ft. x 14 ft.

In the casing of the air mixing chamber leading to each projector nozzle are a number of slots regulated by a set of sliding doors so that the correct amount of air may be admitted to the fuel.

The fuel used in this plant shows an ash content of 27% to 30%. It must be understood that only the very lowest grade of coal is used.

The ash is raked out of the combustion chamber and drops into a tunnel at the side and front of the boiler. This tunnel runs down to the sea and a constant stream of salt water flushes it, freeing it of the ashes from the boilers. This salt water is the overflow from processes in the factory, and need not be considered an additional cost in the operation of the plant.

One of the most remarkable appliances indicative of the minute detail work entailed in the designing of the plant, is the cinder elimination process.

There is an induced draught fan in a sort of "by pass" near the top end of the main flue. This fan is 12 ft. in diameter, and it draws up all cinders, dust, and solid matter.

To prevent the accumulation of fine dust on the tubes of their boilers a complete system of Diamond Soot Blowers has been installed on each boiler.

The boiler plant is as follows:

2 B. & W. boilers, 250 h.p. each.

2 Sterling boilers, 500 h.p. each.

2 Badenheusen boilers, 500 h.p. each.

Pump room—

2 Weir feed water pumps.

De Laval centrifugal pump direct connected with a 50 h.p. Westinghouse Induction Motor.

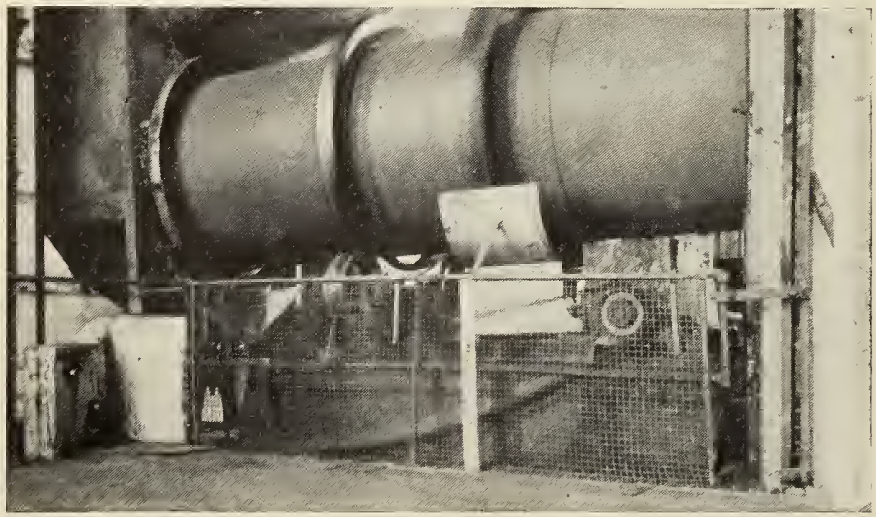
1 Northey ram pump.

This plant consumes over 100 tons of coal per day, therefore its daily consumption has assumed such proportions that a considerable capital expenditure may be warranted, if it results in a reasonable reduction in the cost of the daily fuel bill.

Price of Coal Unknown

Mr. Rogers, unfortunately, did not care to disclose the price he is at present paying for the low grade coal used, and as this is the crux of the whole matter when considered from the point of economy, the writer is entirely in the dark as to just how far the installation has justified itself.

Doubtless the reduction in the actual purchase price of the low grade coal is of substantial proportions.



Rotary Drier.

PIPE LINES

Grunting of an engine is frequently caused by the vibration of the piston rings when they have a trifle too much play between the bullrings. The trouble can partly, if not wholly, be remedied by putting in a set of stiffer piston-ring springs.

Education is the feed water heater of your personal energy—utilizing waste time.

Burnt oil may be cleaned from the cylinder head of an engine by using strong lye-water, and after it is cleaned paraffin rubbed over the surface will keep it bright.

Get the habit of writing down your questions and answers problems. We'll help you answer them.

If an engine is pounding, in searching for the cause of the trouble do not attempt to remedy it too soon. If it is apparent that keying-up is required, do not key too tightly and try to do it all at once, as the crankpin or crankshaft may be flat on one side and there is danger of getting a hot bearing or brasses.

There is always something wrong with a man, as there is with a motor, when he knocks continually.

Follower bolts lose their strength by crystallization, caused by alternate cooling and heating, and are likely to cause fracture when comparatively small strains are brought to bear. To be on the safe side careful engineers make a practice of renewing these bolts at certain intervals.

Luck in fishing is like luck in getting orders—ten per cent. in knowing where to go, ninety per cent. in going there.

Before starting a rotary converter open the field-breakup switch; if this is closed during starting, a dangerous voltage will be developed.

The engineer without a purpose is like a ship without a rudder—a waif, a nothing, a no man.

After a commutator has been turned up in a lathe, it should be carefully inspected to see that the tool has not drawn the copper from one segment to the next across the mica, thus causing a short circuit.

A reliable grease may be made from good cylinder oil and tallow or tallow soap mixed to suit.

Projected area of a bearing is equal to the diameter of the shaft multiplied by the length of the bearing.

Engine cylinders should be inspected at regular intervals so as to ascertain whether the piston has lost its proper alignment by wear or other causes, to determine if the cylinder has been cut, if the follower bolts are secure and free from fracture or if shoulders have been formed on the ends of the cylinder from improper lining of the connecting rod.

Economical Drive of Power Station Auxiliaries

Expenditures Justified in Central Supply Plants Feeding Important Industrial Areas Extravagant in Case of Stand-by Stations Used Only at Infrequent Intervals

By L. BREACH, I.E.E., and H. MIDGLEY, B.Sc.

THE general question of the drive of power station auxiliaries is one which to-day is receiving an increasing amount of attention from up-to-date enigneers.

In the case of the pioneer plants, consisting of boilers with natural draught and hand stoking, supplying steam to simple condensing reciprocating engines, with condenser pumps coupled mechanically to the main engines, practically the only auxiliaries requiring a separate drive were the feed pumps, which were usually of the steam-driven reciprocating type.

At the present time, however, auxiliaries of power plants require a large amount of thought and attention from the designing engineer, and it is therefore proposed to consider a few of the points to be watched when arrangements for a new power station are being made.

When preparing a scheme for the auxiliaries, one of the first questions which arises is as to the purpose of the station, that is, whether it is for constant running on a high load factor, whether it is for an ordinary commercial load, or whether it may only have to run a few hours in the year, as in the case of a station which acts as a stand-by to a hydro-electric supply.

Find Decisive Factor

In other words it is essential to know whether continuity of supply or simplicity of design is the more important factor, for it is obvious that an expenditure on auxiliaries which would be justified in the case of a central supply station, feeding an important industrial area, would be extravagant in the case of a stand-by station to be used only at infrequent intervals.

It should therefore be noted that only a modern station equipped with large turbo-alternators and mechanical stokers is dealt with in this article, and attention has been confined to the supply of power for the auxiliaries, no attempt having been made to include in the discussion evaporators, ejectors and similar equipment.

It is, of course, obvious that it is very difficult to lay down any general rules as to which is the best system of auxiliary supply, for there are many cases where alternative schemes are technically equal, and the choice may quite well be based on the likes and dislikes of the engineer who will be responsible for the satisfactory operation of the station.

3 Aspects of Problem

It is proposed, therefore, to deal with three main aspects of the problem and to outline the most important features of these aspects, which are as follows:

The consideration of the different types of auxiliaries which may be used in a station, and their individual requirements and relative importance.

The consideration of the different types of supplies available for the auxiliaries.

The consideration of the suitability of different combinations of auxiliaries and supplies under different conditions of station working.

For the purpose of considering alternative systems of drive, the auxiliaries in a power station may be grouped according to the length of time during which they may be shut down without causing serious inconvenience and even damage, and this time depends upon:

The importance of keeping the station on load without intermission and,

The importance of keeping the individual turbo-alternators on load without intermission.

Avoid Vacuum Loss

It may be taken as an axiom that in a large power station with turbo-alternators each of not less than 10,000 kw. capacity, loss of vacuum must at all costs be avoided, not only because of the fact that the output falls by about 60 per cent. when the turbine exhausts to atmosphere, but more important still, because the rise of temperature of the blades at the low-pressure end, consequent upon the heat from the windage losses, may cause serious distortion and damage.

We may therefore divide the auxiliaries into four types:

(a) Those which must not on any account stop. This includes the main circulating water supply, the air extraction, and station lighting.

(b) Those which must not stop for more than, say, 60 seconds. This includes the boiler feed pump, and the power for the control circuits.

(c) Those which may stop for five minutes, but not longer. This includes water extraction, individual stokers, individual forced-draught and induced-draught fans, and ventilating fans.

(d) Those which may stop for a period of 12 hours without shutting down the station. This includes coal and ash conveyors, coal crushers, pumps for water-softening plants, and economizer-scraper motors.

Gravity Flow of Water

Type (a).—Unless the flow of circulating water through the condenser tubes is due, in whole or in part, to gravity, it is evident that a stoppage of the circulating water pump will mean a stoppage of the flow of circulating water. As the full-load input of steam would boil the water contained in the tubes in about 50 seconds, a stoppage of the circulating pump consequently means an immediate loss of vacuum.

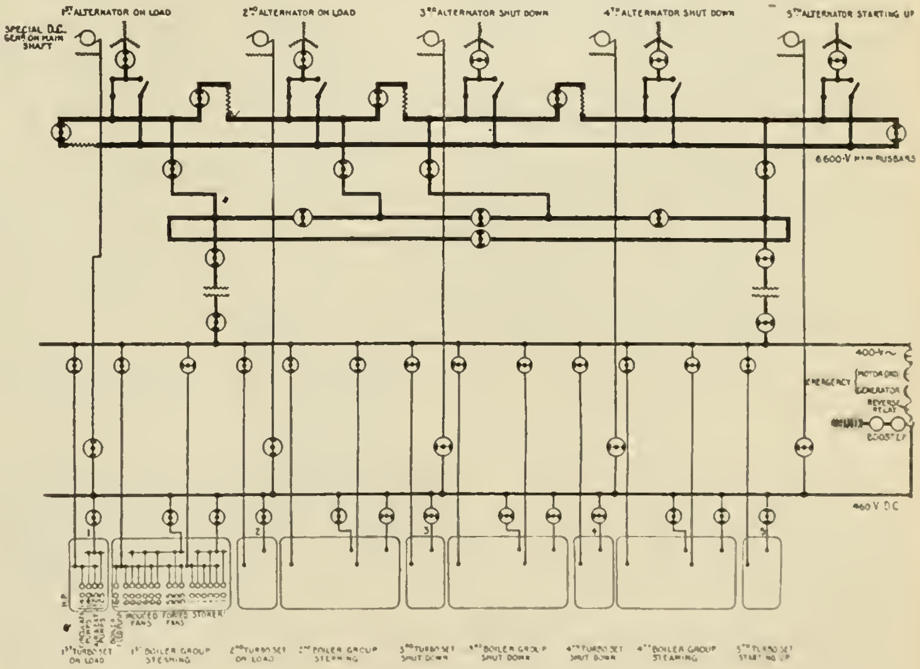


Figure One.

That a loss of vacuum will at once follow a stoppage of the air extraction is a self-evident fact.

The only way to ensure continuity of supply for these duties is to have pumps in duplicate, each of sufficient size to carry the load without too great a loss of vacuum, and drive each pump of the pair from a totally different supply.

It is, of course, possible that both supplies might fail at the same time, but, if the sources of supply are kept absolutely independent, the chances of this are so slight that for all practical purposes such duplication may be considered to give continuity of supply.

For example, one pump steam-driven and the other driven by a motor supplied from the main busbars would satisfy the requirements, but one pump driven by an a.c. motor fed from the main busbars through a transformer, and the other pump driven by a d.c. motor obtaining its supply from a rotary converter supplied through a transformer also from the same section of the main busbars, would not be a good example of duplication, as a fault on that section of the main busbars might shut down both the a.c. and d.c. supplies.

Type (b).—The classification of the boiler feed-pump under this section is consequent upon the high rates of evaporation now obtained in water-tube boilers, in which the water-level will fall to a dangerous degree if the feed supply fails for more than about a minute when the boilers are on full load.

Must Guard Supply

This group of auxiliaries must be so arranged that in the event of a failure of supply, another is immediately available. For the boiler feed-pumps one of the most suitable schemes is to have one motor-driven rotary pump and one steam-driven rotary pump for each group of boilers, either pump alone being capable of feeding the group, the pump which is not on load being always kept ready for immediate use.

Type (c).—For the auxiliaries of this class an alternative supply must be readily available, but it need not be immediately available, a suitable arrangement being to have this type of auxiliaries so arranged that they may all be fed from either of two alternative supplies, the change-over being effected when required, by means of selector switches, the motors being first shut down and then started up again on the new supply.

Avoid Lengthy Shut-downs

Type (d).—In this case the usual practice is to carry spares for such parts are as likely to cause trouble, e. g., motor armatures. These can be installed without entailing a shut-down of more than a few hours, during which time the auxiliary can be dispensed with. It will be obvious that in the case of coal-conveyor motors, for instance, it should be possible to rely on the supply in the service bunkers for such time as is required to replace the armature of the motor.

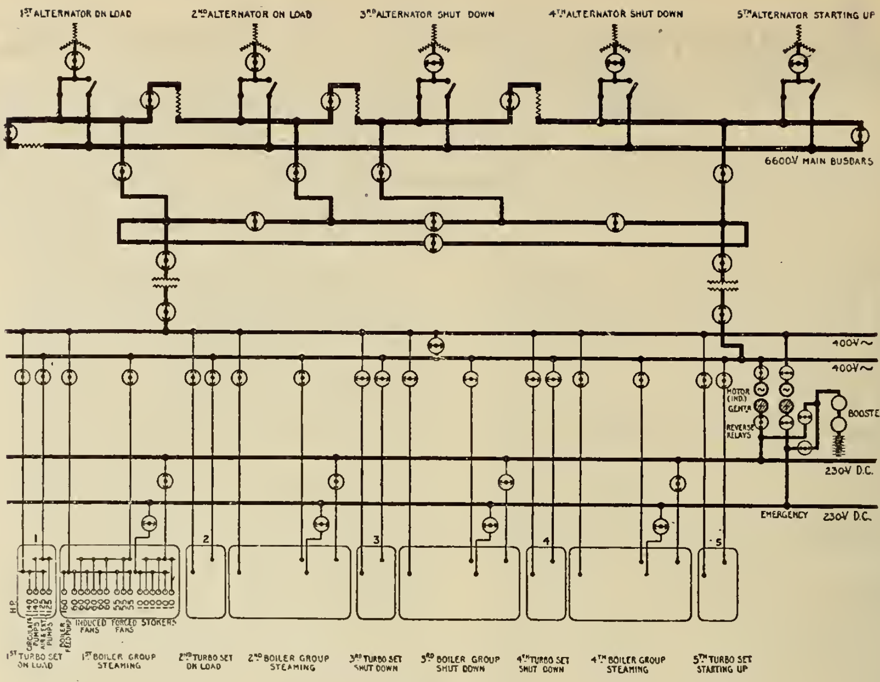


Figure Two.

There are many types of auxiliary supply, the following being the more important:

(A) Direct steam drive.

(B) Electric, from main alternators via high-tension busbars.

(C) Electric, from main alternators direct.

(D) Electric, from main alternators via special windings on main transformers.

(E) Electric, from special steam-driven a.c. or d.c. generator (house set).

(F) Electric, from special a.c. or d.c. generator on shaft of main turbo-alternator.

In the author's opinion, the question of cost should be considered only when absolute reliability has been assured, and if there is any difference in reliability between the alternatives the costs should not affect the decision.

Fear False Economy

After all, the cost of the auxiliary plant is only about 5 per cent. of the total cost of a new station, and it would appear to be false economy to jeopardize continuity of supply through any saving which might be made in the first cost of such plant.

A few of the more important features alternative supplies may with advantage be noted.

A. Direct steam drive.—This may be by either turbine or engine. On the whole, direct steam drive requires more attention than electric drive, but it has the advantage of being absolutely independent of any disturbances on the electrical system. For any except very small sizes the engine type need not be considered, but the turbine either direct-coupled or geared fills a very useful place.

Of course, at times of heavy load, if the main steam pressure falls, the power and speed of direct steam-driven auxiliaries will fall just when they may be most needed; this is especially the case where an auxiliary turbine driving a main circulating pump exhausts into one of the main turbines near the low-pressure end, for under the heavy-load condition the back pressure in the main set rises, with a consequent increase of steam consumption and fall of speed of the auxiliary turbine.

Keep Joints Tight

A considerable amount of attention is required to keep tight the many steam-pipe joints entailed with direct steam auxiliaries, and the overall thermal efficiency of the station is reduced by the heat losses due to increased radiation surfaces, etc. Further (and now that the importance of really pure de-aerated feed water is being more and more realized, this is a matter of considerable weight), the use of direct steam drive increases the make-up to almost double, the experience of one Canadian supply company being that the adoption of electrically driven auxiliaries reduced the make-up of the total boiler feed in circulation from 6 per cent. to 3 per cent.

The one auxiliary for which direct steam drive is especially suitable is the boiler feed-pump, the exhaust steam being utilized to heat the feed water, this being particularly convenient when, for any reason, the main feed-heating arrangements are out of action.

B. Electric drive from main alternator via H. T. busbars.—This auxiliary supply, if alternating current, may be at the busbar voltage or reduced by means of transformers, whilst in the case of direct current the voltage may be whatever is found convenient. Now that the building of a. c. motors of more than 50 h.p. at voltages higher than 400/500 is a matter of little difficulty, the use of the main generation voltage, or at any rate a voltage of the order of 3,000, merits careful consideration.

See Little Advantage

Assuming the main generation voltage to be 6,600, this would be too high for any motors except those for the main circulating-pumps. A pressure of 3,000 volts would be suitable for the main circulating-pump motors, the air-pump and extraction-pump motors (where these latter pumps are both driven by the same motor), and the boiler feed-pump motor, but there appears to be little advantage in stepping down to this pressure. In view of the extra cost of the insulation for 3,000 volts above the more usual voltage of 400, once it has been decided to step down for the auxiliaries it seems just as suitable to step right down to 400 volts for all motors rather than introduce another voltage intermediate between that and the main generation voltage.

Alternating current versus direct current for auxiliary motors.—This is a very much discussed question, and a few remarks on the factors affecting the choice may be of interest.

Direct-current motors require frequent attention to the commutating gear to avoid sparking, and although they are often seen running without any apparent trouble in an atmosphere full of grit and dust, nevertheless the d. c. motor requires more attention than the a. c. motor.

D. C. Motor Advantages

Direct-current motors can be economically subjected to speed regulation over a wide range and, perhaps most important of all, they can be run off a battery in times of breakdown or other emergency.

The greatest disadvantage of a.c. motors lies in the fact that speed regulation is not an economical proposition. Of course the speed of a slip-ring motor can be varied over a small range by varying the resistance in the rotor circuit, but this is a very wasteful method, and the system of having a controller to alter the connections of the stator windings and so alter the number of poles, is only suitable for three or four speeds at the most. Variable-speed motors working on the "cascade" principle might be used, but these give only a limited number of speeds, which are fixed by the number of poles. As final regulation must therefore be obtained by the use of valves or dampers, there is no advantage in the installation of this type of motor as compared with the ordinary asynchronous type.

On the other hand, in the case of pumps and fans, which form a very large proportion of power station auxiliaries, the output can be reduced by throttling, i.e., by control with valves or dampers.

Need Less Attention

Alternating-current motors, of course, require much less attention than direct-current motors, especially, if, in the case of slip-ring motors, brush-lifting gear is fitted. They can run for very long periods without attention, and without having to be stopped for examination.

C. Electric supply taken direct from machine terminals.—This scheme was at one time very popular with one well-known firm of consulting engineers, the main advantage being that in the event of one of the main generator switches being opened the auxiliary supply is not cut off.

D. Electric supply from main alternator via special windings on main transformers.—This arrangement is only suitable for a station in which the step-up transformers are directly coupled to their respective turbo-alternators, and the switching is carried out on the high-voltage side.

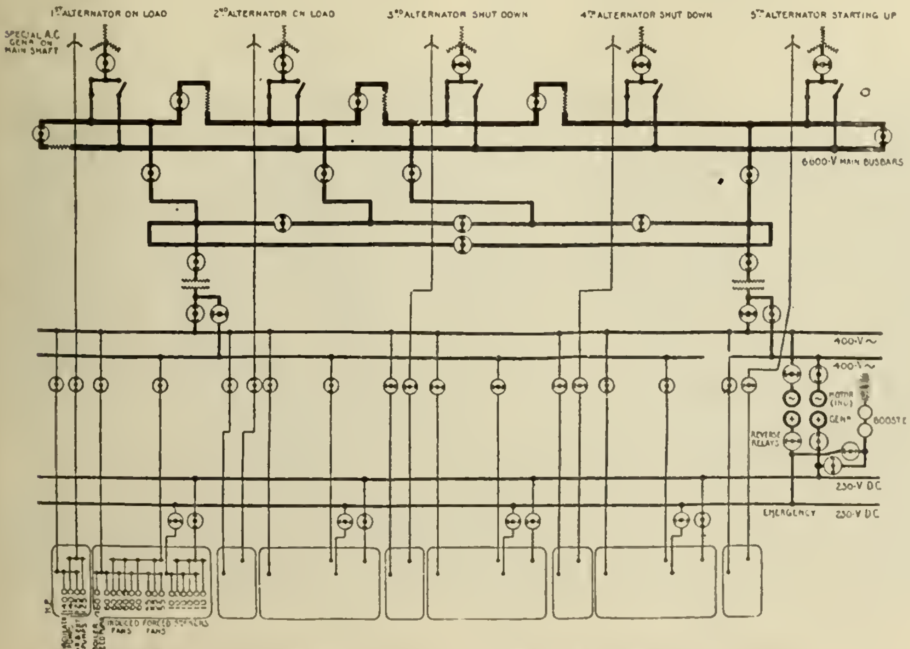


FIG. 3.

E. Electric supply from special house set.—This is undoubtedly the most popular system of auxiliary electric supply in Britain but there is considerable diversity in the disposal of the exhaust steam from the house turbine.

This steam may be taken:

(a) To atmosphere.

(b) To a stage of the main turbine near the exhaust end.

(c) Direct to the condenser of the main turbine.

(d) To a feed heater.

(e) To its own condenser.

Wasteful of Water

(a) Direct exhaust to atmosphere is uneconomical and very wasteful of water, but it is simple. For emergency use it is worthy of consideration.

(b) The disadvantages of exhausting to a stage of the main turbine near the low-pressure end have already been mentioned.

(c) Exhausting to the main condenser suffers from the same disadvantages as exhausting to a stage near the low-pressure end of the main turbine.

(d) Exhausting to a feed heater is a system which has been installed in several Canadian and American power stations. As the purpose of a house-turbine is not to feed heat, but to generate power for the auxiliaries, and as the use of steam bled from the main turbine for feed heating has been found to be both economical and satisfactory in working, it would appear advantageous to dissociate the house set from the duty of feed heating.

(e) A house set exhausting to its own condenser gives an arrangement which is efficient and self-contained but somewhat complicated and, whilst it has many advantages, it entails an increase in the amount of running machinery in the station, a feature to be avoided as far as possible. This scheme may also entail an increase in the operating force.

Whether the house turbine is installed for the auxiliaries of each main set or whether one house set is installed for the whole station, is largely a matter of opinion. In the case of a station in which for long periods only one main turbo-alternator is on load, one house set per main turbine would possibly be more economical in steam consumption, but on the other hand the capital cost of this proposition is much greater than that of the other, and the authors are of the opinion that, where house sets are adopted, it is better to have two per station, one on local and the other for stand-by purposes.

Wins Operator's Favor

F. Special generator on the main alternator shaft.—This is a comparatively recent proposal and appears to have much to commend it from the operating point of view, as the supply from it is totally independent of any faults on the main supply and the only possible source of trouble is internal.

Whether it should be a.c. or d.c. is open to discussion. If d.c. it would be

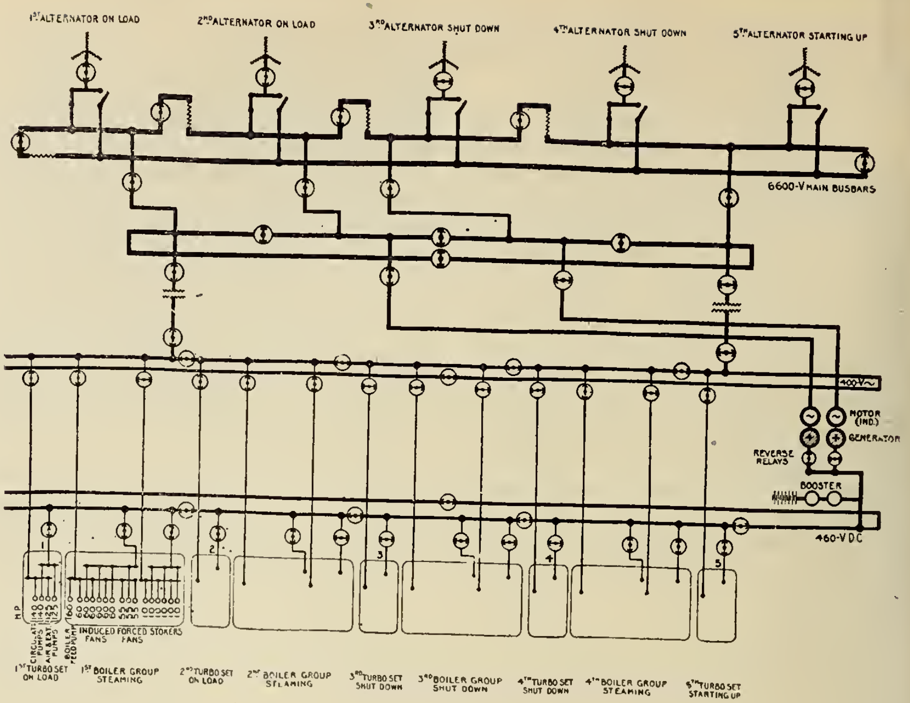


FIG. 4.

run in parallel with the other d. c. plant and the battery which is available for emergencies, and of course a certain number of d.c. auxiliary motors with the advantages previously mentioned are required; if a.c. it could no longer be used directly in parallel, but a simpler machine results, and it is a question for the manufacturers as to whether a d.c. generator, of say 300 kw. and 3,000 r.p.m. in the case of a 16,000 kw. turbo-alternator, and of 450 kw. at 1,500 r.p.m. in the case of a 25,000 kw. turbo-alternator, could be satisfactorily constructed. The excitation of an a.c. generator is a matter of consideration. It might be excited in parallel with the main alternator, but, in view of the facts that main field rheostats are now practically obsolete, and that voltage regulation is carried out by adjustment of the exciter field, it will be necessary either to have a special field rheostat for this alternator or allow its voltages to vary with the alterations in the exciter field, due to the action of the automatic voltage regulator which is governed by the main busbar voltage.

May Utilize Battery

As an alternative, the excitation current of the special alternator may be drawn from the battery. This is perhaps the best way.

Conditions of station.—In addition to the internal arrangements, the conditions of the station must be taken into account when the auxiliaries are being decided.

Stations may be divided into the following classes:

(1) Isolated, supplying an area or an individual works.

(2) One of several supplying an area, but not permanently linked up.

(3) One of several stations supplying an area, and permanently linked up.

(4) A station used as a stand-by (usually to a hydro-electric supply).

In the case of a station of Type (1) or (2), the arrangement of auxiliaries depends upon the importance of continuity of supply. For instance, where the station supplies a works with a large number of interlinking processes, continuity of supply is of primary importance, and in such a case it is essential to see that this continuity is not prejudiced through false economy in the layout of the auxiliary arrangements.

Devise 4 Schemes

The various auxiliary supplies discussed can best be compared by the examination of definite schemes for a station supply, these schemes containing alternative combinations of the different supplies. With this object a few arrangements, drawn out with a view of showing possible rather than recommended proposals, have been prepared by the authors.

The alternative schemes are designed for a station containing five 25,000 kw. turbo-alternators, of which four would be required for maximum load. Steam would be obtained from four boiler houses, one boiler house supplying full-load steam for one turbine. Each boiler house would contain six boilers, five of which would be required for the maximum output of one turbine. This allows one boiler per group always to be laid aside for cleaning.

Each turbine has two separate circulating pumps, each with its own motor, and two air and two extraction pumps, there being two motors for these, each motor driving one air and one extraction pump. An alternative is to drive each air and extraction pump by its own motor, but if each of these pumps is to be in duplicate this necessitates four motors instead of two and, providing the speed of the pumps is suitable, the arrangement put forward appears to be less expensive and equally reliable.

Treated as Units

It will be seen that, generally speaking, each set of turbo auxiliaries is independent of the others, so that it can be trusted as a unit; similarly, the group of boilers required for one turbine forms a unit which is independent of the others, although in emergency any boiler group can be used to supply steam to any turbine.

The use of two circulating, two air and two extraction pumps is, from consideration of design, practically essential for 25,000 kw. sets, but for smaller sizes of turbo-alternators the case is different, and one very usual scheme is to have two circulating pumps for the condensers or two turbines, each pump capable of supplying circulating water for one condenser, but running in parallel on the water side, so that in the event of failure of one pump it is certain that each condenser will have a supply of cooling water adequate to maintain a considerable percentage of the normal vacuum until such time as the trouble can be rectified or one of the turbines shut down. The two pump motors are fed from independent sources, and valves are installed for the isolation, when necessary, of either pump, all these valves being open under normal conditions.

One Drawback Seen

The main drawback to this proposal is that to obtain a duplicate auxiliary supply it is essential either to run the turbines always in pairs, or for one turbine to run pumps of twice the necessary output.

At this stage it may be of interest to consider a scheme adopted in some Canadian and American stations of having the boiler house auxiliaries direct steam-driven, and installing a special d.c. generator for the condenser auxiliaries. This generator is driven at one end by a turbine exhausting to a feed heater, and at the other by an a.c. motor fed from the main busbars. Undoubtedly this gives for the turbine auxiliaries a drive which is unaffected by faults on the main busbars, but, in view of the possibility of failure of the generator, it does not assure absolute duplication of auxiliary supply. It is understood that such an arrangement is installed also for the purpose of regulating the feed temperature. Where it is adopted, care must be taken so that in the event of a fall in frequency of the main supply there is no danger of the motor on the generator shaft acting as a generator and overloading the driving turbine at the other end to such an extent that it is endeavoring to carry the whole station load.

Basis of Motor Power

The powers given for the various auxiliary motors are based on the assumption that the station is a riverside station, with a syphonic circulating system. If it were a cooling-tower station, the circulating-pump powers would be approximately doubled, but the air-pump

(Turn to page 43)

Alberta Heating Engineers Hold Convention

Representatives From All Parts of Province Discuss Modern Installations and Methods of Raising Standards at Enthusiastic Gathering—Hot Water Forced Circulation

ONE of the most successful and enthusiastic conventions which the West has seen for some time was the annual gathering of the Alberta Association of Heating Engineers at Medicine Hat. That the province has a real quota of live and well-informed engineers in this field was strikingly shown not only by the attendance but by the quality of the discussion and the type of address given.

It was apparent that the aim of the whole organization was to keep in touch with modern development in heating equipment and installation, and to give to the public a service incapable of being excelled elsewhere.

Due to the unavoidable absence of the president, R. J. Priestly, the sessions of the conference were presided over by Vice-President C. R. Frost. The first official act of the convention was the receipt of the freedom of the city from Mayor Huckvale. In a short address, the Mayor spoke of his delight in welcoming so many men whose profession was the raising of the standard of health and comfort in the homes of the citizens.

During the course of the convention interesting and instructive addresses were delivered by G. R. Taylor, R.P.E., Superintendent of Utilities at Medicine Hat; S. E. Whiteside, Sanitary Inspector of Medicine Hat, and by L. A. Willison.

Officers

The results of the elections of the officers for the Association for the next year were:

President—C. R. Frost (accl.)
Vice-President—G. W. Henderson.
Sec.-Treas.—W. H. Kelcher (accl.)

Executive Officers

H. J. Ferris, Edmonton.
J. H. Hillier, Calgary.

Chairmen of Committees

Sanitary—D. Campbell.
Heating—R. J. Priestly.
Legislative—W. H. Kelcher.
Apprenticeship—Jas. Carver, J. H. Hay.
Essay—H. Ferris.

In an address before the convention, W. B. Trotter, A. M. I. C. E., discussing Hot Water Heating by Forced Circulation, said:

There are several advantages claimed for the forced hot water system of heating, the first is, that the temperature of the heating surfaces in the building or buildings is at all times under the direct control of the operator and can be varied over a wide range at short notice so that weather conditions can be accurately provided for.

Advantages

If for instance, a chinook springs up all that is necessary is to stop the pump in addition to shutting down the source of the heat, and no excess of heat will be thrown into the building to be dissipated by means of open windows or otherwise. Secondly, a wider range of radiator temperatures is possible than with steam systems; also that no specialties are required, no thermostat, traps, modulation or temperature control apparatus, etc., so that the upkeep is low.

Owing to the small sized piping required, the cost of the pipe work is moderate, while as fairly high temperature can be carried in the radiators if required; on excessively cold days radiation need not be figured for more than average cold conditions.

Types of Systems

While the system may be divided into two parts, the trunk distributing mains and the buildings, there are two distinct systems that can be utilized in both cases: the circuit system and the two pipe system; either system may be open or closed. If the buildings are heated from a central plant and are strung out in a line the two pipe system would be indicated, but if they were placed so that a loop could conveniently handle them all, then the circuit system would be the most economical. In a two pipe system the mains are reduced as the connections are taken off, while in the circuit system, one pipe only is used, and both supply and return connection are taken off this pipe which is full size throughout. The supply on a loop system is usually run from the top and the return into the side of the same pipe. Installation costs are less with the circuit system, also frictional losses are lower.

Application

In the individual buildings a circuit system will often be found the most economical to lay out; in this case the risers and ground floor radiators are usually taken off the mains separately, in all cases long sweep bends are used.

Two pipe work can be laid out according to usual gravity practice, but with pipe sizes as given later, and if possible, a two pipe job should be on the balanced principle, so as to give approximately the same drop in pressure between any parts of the system so that no further

Heating Engineers in Convention at Medicine Hat.

balancing will be necessary. An overhead system with one pipe drop risers makes a very economical lay out.

It must be remembered that an additional advantage of forced hot water is that grades are of no importance, but of course a job graded, as is usual in gravity practice, will run longer with the pump stopped than a job in which there are numerous rises and dips.

Control

As the temperature of the radiators is usually controlled to suit weather conditions as previously mentioned it is not thought necessary to control each individual radiator with a hand valve, but they are often connected in batteries of three with one valve to the battery, making a saving in the cost of riser connections. The connecting piping between individual radiators should be the full size of the tapping, 2 inch. If individual radiators should need control on a loop this can be done as indicated. In two pipe work, if a number of radiators are likely to be shut off at any one time, and so increase the back pressure on the pump, a shunt is provided for. In a circuit or a two pipe system, radiators can be connected below the mains if required and will circulate perfectly. If a large circuit is taken off a one pipe main circuit, a shunt should be provided to balance the pressure.

Pipe Sizes

To obtain pipe sizes it is necessary to know the amount of water that will be pumped, and this will vary. Usually from 6 to 10 lbs. per sq. foot of radiation per hour is sufficient as an average, say one U. S. gallon per sq. foot per hour. As pump capacities are cataloged in U. S. gallons, this is a convenient figure. Where valves are provided on all branches and are carefully regulated the lower figure would be safe while other jobs may run as high as 14 lbs. Of course the temperature drop will be greater; for instance: Assume efficiency of radiator 180 B. T. U. per sq. foot per hour, dividing by 8-1/3 lbs. of water per sq. foot per hour will give a temperature drop of 21.5 degrees which is reasonable.

Velocity

In trunk mains assume 8 to 10 feet per second; circuit mains can be loaded up to 12 feet per second if necessary, smaller pipes in the building say 5 feet per second.

The following is safe:

4 in. pipe, 300 feet per minute.
5 in. pipe, 350 feet per minute.
6 in. pipe, 400 feet per minute.
8 in. pipe, 500 feet per minute.
1½ in. pipe will carry 2,000 ft.
2 in. pipe will carry 4,500 ft.
2½ in. pipe will carry 6,000 ft.

Then, the quantity being known, Area of Pipe (sq. ft.) equals:

$$\frac{\text{Wt. of water in lbs. per hour.}}{\text{V. F. P. M.} \times 60 \times 60.3 \text{ (density at 180°)}}$$

In a distributing system the branches to the different buildings from the trunk mains can be smaller than the mains in the building, but mains in building itself will be usual size.

After laying out the system the pipe sizes can be fixed tentatively from the following tables and then can be checked for frictional resistance. If the frictional resistance is too high larger pipes are indicated.

> **A steam leak is in reality the same as a hole in the power plant pocket book. Were the holes in our pants pocket we would promptly have them repaired before too much money was lost. Unfortunately it is often not so with leaks in steam pipes. It is hard to realize that a little wisp of steam or dripping water may be an important factor in loss, a factor which can be directly measured in pounds of fuel. Such wastes are far more tangible and more easily corrected than are certain of the more obtuse operating methods that a few engineers seem prone to consider of importance.**

Sizes	One Pipe	Two Pipe
½	0	45
¾	25	100
1	100	225
1¼	350	450
1½	500	660
2	1000	1300
2½	4000	2500
3	6000	3850
4	12000	8400
5	20000	15000
6	30000	23000
8	45000	30000

Friction

Friction: when the quantity of water and size of pipe are known, friction loss per 100 feet pipe is:

$$\frac{0.33 \times \text{V. } 1.86 \text{ (in ft. per sec.)}}{10 \times \text{D } 1.25 \text{ (in feet)}}$$

Valves on mains should be O. S. & Y. so that the control is indicated at a glance. Radiator valves can be any good valve with a good packing nut.

Branches should be valved perfectly, with lock and shield type gate valve where likely to be tampered with.

The end of mains should be vented the expansion tank where possible; this saves time filling the system.

Heater

Figure size of heater from gallons pumped as before, and estimate a temperature drop on a large central station of 30 degrees, but 20 degrees is ample for ordinary conditions.

Means; (1) direct heat of boiler. If this is used boiler should be cast iron type. (2) Waste heat from boiler, viz., economiser, but this apparatus is expensive in up-keep. (3) Exhaust or linesteam heaters; frequently one of each; two means of heating should always be provided. One pound exhaust steam should heat 28 lbs. water, 180 feed radiation per boiler horse power. Heater should be vertical or horizontal, 2 or 4 pass type.

Control Apparatus

Air controlled thermostat dial type, or expanding liquid thermostat, should be used.

Gauges.—On supply and return.

Thermometers.—On supply and return —30—260. Also thermometer for outside temperature and possibly a wind anemometer, are useful.

Pumps

Figure frictional losses carefully; feet head loss per 100 feet of pipe equals:

$$\frac{0.32 \text{ V } 1.86 \text{ (feet per second as before),}}{10 \text{ D } 1.25 \text{ (in feet)}}$$

but tables are available for frictional losses in all sizes of pipe carrying different capacities.

Type:—Horizontal split case single stage pump, turbine or motor driven. For capacity and head as calculated, average efficiency 70 per cent.

Expansion Tank

Radiation will carry 1½ pints of water per sq. foot. Double this, and to this allow for mains, and add trunk mains to arrive at the amount of water in the system. Capacity of tank should be 2 to 5 per cent. of the total water in the system. Tank can be closed pnuematic type in engine room, or open type in attic of building. The tank should be fitted with an automatic water feeder and a gauge glass.

Temperature

Closed system 240 degrees Fah. is maximum.

Open system 210 degrees Fah. is maximum.

Design of piping should provide for expansion and contraction due to high temperatures used. Hangers should be devised to hold weight of water and pipe. Use long sweep pipe bends at all changes of direction of mains.

Announcements

For the new Ford plant at Ford, Ont., the Combustion Engineering Corporation are making good progress in the installation of a fuel pulverizing plant which will be equipped with three 1,000-horsepower units. Three McAleenan boilers are being installed.

British trade generally keeps improving, despite disputes brewing in the industrial, shipping, and railway world. Iron and steel prices reached a peak in April. The week ending April 14 saw record coal shipments. Production reached 5,776,600 tons. Fifteen vessels aggregating 51,531 tons, were launched by Clyde builders during the month.

Editorial Comment

CAMPBELL BRADSHAW, Editor

Coal Storage Economy

ON EVERY hand it is the consensus of opinion that much can be done to overcome irregular demand by encouraging the storage of fuel, and in the case of coal no one can stress too strongly the great advantage of such action during the spring and summer for winter and fall use.

This recommendation should apply to all consumers of coal—railroads, public utilities, industries, and the home—and on the measure in which it is adopted will largely depend the evenness of distribution and the cost of coal to the public during the season of heavy consumption.

Fuel storage, adopted by the consumer, large and small, would benefit the carrier systems of the Dominion by equalizing their load. It would have the effect of reducing the cost to the consumer for it must not be forgotten that only for short periods since 1918 has the price of coal been closely related to the cost of production. It has been controlled by its availability in the market, which has depended upon and been influenced by various interruptions to the process of distribution.

In connection with distribution for the homes it may be pertinent to ask Sir Henry Thornton, at a time when the taxpayers of Canada are paying around $60,000,000 a year into the Dominion treasury to meet deficits on the C. N. R., what further loss would be incurred if a $6 rate were offered on Alberta coal to Toronto and Montreal in place of the $9 rate demanded "as profitable."

Mr. Thornton is losing sight of the fact that more than $12,000,000 of Ontario money alone is going out of the Dominion annually to the United States to pay for the anthracite the province buys there. Anything which will increase the supply and lower the cost thereof tends toward a reduction in the cost of living generally, and means a greater purchasing power for the wage earner himself.

Going Down Hill

THERE is an impression that because the engineer is the most important piece of "machinery" in a power plant he is the only man who can conserve fuel, and that the only place he can save it is in the place where fuel is used—the boiler room. Indeed, little effort has been made in the past to save fuel anywhere else.

There are, of course, many opportunities for saving fuel by efficient firing and good boiler room methods, but there is as large a field for fuel economy beyond the boiler room—a field that has been allowed to go down hill.

Boiler rooms must meet the demand made upon them, but that demand is created outside of their confines, and engineers who desire to measure up to present day standards must do everything possible to make that demand as reasonable as possible.

A few random recommendations to obtain this result may be summarized as follows:

Many unnecessary lights are kept burning. Get everybody to help the cause by turning them off.

Your belts are not looked after closely enough. You are losing power and money by having belts too tight or too loose.

Your motors are underloaded. Loss in efficiency and power is large if motors run much under load.

Your shafting should be lined up. Friction load in the average plant is very high, and power is wasted at a terrific rate if shafting is out of line.

You have a lot of uncovered high-pressure steam pipes. Your losses are high from this cause.

You have many machines running idle and wasting power. Install belt hooks and slip the belts off on machine shutdown for long periods. If for short periods educate the operators to shift to loose pulley.

Fix your doors and windows in cold weather to prevent undue loss of heat.

Wash your windows. You have an opportunity many days in the year to save at least half an hour of lighting by doing so.

Your fire-room practice should be improved. Keep fires bright, fire frequently, avoid holes, clean regularly, keep ashpit cleaned out, clean tubes oftener, get better damper regulation.

Many other suggestions of the common sense variety could of course be made but it is evident that if engineers work concertedly to attain this end an economy in fuel must, of necessity, result.

Simply Penny Wise

THE use of obsolete methods of generating steam is an example of the old adage, "Penny wise and pound foolish," yet it is practised in many plants in Canada to-day, with the idea of saving money.

Where coal is used as a fuel, it is too often dumped in a pile several hundred feet from the boiler house to be hauled to the firemen on either wheelbarrows or carts. This results in three successive handlings, each necessitating a certain amount of waste as well as requiring the retention of manual labor on the job simply to perform this work.

The installation of a railroad switch to a storage bin or yard, from which the coal could be discharged by means of a hopper or similar device to hand lorries running on a track in front of the boilers for hand firing; or to an automatic distribution system, if stokers are in use, it must be admitted involves considerable initial expense, dependent of course on the size of the plant, but the saving in fuel waste and useless labor will pay for this first cost in two years' time under average conditions.

Deliver the Goods

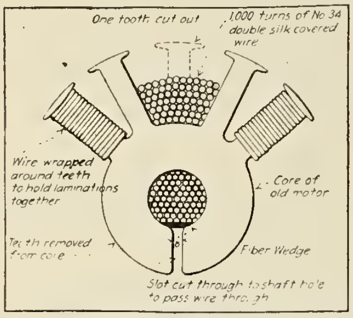
TO INVEST money for "refinements" without a reasonable certainty that greater efficiency and a lower operating expense will result is far from the purpose of the real engineer of to-day. A keen sense of analysis, good judgment and extensive practical experience are vital qualifications if a man is to "deliver the goods," retain the confidence of his employer and cut his operating expense and fixed charges. No change should be made, however slight, unless cash is available to carry it through as planned, and it is beyond doubt that greater economy will result from new equipment or methods.

Practical Ideas From Practical Men

SHORT CIRCUIT TESTS

Any engineer seeking a simple test to locate grounds and short circuits in small stators may find the following outfit, which we made in our shop, valuable for use on 110 volts, 60 cycles:

We moved the shaft from an old d. c. fan motor armature and cut off the teeth as shown in the accompanying sketch. A slot was then cut in one side to allow the wires of the winding to be inserted in the hole formerly occupied by the shaft. A thousand turns of No. 34 double-silk-covered wire were wound on. After the winding was put in, wedges were inserted to hold it in place. Lamp-cord leads were fastened to the growler and taped.


One tooth cut out
1,000 turns of No 34 double silk covered wire
Wire wrapped around teeth to hold laminations together
Core of old motor
Teeth removed from core
Fiber Wedge
Slot cut through to shaft hole to pass wire through

Details of construction of small growler.

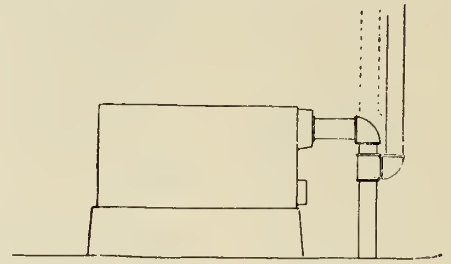
To test for shorts, this small growler is placed on the stator teeth and a tin feeler is used across the slots, one coil pitch in advance of the growler. If the tin vibrates there is a short in that slot. To test for grounds, place the growler on the core and then touch one lead of the stator winding to the iron core. If a spark is produced, the winding is grounded. This test can be made after a stator is rewound and before connecting it up. Try each coil in the starting and running winding. The slot the ground is in can be located by making a good steady contact with one lead of the grounded coil to the stator core; then apply the growler and use the tin feeler to bridge the slots until it vibrates.—A. C. Roe.

BOOSTING TEMPERATURES

In the local electric light plant they had a 1,000 h.p. feed water heater of the open or contact type which took steam from a 12-in. exhaust riser, the connection to the heater having been made from a tee, as outlined in broken lines on the illustration, the surplus steam passing up through the exhaust pipe to atmosphere.

While they had plenty of steam always available, they were unable to get a higher feed temperature than 195 deg. though sometimes under heavy load it fell below this. The engineer in charge had assumed that the apparatus was not large enough and had it in mind to secure a new and larger heater when funds were available.

While visiting the plant one day he called the heater matter to my attention, asking what I thought about it, and I recalled a similar experience I had been up against under almost similar conditions, and recommended that they make a change in the piping so that the exhaust steam would not have the chance to shoot right up the exhaust pipe without being forced into the heater. This was accomplished by the change in piping shown in solid lines from which it will be seen that the flow of steam to the heater has the preference at all times, and this change having been made, at the expense of two elbows, the temperature immediately went up to 212 and stayed there even under the peak load conditions.



J. C. N.

CEMENT WORK PAINT

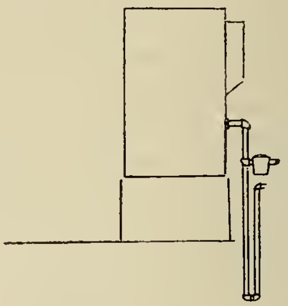
In a new addition which we put to our power plant we had a number of concrete piers and foundation structures which we wanted to paint in some way to keep them from dusting. A considerable area had to be covered and the use of an oil paint would have involved quite an expense, so we took advantage of the suggestion of a neighboring engineer that we use a coating which he had found satisfactory, made up of equal parts of cement and kerosene mixed together thoroughly, and then the addition of four or five parts of coal tar. This gave us a waterproof coating which was admirably adapted for the work we had in mind, at a low cost, and with good results as to durability.

S. T. M.

HEATER LEAKS OIL

In one of my former plants we had a direct contact feed heater which gave excellent service as far as water heating was concerned, but which occasionally got us on the anxious bench because it would allow oil to get through to the boilers. After a number of attempts at hunting down the trouble, we located it in the independent trap which was installed to take care of the overflow and oil drip.

The thick grease which came down from the separator would gradually accumulate in the trap until it clogged things up, causing it to work sluggishly until perhaps another slug of overflow water would come over and clear it out. We decided, therefore, to do away with the uncertainty involved in the operation of the trap, and since we were only carrying about 2½ pounds back pressure, we built a pipe water leg seal, making it about six feet deep. This we put into service and have never had occasion to be worried over oil in the boilers since.

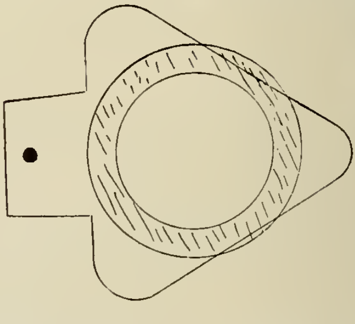


C. B. W.

INSTALLING GASKETS

Probably no job which the average engineer has to do is more detested than that of installing new gaskets, especially in old lines which are already installed, and where replacements usually have to be done after closing hour or in a big rush, with hot pipes, etc.

Where the pipes can be sprung sufficiently to permit easy inserting of the gasket the job is not so difficult, but where little "give" can be had, the job of sliding the gasket up between the flange faces is one that is a good test for patience.



Having had several jobs of that kind to do, and having found that a flat piece of tin helped materially in inserting the gaskets, the writer decided to add a "tool" of this nature to his kit, making it of thin sheet brass, of the form shown in the attached sketch, the purpose being to support and hold the gasket as it is being slid in between the flange faces, and to keep it from catching on the inner edge of the flange and buckling.

H. A. H.

WATER FEEDING METHOD

I wish to hear from some of the readers of your useful journal regarding what is recognized as the best method of feeding water into the water jacketed refuse burner as used at sawmills. I consider it should go in near the top and in descending pass the ascending heated water.

The one I am interested in is practically a vertical, hollow, cylindrical tank constructed of eight tiers of ⅜-in. plate, with a flanged bottom; it is 30 ft. internal dia., 33 ft. external dia. and 64 ft. high, thus forming a parallel water jacket 18 inches wide.

The grates are ranged around the inner circumference, the refuse is dumped through an opening 28 ft. from the bottom and considerable wood is disposed of in this 30 ft. dia. space in a working day.

There are three feed inlets to this tank: the two original ones 5 in. and 4 in. dia. each enter through the side about 8 inches from the bottom and is connected with an ell with a vertical length of pipe perforated along its entire length with ¾-in. holes; the other inlet, added later, is a 3-in. pipe entering about 24 ft. from the bottom and is connected with a short length of perforated pipe.

Two 5-in. pipes take the overflow from the top of this burner, one of which is connected with the boiler feed tank; and two 3-in. drain or blow-down pipes are attached to the bottom diametrically opposite each other.

We have considerable trouble at times in keeping the temperature of the water at the top of this burner below boiling point, when there is violent ebullition.

What I object to is that when pumping water through the 5-in. and 3-in. inlets to the limit of our capacity, the temperature of which may be about 45 deg., the temperature of the water at the top of the burner may be around 200 deg. while the temperature at the bottom will be around 60 deg. even though we are running considerable water through the bottom drains in an endeavor to lessen the disparity between the temperature of the water at the top and at the bottom of the burner.

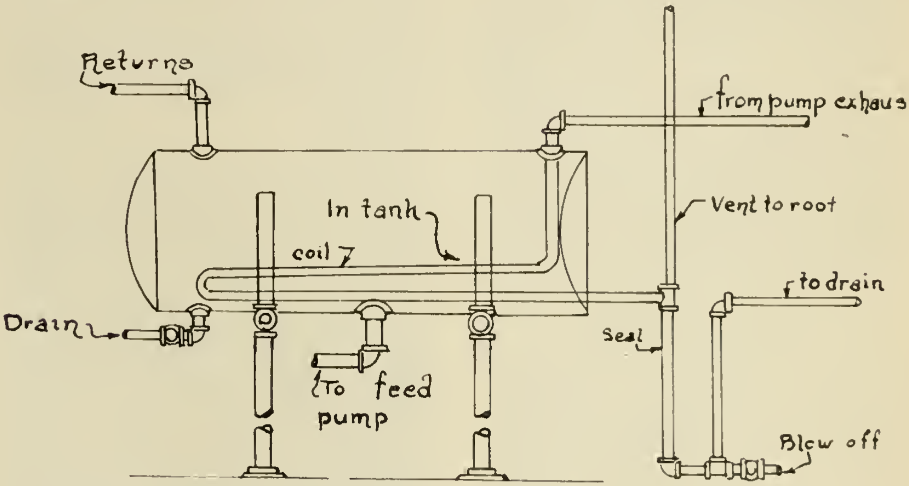
There has been considerable leakage at the seams of the three bottom tiers of plates and some distortion of these plates on the inside of the burner. I consider this trouble due, to a great extent, to the difference in temperature between the top and bottom of this tank: the plates will be practically the temperature of the water with which they are in contact: a difference of 100 deg. in temperature means a difference of ¾ in. in the length of the inner circumference of this burner, and even with a height of 64 ft. I reckon this will put a curious stress and strain on the material of the plates, as it adapts itself to this condition, and the greater the difference in temperature the greater the stress and the resulting strain.

Golden, B. C. O. E. S.

EXHAUST STEAM ENERGY

The use of exhaust steam from engines, turbines, pumps, compressors, and other steam propelled machinery, for heating purposes, has long since ceased to be a novelty.

Exhaust steam was used with varying degrees of success, for heating purposes, before the present day vacuum system came into use. However, as with other present day improvements in industry, defects in the early methods of using exhaust steam for heating, served as a stimulus to their solution.



Showing exhaust from pumps used in heater

It was an outstanding fact that there was a need of some method for removing back pressure on the engine to secure greater economy in power generation, which had much to do with the development of the vacuum heating system.

The old heating method, of using exhaust steam, consisted of discharging the exhaust into a none too well planned, piping system, and forcing it through the heating units against the resistance offered by air due to improper means for venting it, and the friction of pipes. This condition would cause a back pressure, some times, of as much as ten pounds, which materially cut down the efficiency of the engine.

Cut Back Pressure

To reduce this back pressure, several things were necessary:

(a) Improved piping installation, free of pockets, and well dripped to remove any accumulation of condensation.

(b) The application of vacuum traps at the return end of pipe coils and radiators, and steam main drips, so as to provide for the free and easy venting of air from all heating units.

(c) The installing of a definite common return piping system, well graded to avoid pockets, which would connect from the vacuum traps on all of the radiators, coils and steam main drip traps.

(d) This return main piping system would grade back to, and would carry all of the air and water of condensation from the heating system to a vacuum producing pump.

(e) The vacuum producing pump would draw all air and water of condensation away from the radiators, which would allow the steam, exhausting from the engine, to flow to the various heating units, with the minimum pressure to provide circulation.

The function of the vacuum trap, at the radiators and on the steam main drips, is to pass all air and water and to close off, preventing the loss of any steam into the return line piping system.

The vacuum system of heating, in connection with power plants, where exhaust steam is utilized, had gradually been refined until to-day circulation can be secured throughout a well designed system at practically atmospheric pressure, and oftentimes it is possible to produce an actual vacuum on the exhaust side of the engine, or other fixture furnishing the exhaust steam.

Exhaust steam contains about 85 per cent. of the original heat units after it leaves the engine, but, it also contains an amount of oil. It is obvious that this oil, if permitted to pass with the steam through the heating system, would cause a great deal of difficulty such as—reduced efficiency of heating surfaces, because of oil film on the inside—the gradual clogging up of piping, traps, etc.—but the greatest damage would occur through the returning of this oil, with condensation, back to the boiler.

Must Extract Oil

It is thus necessary to make use of the very best methods of extracting the oil from the exhaust steam, before making use of the exhaust in the heating system.

Some times, in addition to the oil separators, in the exhaust steam line, an oil filter is used to filter the condensation returning from the heating system.

One safeguard against oil, is the use of a heater with an oil separator attached to it, through which the exhaust steam passes. If care is always taken to keep the drain from such an oil separator thoroughly clean and in good working order, there will be comparatively little oil pass into the heating system, and as all of the heated water usually passes through a coke filter bed to the boiler feed pump, this process tends to further reduce the percentage of oil in the boiler feed water.

Boiler Pressure Varies

There are many boiler plant installations where this type of installation serves a group of buildings, situated a considerable distance from the boiler plant. The plant usually consists of more than one boiler, and is equipped with steam driven vacuum and boiler feed pumps. The boiler pressure may vary from forty to eighty pounds or more, and this pressure may be carried through smaller distributing mains a considerable distance to the respective buildings in the group, and at these individual buildings, reduced through reducing pressure valves, to the low pressure necessary for the heating system.

In this case, the amount of exhaust steam discharged from the pump at the boiler plant is not sufficient to warrant the use of a heater, yet it is desirable to make use of the exhaust steam from the pump in some manner, and it is apparent that it would be unprofitable to attempt to discharge the exhaust steam through an oil separator into a low pressure heating main, due to the fact that the low pressure heating mains are located too far away in the individual buildings.

Cuts Steam Waste

The illustration* shows a method of utilizing all, or a portion of this exhaust steam, by discharging the exhaust through a coil located in the tank. A large quantity of the heat is absorbed by the water before passing through the feed pump back to the boiler, and the oil and excess steam above that absorbed by the feed water is discharged through a convenient drain and vented out of the boiler room at some convenient point.

Sometimes a laundry room, or other small building adjacent to the boiler house, containing a few radiators may make use of this exhaust steam from the pump, and the condensation is then wasted to the drain.

---

*Illustration by C. A. Dunham Co., Toronto, Ont.

To reverse the direction of rotation of a compound-wound-motor either reverse the armature leads, keeping the other connection the same, or leave the armature leads untouched and reverse both the series and the shunt fields; or shift the brushes, as in the case of the shunt motor.

Convention Notes

Complete plans have now been made by the executive committee of the Montreal Spring meeting of the American Society of Mechanical Engineers, to be held at the Mount Royal Hotel from May 28 to 31.

On the opening night of the convention the council of the A. S. M. E. will be entertained to a dinner at the St. James Club by the council of The Engineering Institute of Canada. On the following evening the Montreal branch will tender a complimentary smoking concert at the Mount Royal Hotel to the delegates.

The committee in charge of the arrangements is composed of: H. H. Vaughan, chairman; J. A. Duchastel, vice-chairman; Fraser S. Keith, secretary, and Fred B. Brown, John T. Farmer, George R. McLeod, and Major C. M. McKergow.

The work of the convention itself will be largely of a technical nature. In addition to the general sessions on the opening day, there will be technical sessions on the following days devoted to the following subjects: Power, textiles, machine shop practice, management applied to the pulp and paper industry, port development, fuels, railroads and general mechanical engineering, with papers by experts in these lines from all over the continent.

A feature of the technical program will be the paper on Tuesday morning on hydro-electric development, by Julian C. Smith, vice-president and chief engineer of the Shawinigan Water and Power Company, who will speak on the power developments in the province of Quebec, and Fred Gaby, chief engineer of the Hydro-Electric Power Commission of Ontario, who will discuss the progress of that work.

The second session on power will have two papers, one by H. G. Acres, hydraulic engineer of the Hydro-Electric Power Commission of Ontario, on "Modern Hydro-Electric Turbines of Large Capacity," and Payne Dean, Stamford, Conn., on "Sectionalization of Remote Control of High Pressure Steam Lines."

C.A.S.E. Notes

Toronto No. 1 at its first meeting in May had a very large attendance. Whether it was the wiles of the typewriter of the secretary or the annual meeting for the nomination of officers, has yet to be found out but many were the congratulations offered Bro. John Brown who was looking remarkably well after his long illness.

Among others present were Bro. M. B. Watson, director of engineering at the Central Technical School; C. B. Turner, president of the Exhibitors' Association; J. Thompson, president of the Supply Men's Association, and H. Fletcher, director of sales for the Garlock Packing Co.

The officers elected for the coming year were:—

President, R. McLaren, by acclamation, because of his ability to bring in interesting papers on educational matters, mingled with ability to get new members.

Vice-president, Ed. Golightly, by ballot, because he is young and aspiring.

Corresponding secretary, Geo. A. Brown, by ballot, but modesty forbids me to say why.

Financial secretary, T. S. Jones, by ballot, because he is a first-class engineer and a little new blood on the executive helps to keep the best of organizations in trim.

Treasurer, Geo. J. Soucy, by acclamation, because he is an optimist and knows how to keep the bank account well filled.

Conductor, J. Quinlin, by acclamation, because he is polite and decorous and does things in such a nice way that one of the scrutineers said he deserved the freedom of the city of Toronto.

Doorkeeper, L. W. Thomas, by ballot because he ushers more in than out.

At the next meeting delegates to the convention will be elected.

Geo. A. Brown, Secretary.

At the last regular meeting in Kitchener we had Bro. Ellis with us and he gave an interesting talk on blackboard work on A. C. motors. We had a good attendance and everybody was well pleased with the lecture. We also initiated Bro. Wilson, chief engineer at the Kitchener and Waterloo Hospital.

At our next regular meeting on May 25th we will have a lecture on steam turbines.—C. Ott, Secretary.

London No. 30 C. A. S. E. held their regular meeting May 4th and the coming convention was freely discussed.

Officers for the coming year were elected as follows: President, Geo. Mott; vice-president, D. J. Freedy; rec. sec., G. F. Galloway; financial secretary and treasurer, Jos. H. Ward; conductor, J. W. Reynolds; door keeper, T. W. Baker; auditors, Freedy, Reynolds and Baker; delegate, J. H. Ward.

J. H. Ward, Secretary.

U.C.C. of E. Notes

On May 14 Canada Council No. 27 held a regular session, a good attendance and busy meeting. Delegates to represent us at the Rochester, N. Y., convention were elected as follows:

Delegates	Alternates
Chas. L. Holmes	L. Westwood
Jas. L. Cudbird	G. Aldridge
A. M. Aucterlonie	C. Shaw
H. E. Terry	H. Potter
Geo. H. Jenkins	W. A. Bruce
P. Davies	

The convention will be held Aug. 7.

Odd Questions and Their Answers

Queries are invited on the every-day problems of engineers in all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped a fellow engineer and a pleasure for us to pass on the data.

G. W. V. A. HEATING SYSTEM

The G. W. V. A. house at Welland is at present heated by a hot air system which is practically worn out and has cost considerable money for operation in the past winter.

Kindly give us advice on the proper heating system to install, remembering that economy in initial outlay is a great consideration.—P. A. W., Welland.

Answer:—In view of the size of the building and the general layout, that is with part of the building being used as a residence and the large assembly room on the first floor, some type of steam heating would be best. Since economy in initial outlay is the main consideration a one-pipe gravity system would be preferable. No excavation work is necessary as there is sufficient space in the basement.

A cast iron boiler of a reliable make, in which bituminous coal could be burned would assist in keeping down the fuel bill.

* * * *

SAFETY VALVE SIZES

What is the largest size safety valve allowed on an air compressor?—C. A. S. E.

Answer:—The safety valve of a compressor must be large enough to relieve the receiver of the full capacity of the compressor without any appreciable rise in pressure above that at which it opens.

There is a limit on the minimum but not on the maximum size which may be used.

* * * *

EFFECT OF COAL CHANGE

What do you consider the effect on efficiency of having the coal constantly changing, not only in ash and heat value, but in coming from different fields, particularly on hand-fired outfits where there are no instruments to aid the engineer in his work?—A. C.

Answer.—It is quite possible that constant changes in the grade of fuel used will result in destroying the regular operation of the boiler plant to such an extent as to have a definite effect on the economic performance of the plant.

If the boilers in the given plant are hand-fired, the firemen become accustomed to handling a certain type of coal and usually work out a more or less definite schedule as to how the coal should be handled, that is, whether the fuel should be fired fairly heavy, or light, or the fuel bed will or will not stand slicing, or whether it may or may not need breaking up with a hoe, etc.

With a given load on their boilers, the firemen usually have definite times for cleaning fires. Any material change in the character of the fuel being used will often times upset this schedule, and make a change in the period between cleanings and it may take a long time for the firemen to get accustomed to the fuel and establish a new schedule. If the coal is bought in fairly small quantities, these schedules may have to be worked out so frequently as to keep the operation of the boiler plant more or less upset right along.

In addition to the actual reduction in economy, due to the upset of one schedule and working out of another, resulting from changing the fuels in a given plant, there is also the psychological effect that such changes have on the firemen.

When fuel is supplied to a plant which gives little trouble in cleaning fires and keeping up steam, the firemen usually protest when a poorer grade of coal is furnished them, and in many cases become so indifferent to their work that the economy in the plant is greatly reduced. This condition often does lead to disputes and differences between the firemen and their employers which may result in the loss of good firemen and possibly the substitution of less experienced men.

* * * *

FUSE SIZES

How do you determine the ampere size fuses to use for a given h. p. motor?

Answer.—A. h. p. is 746 watts. Volts × amperes = watts. As the current flowing determines the size of fuse it is only necessary to know this and allow a suitable margin for starting current or temporary overload. In the case of a D. C. motor multiply the h. p. by 746 and divide by the voltage, to find the amperes. The A. C. motor is more complicated; power factor must be taken into account. For single phase multiply h. p. by 746 and divide by voltage and by power factor to find amperes. In polyphase motors the current flowing in each branch is

$$I = \frac{\text{H. P.} \times 746}{\sqrt{3} \times V \times \text{Power Factor} \times \text{Eff.}}$$

It is usual to add 25 per cent. to full load current to allow for overload.

* * * *

SETTING BOILERS

How much should a return tubular boiler be set lower at the back end than at the front end?—C. A. S. E.

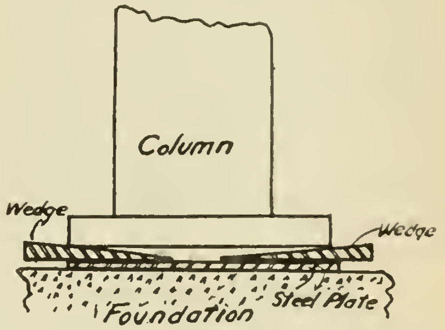
Answer.—Most manufacturers of return tubular boilers advise setting the back end from one to two inches lower than the front end, sufficient to allow good drainage to the back end.

* * * *

RAISING BOILERS

I wish to raise three horizontal return tubular boilers ½ inch. They are hung by cast iron columns and beams. Kindly give procedure.—W. W. P. Sinclair, Medicine Hat.

Answer:—Make a number of thin iron wedges and drive under the base of the columns as shown in the illustration. If the concrete has a tendency to crush under the wedges, chip away sufficient under one half of the column to insert a thin steel plate, then wedge between the plate and the base of the column.



By raising one end of each boiler at a time and blocking up with ½ in. steel plate, a small number of wedges will suffice for the three boilers.

* * * *

A TRANSMISSION PROBLEM

In our factory we are running at present from one of our 390 h. p. Allis-Chalmers heavy duty Corliss engines, one 100 kw. direct current generator. Our engine has one fly wheel on it 15 feet in diameter by 30 inches wide, speed of the engine 90 r. p. m.

We want to put a heavier load on this engine and by so doing we will then be able to shut off one of our other engines entirely and effect at least about a 10 per cent. saving in coal. We are somewhat limited for space in our power house and also considering a contemplated change at a further date regarding our power requirements; we do not want to purchase any larger generator equipment at this time.

It has, therefore, been suggested that instead of buying now a 200 kw. new generator to set in place of our present 100 kw. generator, that we leave this 100 kw. generator where it is, and connect to the same fly wheel of our engine another generator that we have on hand, thus running the two generators off the one fly wheel and having one leather belt running over the other.—A Reader.

Answer.—This scheme is perfectly feasible, just as the scheme of increasing the power of a drive by super-imposing another belt on the original belt. The second belt is referred to as a "rider" belt, and the applications of the idea may be found in many plants throughout Canada.

The fly wheel width of 30 inches is fully sufficient for a belt width to meet a load of 200 kw. It would be well for you to investigate the character of the surface of the fly wheel before proceeding with the installation. Iron casts rough and uneven and with warping and twisting of patterns, gives a surface that may not be entirely suitable for belt driving. Also in this connection the expense of dismounting the fly wheel and returning should be considered.

The load characteristics of your plant are a serious consideration in this type of drive. It is obvious that the use of the generator employing the under belt for an operation that is intermittent would mean either removing this belt or running that generator idle during the periods of non-use. In the latter case, this will mean the carrying of the mechanical losses of the generator, while in the former case the outside belt would be a very loose drive and may not be entirely satisfactory. That is to say, that with one particular direction of drive on the fly wheel, the surface of contact with the belt would be considerably reduced.

* * * *

FORCED-DRAFT FANS

Can you give me any instructions for operating forced-draft fans?

Answer.—Forced-draft fans should be started under minimum load by having the damper closed when starting. This also prevents the furnace gases from being forced out of the side doors if the stack damper is not properly set. The main oil switch should be used only for the purpose of disconnecting electrical energy from fans, and if it automatically trips, then something unusual has happened which requires the attention of an electrical mechanic before starting the fans again. The following instructions for starting and shutting down forced-draft fans have been taken from the operating code of a well known electrical company:

1. See that the forced-draft damper is closed.
2. Turn on the cooling water to the bearings.
3. Start the turbine or motor.
4. Inspect the oiling system and see that the gear case contains the proper quantity of oil and that oil rings, pumps, etc., are in operation.
5. Bring the unit up to speed.
6. Inspect the unit for excessive vibration, and if excessive vibration is discovered, report the trouble to the shift superintendent.
7. If the main oil switch (controlled at the boiler operating boards) should trip, have an inspection made by the electrical mechanic and any trouble corrected before closing time.

Shutting Down

1. Shut down the turbine or motor.
2. Turn off the cooling water.
3. Close the forced-draft damper.

* * * *

INCREASED HORSE POWER

In how many ways can the H. P. of a non-condensing engine be increased?—C. A. S. E.

Answer:—The general formula for H. P. is given by the following: P. L. A. N. where

P—Mean effective pressure.
L—Length of stroke.
A—Area of piston.
N—Revolutions per minute.

Assuming that no change can be made in the design of the engine and no condenser is to be added the only ways in which the H. P. may be increased, are by an increase in speed or by an increase in the M. E. P.

Speed.—The increase in H. P. is almost directly proportional to the increase in speed.

M. E. P.—This may be increased by an increase in boiler pressure or by altering the point of cut-off so that steam will follow up the piston for a greater length of the stroke. In the simple D slide, valve cut-off may be varied by changing both the angle of advance and the throw of the eccentric, the less the angular advance and the longer the throw the later the cut-off.

* * * *

COAL OR OIL

How can I determine when it is advisable to change from coal to oil burning, also, if I find it advisable to install one oil burning unit, which one of these systems would you advise and why?—gravity flow, low pressure head steam jet and high mechanical atomization?—C. A. S. E.

Answer:—When it is advisable to change from coal burning to oil burning depends on many factors apart from the relative cost of the fuels based solely on a B. t. u. basis.

Local conditions, such as storage room available, efficiency of coal and ash handling equipment, labor costs, smoke nuisance and boiler rating and efficiency desired, all must be taken into account. No general rule may be given, each installation needs to be studied in detail.

The system adopted also depends on local conditions, but where only one unit is to be installed it would be well to use a simple installation, possibly gravity flow. Steam atomizers use from 3 to 5 per cent. of the total steam produced. This would be objectionable in a heating plant where the condensate was repended on for boiler feed.

RADIATOR LOCATION

Is it possible to locate the radiators on the floor for the purposes of heating a one-storey building? The boiler is a return tubular, set about three feet above the floor and the radiators are at present located on the ceiling.—R. I., Winnipeg.

Answer:—Two possible methods may be applied to this change in installation, both necessitating the purchase of some additional equipment. The best method, applicable to any boiler pressure, is to install, beside the boiler, a small, motor-driven, centrifugal pump, fitted with automatic control. To this pump would be connected the returns from the floor radiators. When sufficient condensation water had collected in the pump control chamber, the automatic control would throw the switch, and the pump would force the water back into the boiler. If your radiation surface does not exceed 3,000 feet a motor of less than one horse-power will suffice. These are obtainable for operation from any type of current.

A second method is the installation of a couple of steam traps, one above the boiler and the other on the floor beside it. Connections would necessitate a steam supply from the boiler to each trap, the main return from the radiators to the floor trap, a return from the floor trap to the second trap, and a return from the second trap to the boiler. Such a system would necessitate maintaining a pressure of at least ten pounds on the boiler and might possibly give trouble if the fires were banked during the night.

As to comparative costs, the second system is somewhat cheaper than the installation of a pump, but we understand that there is some possibility of legislation being enacted by the Ontario government forbidding the installation of steam traps above boilers.

* * * *

STEAM ACTION

How does the steam act on the tube of a pressure gauge so as to make it straighten out and why is the longer axis of the tube sometimes at right angles to the spindle to which the pointer is attached?—J. M.

Answer:—The pressure of the steam in the boiler acts against the condensed water with which the so-called syphon tube is filled. This tube is necessary to prevent the hot steam from causing inaccurate readings on the gauge. Since the tube inside the gauge is coiled up, the outer surface has a greater area than the inner surface and therefore receives greater pressure, tending to make the tube uncoil. This action is communicated to the pointer of the gauge by means of a spindle. The variation of the relative positions of the tube and spindle are irrelevant and are due simply to different designs employed by manufacturers.

More modern practice in pressure and temperature gauges is to employ the recording type, in which the action of the coil is transmitted to a recording pen by means of two link arms, providing the recorder with a non-variable centre. Additional equipment in the recording type is a clock movement which rotates the dial face bearing specially ruled paper upon which the temperature or pressure is recorded.

* * * *

GENERATOR REWINDING

I have a small four-pole dynamo which I wish to rewind to supply about 20 amps. for the purpose of charging batteries. Would you advise such procedure?—W. R. T.

Answer:—It would seem that, for the purpose you mention, rewinding the generator would hardly be a sound proposition. In small units, nearly all storage batteries are charged by means of rectifiers operating on alternating current. If your operation is either large or small, suitable apparatus can be obtained to meet varying requirements. The rewinding of the generator would be a job for a firm specializing in such work, and while the cost would be considered less, provided the generator is in good condition, than the cost of installing a rectifier, the efficiency of the generator for battery charging would not compare with that of the rectifier. If it is a question of installing the proper equipment for the charging of batteries alone, we would advise a rectifier.

* * * *

PERCENTAGE OF CLEARANCE

Can you tell me why the percentage of clearance is greater in high-speed than in low-speed engines?—D. A.

Answer:—The term "high-speed" is commonly applied to shaft-governed single-valve engines of shorter stroke than slow-speed single-valve engines of the same bore of cylinder.

The long and large steam passages required in single-valve engines, together with the mechanical piston clearance, makes the actual clearance space as great as for a slow-speed, single-valve engine of the same diameter of cylinder, but having a shorter stroke, the cylinder clearance space becomes a larger percentage of the piston displacement.

In four-valve high-speed engines with non-releasing gear, the actual cylinder clearance volume may be as low as in an engine of the same diameter of cylinder and slower rotative speed, but as usually designed, the stroke is shorter in proportion to the diameter of the cylinder than in slower-speed releasing gear engines of the same diameter of cylinder and same piston speed; therefore the same actual clearance becomes a larger percentage of piston displacement, although less than in the single-valve engine of the same diameter and stroke, because the actual clearance is less.

* * * *

CALCULATING WIRE SIZES

Is there any method of calculating the size of wire for armature coils?

Answer:—Where an electrical machine is to operate on one-half the voltage that it was originally designed for, the number of turns in the winding connected in series must be reduced by one-half. Since the number of turns is reduced by one-half, the cross-section of the conductors in each coil can be increased by two. On the other hand, if the voltage is reduced by 4 the number of turns in series must be reduced by 4 and the size of the copper can be increased by 4.

Conversely, if the voltage is increased by 2 the number of turns must be increased by 2 and the size of the copper reduced to one-half. This is easily figured out. But if the voltage is increased or decreased by, say, 25 per cent., the size of copper may not be so easily determined by those who do not have their arithmetic at their finger tips.

For example, take the case where the coils of a 120-volt armature are wound with 8 turns of No. 12 copper and it is desired to rewind the machine for 90 volts. The number of turns per coil will vary directly as the volts and is equal to,

$$\frac{\text{New volts} \times \text{Original turns}}{\text{Original volts}} = \frac{90 \times 12}{120}$$

= 9 turns. No. 12 copper has a cross-sectional area of 6,530 circ. mils, and since there are 12 turns in the original coil, there is 6,530 × 12 = 78,360 circ. mils cross-section in the coil conductors.

Now the new coil should have approximately the same cross-section of copper. Therefore if the original cross-sectional area of the coil in circular mils is divided by the new number of turns, the new size of wire will be obtained. In this problem 78,360 ÷ 9 = 8,703 circ. mils. The nearest standard size of wire to this is a No. 11, which has 8,234 circ. mils cross-sectional area.

From this it is seen that the one thing to remember is that the new turns in the coil must have approximately the same total cross-sectional area as the original turns.

* * * *

CAST-IRON PISTON RINGS

What is the usual turned diameter and thickness of cast-iron piston rings for steam pistons?

Answer:—The rule for piston rings when made of cast iron is to turn them out of the solid ¼ in. larger than the cylinder diameter for cylinders 20 in. in diameter, and then cut out enough to spring the ring to the diameter of the cylinder. For larger or smaller cylinders the greater diameter for turning the ring out of the solid and the amount to be cut out is in proportion. That is, a ring for a 15-in. cylinder would be turned off, solid 10 3/16 in. diameter and then have enough cut out to be sprung to the diameter of the cylinder.

The thickness is commonly made 1/30 of the cylinder diameter plus ⅛ in., and the width is made equal to the thickness plus ¼ in. Hence for a 15-in. cylinder the thickness would be 15/30 + ⅛ = ⅝. and the breadth would be ⅝ + ¼ = ⅞ in.

For an eccentric ring—that is, with the thickest part diametrically opposite to the cut ends—the average thickness is made the same as for a ring of uniform thickness and the thickness at the place where the ring is cut is made two-thirds of the greatest thickness. Thus, for a 15-in. cylinder the average thickness of an eccentric ring would be ⅝ in., the thickest part would be 1.2 × ⅝ = ¾ in.; the thickness at the cut ends would be 0.8 × ⅝ = ½ in.; and the width as for a ring of uniform thickness for the same diameter of cylinder would be ⅞ in.

* * * *

BLOWING DOWN BOILERS

When is the proper time to blow down a boiler when banked or when steaming at full blast?—C. A. S. E.

Answer:—The best time to blow down a boiler is after a period of rest, and with a small head of steam. A good time is in the morning when firing up for the day, before full pressure is raised, the sediment then has had time to settle.

* * * *

BOILER HORSEPOWER

Kindly state how to work out the horsepower of a boiler and give probable size of a boiler required to heat a building having 14,000 sq. ft. of radiation surface.—P. E. L., Winnipeg.

Answer:—Manufacturers of boilers usually rate their boilers on a basis of the number of square feet of heating surface they contain, generally allowing 10 sq. ft. of heating surface per boiler horsepower.

All the surface in contact with fire or hot gases on one side and water on the other is called heating surface, the area of the tube sheets, being small in comparison with the total, is neglected.

To illustrate the method of calculating heating surface, consider a horizontal return tubular boiler with a 42-inch shell 14 ft. long with 34 three-inch tubes:—

Circumference of shell—3.1416 × 42 = 11 ft.

Surface of shell—14 × 11 = 154 sq. ft.

Suppose brick work corbeled off so that full half of shell may be considered as heating surface.

Heating surface of shell—77 sq. ft.

Internal circumference of one tube —3.1416 × 2.782 = 8.74 inches.

Internal area of tube—14 × 12 × 8.74 = 1468.3 sq. in.

Internal area of 34 tubes—34 × 1468.3 = 49,922 sq. in. or 346 sq. ft.

Total heating surface—77 + 346.6 = 423.6 sq. ft.

Allowing 10 sq. ft. of heating surface per boiler horsepower gives 42.3 H. P.

For the average factory with 14,000 sq. ft. of radiation surface a 150 H. P. boiler should be used.

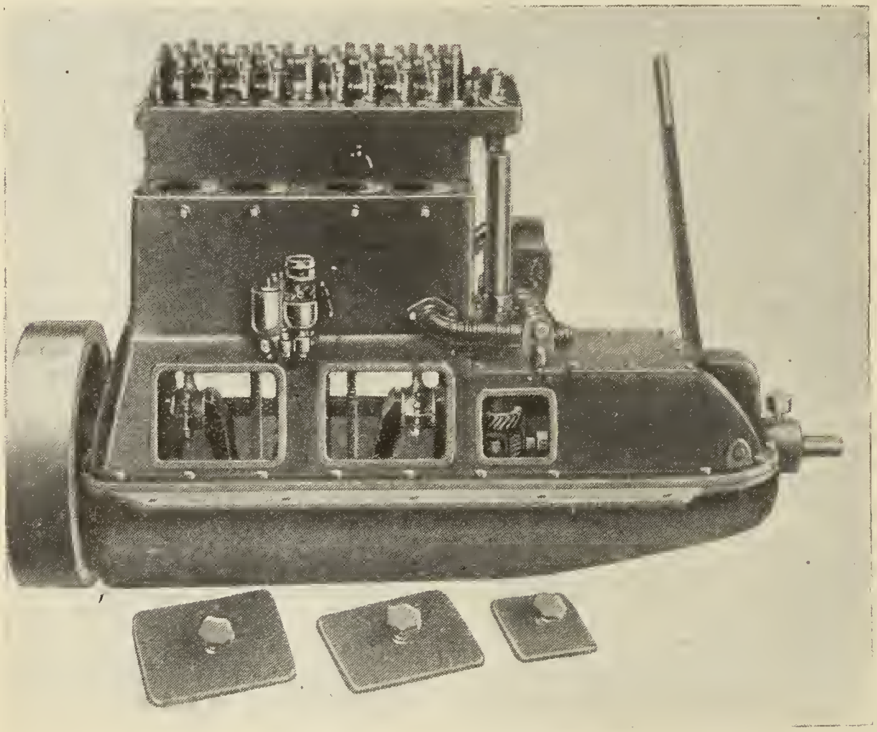
Fuses are rated at their maximum continuous current-carrying capacities and will usually blow at current values about 25 per cent. above their rating, depending upon the duration of the load.

Progress in New Power Equipment

New Engine Design

The Simplex Motor and Machine Co., 48 Abell St., Toronto, are putting on the market shortly an engine which embodies several revolutionary ideas in design. The striking feature of the new engine is the absence of springs on the valve stems, which are completely mechanically driven, a principle which, it is claimed, does away with all valve noises in addition to increasing the ease of adjustment in operation. Other variations from the ordinary type of engine are, a unique system of lubrication, provision for double installation of spark plugs and the removal of all gases from the engine through the exhaust.

The engine is of particularly clean-cut appearance, being of the completely enclosed type. While, from the illustration it would appear somewhat higher than ordinary, the vertical dimensions correspond with those of similar marine or automobile engines. The stroke and bore of the engine are 3½ x 5 and on rough tests it has developed over 20 h. p. The overall weight, with marine transmission is 620 lbs.



New Simplex Motor.

Mounted on the top of the cylinder head and driven by a vertical shaft as illustrated, the cam shaft carries a double set of cams for each valve stem. The tappets are mounted on a hollow shaft, which serves as an oil conveyor, slightly above the cam shaft. The end of each valve stem is fitted with a removable washer and the tappets are so designed that one engages the top of this washer while the other fits tightly under it. By properly mounting the cams and tappets to operate at the correct time, it will be seen that the valve will be opened and closed mechanically by the action of the tappets on both sides of the disc on the valve stems. A feature of this arrangement is the fact that all tappets are instantly adjustable on the tappet shaft by means of a set screw and lock nut on each. The manufacturers maintain that the new principle will completely obviate all noise and other valve troubles, in addition to providing greater accessibility in valve grinding and adjustment.

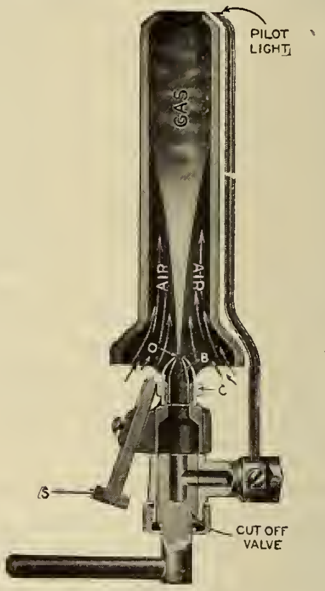
The oil of the lubrication system passes up from the crank case through a vertical tube at the front of the engine and supplies the cams and tappets, the former operating in oil continually. From the top of the cylinders the oil returns to the crank case through the casing of the vertical cam shaft drive.

An engine of this type has been operated for one season by the inventor, E. S. Lorimer, in a 28 foot motor boat and in this hull, which was not designed for speed in any way, he obtained 18 miles an hour. In a proper hull, it is claimed, that the new engine, operating at approximately 1,400 r. p. m. will develop over 20 miles per hour.

Production on an extensive scale is to begin very shortly.

Direct Jet Regulator

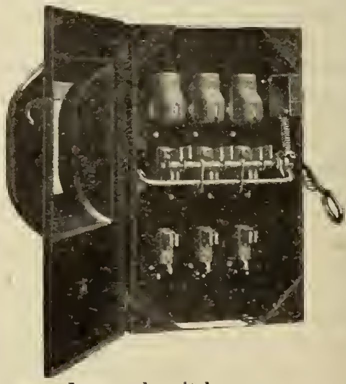
The device here illustrated is used in connection with the atmospheric bunsen burners, and can be used in service with any type of gas burner other than those used for blast purposes. The regulating feature permits of an adjustable gas orifice, and one that delivers a solid jet of gas directly down the centre of the mixing tube under maximum jet velocity, producing perfect combustion, and results in giving a high flame temperature without the use of any forced air blast or blower. These regulators are made by the Johnson Gas Appliance Co., Ceda' Rapids, Iowa.



Direct Jet Regulator

Safety Switch Cover

It is now claimed that the safety switch has been perfected to the point where it is just about 100% safe. The last point of danger to be removed is the live line terminals and jaws which were exposed when the switch cover was open. This has been overcome by en-



Improved switch cover.

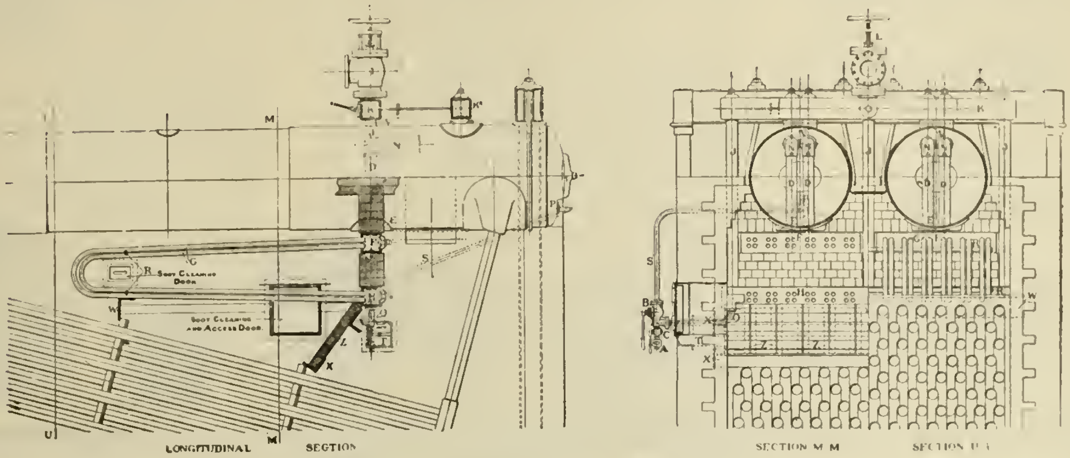
(Continued on page 42)

Babcock & Wilcox

Patent STEAM SUPERHEATER

(Integral with Boiler) (Standard Type)

Effects Great Economy in Fuel Consumption



Babcock & Wilcox Boiler Fitted With Integral Superheater.

DESCRIPTION

The Babcock and Wilcox Patent Integral Superheater has a heating surface consisting of solid drawn weldless steel tubes U shaped. These tubes are expanded and bellmouthed at both ends into holes drilled into wrought steel boxes (F) and (H).

The steam enters the upper box (F) through the dry pipes (N) and inlet pipes (D). It then passes through the superheater tubes (G) to the lower box (H), from this it ascends through the pipe (J) to the cross box (K) and the stop valve (L).

Hand holes are placed in the boxes opposite the ends of the superheater tubes.

There is also an arrangement for flooding the superheater with water from the boiler drum when starting the fires to prevent overheating of the tubes when there is no steam in them and for emptying this water from them at time of starting to steam.

This Superheater adds heating surface in a very effective part of your boiler and shows better efficiency by the lower temperature of the exit gases.

Your losses by radiation will not be so great and you avoid trouble with water in your steam pipes.

Superheaters are considered an absolute necessity by turbine users. Reciprocating engine users can save ten to twenty per cent. by the addition of enough superheat to make up for the heat robbed by the cylinder walls.

BABCOCK & WILCOX, LIMITED

TORONTO OFFICE:
Bank of Hamilton Building

ST. HENRY, MONTREAL

SAFETY SWITCH COVER

(Continued from page 40)

closing each live terminal and jaw in a protective cover. This box completely covers the terminal and jaw. Contact is obtained through a narrow slot just large enough to admit the switch blade, but too small for a finger to slip through. In addition to the protection from accidentally touching live terminals, the new porcelain covers protect the switch itself from all possibility of arcs. They can be attached or removed easily and quickly by means of two small spring clips, which hold the porcelain covers securely in place. They can be applied either before or after the switch has been installed. This feature, together with the individual base construction and key cover control, makes the modern safety switch practically 100 per cent. safe. These covers are made by the Square D Co., Detroit, Mich.

Construction

Orillia, Ont., plans the construction of a municipal heating plant, including boilers and equipment to use soft coal.

Sarnia Cement Products Co., Point Edward, Ont., is rebuilding its one-storey plant and plans to install three dry kilns, cupola, and one 20 h. p. electric motor.

Insurance Exchange Corp., Ltd., Montreal, Que., awarded the contract for the construction of a 10-storey office building on St. James St., to the Anglin, Norcross Co., Victoria St. Estimated cost $1,100,000.

Gowans Kent Ltd., 16 Front St. E., Toronto, plan the construction of an 8-storey factory for manufacturing purposes, including steam heating system and freight and passenger electric elevators. The cost is estimated at $300,000.

Western Quebec Power Company are planning to extend the power and distributing systems. Present capacity of 3,000 h. p. is likely to be increased to 6,000 h.p. before the end of the summer. If the work is carried through it will require additional capital, and a bond issue of $1,000,000 is being discussed.

Montreal has been authorized by the Legislature to spend $1,500,000 on the construction of a new City Hall. By using the old walls they will be able to keep within this sum. $200,000 already has been expended, mostly for the erection of the steel frame of the building.

East Kootenay Power Company, Cranbrook, British Columbia, announce that a contract has been let for the driving of a tunnel and other work in connection with installing a big hydro-electric plant on the Kootenay River, near Elko. It will cost $250,000 when completed.

The Canadian National Railways are building new railway yards at Kitchener. An extra gang of 26 men have started work, and this will be one of the biggest improvements that will take place on the central division this year. It is expected that the men will be engaged in this work during the greater part of the summer.

Dominion Government will erect its own building for the British Empire Exhibition to be held in London, England, next year. It will cost $1,000,000.

St. Maurice Power Co., Ltd., are proceeding actively on the new power project at La Sabelle, Quebec. The completed project will mean an additional 120,000 h.p. for the Shawinigan Power Company.

Ratepayers of Vernon, B. C., have recently authorized the city council to borrow $30,000 to establish a pumping station in the city park, and to carry out certain repairs required for the maintenance of the civic water system.

A sixteen-room structure to be known as the St. Pierre Claver School is to be erected at the corner of St. Joseph Boulevard and Delorimier Avenue, Montreal. Bernier and Despatie are the architects and work will be started sometime in June. It is expected the building will be ready for occupancy on Feb. 1, 1924.

Board of Trade and members of the Quebec harbour commission are discussing the construction of a cold storage plant in the port of Quebec which will cost $5,000,000. The Federal Government, it is expected, will make a loan of $5,000,000 for the construction of the plant, and the City of Quebec and the Provincial Government will furnish $26,000 between them every year for five years.

Power Notes

Toronto Gear Co., 175 Bathurst street Toronto, wish to procure a gear-cutting machine.

J. H. Lavin, Hillcrest Dairy, Whitby, Ont., is in the market for a 10 h. p. boiler and a steam turbine bottle washer and sterilizer.

A 150 B. H. P. Polar Diesel Engine is being installed by Lammers & Maase, Limited, Montreal, at the Blue Quartz Gold Mines Limited, Matheson, Ont., to drive the main air compressor.

A steam plant has up to now been used for the purpose, but the lower operating cost claimed for the Diesel engine has induced the management to make the change.

The Devoe Electric Switch Company of Montreal and Toronto have just been awarded the contract for the lighting safety panels and switchboards for the new big building which Henry Morgan & Co. Ltd., are adding to their Montreal store.

These panels are built on one solid base of "Bakelite" and will total in value to upwards of $20,000 exclusive of installation costs.

Taylor Stoker Company Limited, of Montreal, have just closed a contract for four automatic underfeed stokers with steam power dumps, fans and drive for same, to be installed under B. & W. Boilers in the plant of Bathurst Company Ltd., Bathurst, N. B.

These Taylor automatic underfeed stokers were made in Canada.

The John Inglis Co., Strachan Ave., Toronto, are this month delivering 3 pumping units to the city of Toronto. One of these is to be used in pumping the domestic water supply at Toronto Island, another is to be used in connection with the main sewerage equipment in the city, and the third is to be installed for the sewerage disposal system at Sunnyside.

G. D. Peters & Co. Ltd., of Montreal, who have recently introduced into Canada the well-known "Wilson Color-tipt" welding rods for electric arc welding, state that there is a growing demand for this product. Recent tests by the Canadian National Railway show that electric welds having a tensile strength as high as 67,000 pounds per square inch are now being obtained.

The City of Toronto is being pressed more closely as each month passes, by the need of certain public utilities. It is practically certain that on Jan. 1 next the ratepayers will be called upon to vote upon a duplicate waterworks system which will cost about $14,000,000. Another project which must be carried out very shortly is the installation of a $12,000,000 sewage disposal plant for North Toronto. In 1912 plans were submitted which called for a sewage disposal plant estimated at $6,000,000. The proposal was rejected and now the city will have to pay at least double for practically a similar installation.

Personals

A. J. T. Taylor, president Combustion Engineering Corporation, Toronto, has returned from a ten-day business trip in Eastern Canada, where the Corporation's operations are now centralized in the Canada Cement Co.'s building, Phillips Square, Montreal.

F. G. Morley, who has acted as secretary-treasurer for the Ontario Associated Boards of Trade and Chambers of Commerce since organization, has resigned his position, and Thomas Marshall, traffic manager of the Toronto Board of Trade, has been appointed his successor.

Toronto Hydro-Electric Commission will make an extension to its sub-station on Bay Street, which is estimated to cost about $90,000.

A shunt-wound machine when running as a motor will run in the same direction as when driven as a dynamo provided the connections remain unchanged. A series-wound machine when operated as a motor, will run in the opposite direction to that in which it must be driven to operate as a dynamo.

Dunham Packless Radiator Valve with 3 interchangeable parts

Simply constructed and uncommonly accessible! The Dunham Packless Radiator Valve is a sturdy, dependable and durable valve.

No springs or stuffing boxes. A remarkable "built up" bellows makes this valve absolutely leak proof. It can be fully opened or closed with approximately one turn of the vulcanized, non-breakable, heat resisting wheel handle. It's equally efficient for top or bottom radiator connection on steam or hot water type radiators where low pressure steam heating is used.

TYPE NO. 140.
Leakage of air into the radiators of vacuum systems is absolutely prevented by the "built-up" bellows construction. Steam, water, or dirt cannot come in contact with the valve spindle threads. Usable in any steam heating system.

MADE IN CANADA

Plant owners, executives and engineers are invited to write for the Dunham Hand Book which interestingly describes Dunham Heating Service and the application of Dunham Heating Specialties.

C. A. DUNHAM CO., Limited
Toronto, Ontario
Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary.
London, Eng.: 18 St. Thomas St., S.E. 1.

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE

ECONOMICAL DRIVE OF POWER

(Continued from page 30)

powers would be lower because of the lower vacuum. Ejectors may, of course, be installed instead of the air pumps.

The boiler-feed arrangements are the same in all the schemes, each boiler house containing one electrically-driven feed-pump, and one steam-driven (turbo) feed-pump, either of which is capable of supplying the whole boiler house, and both are always available for immediate use. In addition, the feed systems of the individual boiler houses would be interconnected, so that practically any feed-pump would be available for any boiler in case of emergency.

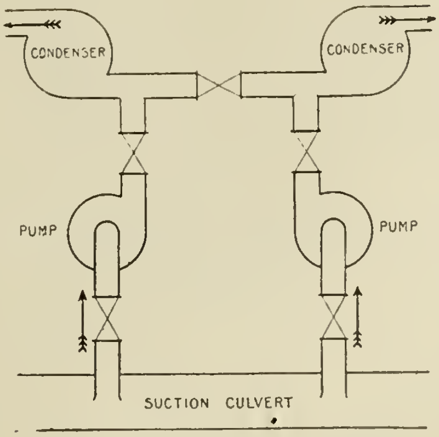
Six motors are provided for the stokers of each boiler house, but only three, each of 10 h.p., are required at any one time, the other three being available for immediate use by the operation of clutches.

Where a.c. motors are shown it is intended that, as previously mentioned, regulation should be obtained:

(a) For stokers, by variable gears.
(b) For pumps, by valves.
(c) For fans, by dampers.

For the reasons already given, feed heating by steam bled from the main turbines has been assumed in all the schemes, and the interlinking of feed heating with the use of steam from auxiliaries has not been considered.

In drawing up the alternative schemes the authors have endeavoured to keep to a minimum the number of oil switches on the main busbars, because every switch on the main bars must obviously be capable of breaking the whole capacity of the section of the busbars to which it is connected.



Synchronous motor-generators have only been put forward where it is necessary to provide for feeding the a.c. bars from the d.c. bars.

In all other cases induction motors are proposed because they are much less likely to trip out at times of fault on the a.c. supply, and they can also be started much more readily.

Fan for 2 Boilers

One forced-draught fan supplies two boilers and as a slight modification of the arrangements shown in the figures, it is well worth considering the advisability of feeding the induced-draught fan motors of each pair of boilers from one supply, and feeding the forced-draught fan motor of the same pair of boilers from the other, so that a failure of either auxiliary supply will not deprive any of the boilers of all artificial draught at times of peak load when both forced and induced draught are in use.

Where supplies to an auxiliary busbar are in parallel, it is to be understood that suitable reverse-current relays would be included to prevent other supplies feeding-in to any generator that may become faulty.

Layout in Fig. 1

D. C. generators would be self-excited, and reverse-current relays would be required between them and the d.c. busbar to prevent any possibility of motoring. They are not intended to supply current for the excitation of the main alternators, this being obtained from the usual type of exciter mounted on the main shaft, or from separately driven exciters if this latter method is preferred.

In many respects this scheme is similar to Scheme 4, but, as the possibility of total failure of auxiliaries is less, the size of the battery may be considerably reduced. The maintenance required would be fairly great because of the large number of d.c. motors, and a considerable number of spares would have to be carried, as both a.c. and d.c. motors are employed. However, there is much to commend the scheme if the d.c. generator can be considered a reliable proposition.

To rectify any minor trouble occurring with any d.c. generator without shutting down the main turbo-alternator, the troublesome generator would be switched off the bar, the d.c. supply being maintained by the other generators, which would each carry a larger load than usual, the battery and motor-generator assisting if necessary.

Layout in Fig. 2

Two auxiliary a.c. busbars, each fed by transformer.

An interconnecting switch is provided between the two 400-volt a.c. busbars, so that in the event of either transformer being out of action all the a.c. motors could be fed from the other transformer.

In view of the fact that, with the arrangements shown in Fig. 2, it would be necessary to start the first turbine of a "dead" station to atmosphere, as the station does not form one of an interconnector system (or even in the event of there being an interconnector, if this is out of action), it would be highly desirable to have at least one of the motor-generators of the synchronous type, so as to be reversible, thus dispensing with reverse-current relays on the d.c. side, and have the battery of sufficient output to carry the load of one set of turbine auxiliaries.

General Features of Scheme

This arrangement is simple in operation, efficient, and does not require a considerable amount of maintenance, and the spares required would be a minimum.

Where continuity of supply is very important, it is questionable as to whether this scheme can be considered to be really satisfactory.

The following arrangement of house set may be considered as being especially suitable for this scheme, and may increase the reliability of the auxiliary supply.

The house set to be of the simplest possible character, exhausting to atmosphere, and to be connected up so that the pressing of a button on the switchboard would enable the set to be on the bars within, say, 10/15 seconds. This would be effected by having a motor-operated steam stop-valve, the pipe line being so designed as to be continually drained. The lubrication arrangements would require special consideration.

As soon as the set approached full speed the governor would automatically put the generator on the busbars through a reactance, and one or two seconds later would short-circuit the reactance. The mechanical shock due to this switching would be severe, but the set would be designed to withstand it. By this means, in the event of the switchboard attendant observing a failure of supply on one of the auxiliary bars, he could run up the house set and switch off the faulty supply, with a reasonable chance of saving the motors on that auxiliary bar from being shut down.

Layout in Fig. 3

Special a.c. generator on shaft on main turbo-alternator, for turbine auxiliary motors only.

As stated in the table, for starting up from a "dead" station it would be necessary in this scheme to run to atmosphere the first turbine to be put on load, but if, before starting, the auxiliary generator were switched on to the motor which it normally feeds, these motors would run up to speed with the generator, and it appears possible that a vacuum might be obtained sufficiently quickly to avoid any distortion troubles in the main turbine.

In the event of a fault on one of the auxiliary generators, half the auxiliary motors of the main turbine to which it belongs will be shut down until the generator has been repaired or other arrangements have been made. To obviate this, switches might be installed so that the auxiliaries normally fed from the special generators could, in emergency, be fed from the auxiliary busbar.

In preparing the scheme the authors considered the use of such switches, but as with this arrangement there would be considerable danger of coupling together supplies which are not synchronized, and as the break-down of the auxiliary generators should be a very remote contingency, it was decided to omit them from the diagram.

Find Slight Difference

It will be noted, in comparing this with Scheme 2, that there is a slight difference between methods of connecting the low-tension sides of the auxiliary transformers to the busbar, but neither arrangement appears to have any special advantage over the other. The arrangement is simple in operation, efficient and does not require a very considerable amount of maintenance, and the spares would be at a minimum. The special a.c. generator should be more satisfactory in use than the d.c. generator of Schemel, and continuity of supply could be relied on to a considerable extent.

Layout in Fig. 4

Two auxiliary busbars, fed respectively by transformer and motor-generator.

This arrangement would be reliable, simple in operation, flexible and fairly efficient. It would require a fair amount of maintenance, because of the large number of d.c. motors used, and the spares required for the motors would be considerable. As a large battery would be required, the first cost of the scheme would be high.

In considering the relative merits of the foregoing scheme, it must be kept in mind that they are only typical and that it might be advantageous to adopt a combination of some of the alternatives. For instance, where all the supply, except the stoker motors, is shown as a.c. these also might be a.c. although the authors consider that this would be a rather unwise change. The ring main shown for the auxiliary (400-volt) busbar in Scheme 4 might equally well be adopted in any other of the arrangements. Instead of the d.c. generators of Scheme 1 feeding in parallel to one bar, they might each feed a separate bar, with an emergency switch to a common-battery bar, so that the battery might, as found necessary, be used for any group of auxiliaries.

Final Decision Difficult

It is also very difficult to come to a decision as to which is the best of the schemes, but on broad lines the authors suggest that they might be graded in two groups, the first and the best group containing Schemes 1 and 4. In the second group would be Schemes 2 and 3 which, although of equal merit one with another, cannot be considered as being of the standard of the first group.

Once the general scheme of the auxiliaries has been determined, a number of details having a considerable effect on the satisfactory running of the station must be considered.

The switch-gear and accessories used for the auxiliary gear of the station should be of the very best quality and design, for it would be unwise to run the risk of breakdown through false economy on plant, the cost of which is only a very small proportion of the total cost of the station. Switch-gear for electrical auxiliaries needs careful selection, especially with regard to the protective devices, in order that faults may cause the minimum shut-down, but at the same time to ensure that the protective gear will not operate except in case of faults.

Get Same Voltage

Where there are a.c. and d.c. low-voltage circuits in a station, these should be chosen so as both to give the same voltage on lighting circuits. For instance, in the schemes put forward, 400 volts a. c. give 230 volts between one phase and neutral, corresponding to the d.c. voltage of 230.

Considering the choice between the d.c. voltages of 230 and 460 the lower voltage would require only half the number of cells in the batteries, and, although these cells would be larger than in the case of the higher voltage, the reduction in the total number of cells would mean that less would be required in the boxes, and this would to some extent compensate for the extra copper required in the connections.

In all cases where a battery is not installed for d.c. auxiliaries, a small one would be put in for control circuits, and pilot lights fed from this should be placed at various points in the station, so that any failure in the main lighting supply will not result in total darkness in the station. Two motor-generators, one running and one as a stand-by, should be provided for this control battery.

Auxiliary Switchboard

As the drivers should be concerned solely with the starting of motors, the auxiliary supplies should be handled by a special auxiliary switchboard attendant. The auxiliary switchboard should not be far from the main high-tension control board; the high tension switchboard attendant would thus not be concerned with the details of the auxiliaries in the case of breakdown. Auxiliary

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________________

Occupation ____________________

Employed by ____________________

Residence ____________________

References ____________________

GEO. CALLARD
BUILDER & CONTRACTOR

Furnace and Boiler Work a Specialty

Highest References from All the Leading Engineers of the City

Phone: Uptown 1590

210 Quesnel Street
Montreal

POSITION WANTED

FACTORY SUPERINTENDENT OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1¼-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order. Apply Box, 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

SAWMILL MACHINERY—MODERN DESIGN—most satisfactory to operate. Apply Box 105, Power House.

SAWMILLS—PORTABLE — DOUBLE EDGES; also all kinds sawmill machinery. Apply Box 106, Power House.

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

WELDING

ELECTRIC AND ACETYLENE WELDING of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

BELTING BARGAIN

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

M. BARRY WATSON
B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer
Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W

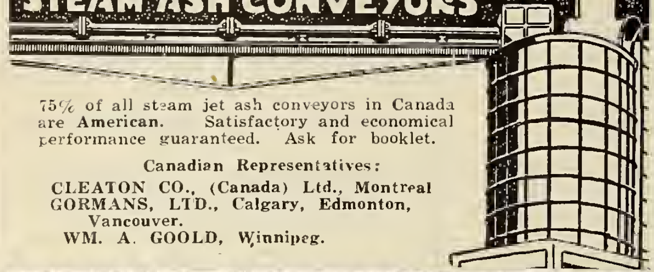
No Cinder Waste

A Sturtevant Cindervane Fan eliminates a big item of production waste. Let us send you Folder 609.

B. F. STURTEVANT CO.
OF CANADA, LTD.
MONTREAL GALT TORONTO

See
Buyers' Guide
Pages
48, 50, 52

When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*



AMERICAN STEAM ASH CONVEYORS

75% of all steam jet ash conveyors in Canada are American. Satisfactory and economical performance guaranteed. Ask for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Calgary, Edmonton, Vancouver.
WM. A. GOOLD, Winnipeg.

CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and draft in last pass.

It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

Write for Bulletin CF-131.
THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

FOXBORO
REG. U.S. PAT. OFF.
THE COMPASS OF INDUSTRY

5323

switchboards controlling duplicate supplies should be symmetrical and as close together as possible. Whenever possible all the feeders and cables duplicating the supply to any auxiliary should be run by different routes, so that in case of fire or mechanical damage the danger of the supply being cut off from all the auxiliaries would be reduced to a minimum. For example, in the case of the auxiliaries shown in Schemes 2 and 3, the feeders for the stoker motors should be led by different routes. As the motors may have to run without stoppage for periods of several weeks, special care must be taken in the design of starters, control gear, etc., to reduce to a minimum the heating due to resistance losses in conductors or to hysteresis in the ironwork.

The latter feature requires special attention, as apparatus which has been quite suitable for ordinary industrial service has become so hot when used on auxiliary plant for long periods without a break that it has had to be replaced. Contractor gear for starting has been adopted in certain cases, but the authors are of the opinion that there is little to justify the extra cost of this, although push-button releases operated from suitably chosen places in the station may be of considerable advantage. For example, a conveyor should have push-button releases provided at intervals along its length, so that the motor can be stopped at once in the event of breakage.

Starters for motors should be placed in very accessible positions and in sight of the moving machinery which they operate.

The use of motors, in addition to hand gear, for the operation of large valves such as those on main circulating pipes, is increasing. When these motors are d.c. it is to be noted that they must not be series wound, as a series motor may, once the valve gear is in motion, speed up to such an extent that considerable damage results.

A. c. slip-ring motors, where used for station auxiliaries, should be fitted with brush-lifting gear, and interlocks should be provided between this, the main oil switch and the rotor resistance, so that the main oil switch cannot be closed unless the short-circuiting gear and the rotor resistance are in their correct starting positions.

Batteries must in all cases be installed with hand-reversible boosters so as to be suitable for charging and discharging, and the protective gear should be such that in the event of a heavy overload the booster is cut out and the battery connected directly to the bars. End-cell regulation is unsuitable for station auxiliary work, as it entails taking the battery off the bars during charging.

Trade Catalogs

Stephens Chemical & Mfg. Co., of 2004 Dundas St. W., Toronto, have issued a pamphlet giving some surprising figures as to the effects of boiler scale on the efficiency of boiler operation. The company is marketing a product for the treatment of scale, the methods of application of which are outlined in the pamphlet, which is called "Efficiency."

The Main Electric Co., of Cleveland, makers of small complete lighting equipment, storage batteries, and battery charging apparatus, have just issued a booklet dealing with their products. Specifications are given very completely of each article, while a new departure is the inclusion of a description of radiophone sets, manufactured by the company.

The National Meter Co., 299 Broadway, New York, are issuing an attractive pamphlet dealing with the measurement of the flow of fuel oil by their "Empire" meter. In addition to an excellent illustration of the "Leviathan," one of the largest trans-Atlantic liners, on which National equipment is installed, the booklet contains a brief description of the operation of the meter illustrated by comprehensive diagrams.

The Dayton Safety Ladder Co. through their agents, Allen General Supplies, Ltd., 205 Yonge St., Toronto, have introduced to the market a ladder of a design both unique and pleasing. This ladder embodies many new features which are described in detail in their recent booklet which shows the application of the new equipment both in the factory and in the home. The pamphlet should prove of general interest.

G. F. Sterne & Sons, of Brantford, are the publishers of a series of booklets which should be of great interest to all who are interested in the operation of boilers. The most comprehensive of these books is entitled "Boiler Scale, Its Prevention and Removal," and deals with the elimination of this boiler room nuisance by the use of silicate of soda. The passage of water through a boiler is dealt with most thoroughly, attention being paid to all of the factors which enter the field. Attractively put together, this book should prove of value to all stationary engineers.

Other publications, recently issued by the same company, deal with the use of high temperature cements and fireclay for fireboxes, mountings, baffles, etc. In addition to their own manufacturing processes, the company are agents for several English and American firms producing articles of interest to the engineer.

The Combustion Control Co., of Philadelphia, have developed a special type of dual valve controller for maintaining an even rate of combustion in industrial furnaces. This apparatus, which is described with clear illustrations in their Bulletin No. 8-A, may be utilized to control temperature, pressure, or both. An interesting feature of the bulletin is the diagram of pressure charts, taken from recording meters, which shows the uniform results accomplished by the combustion controller.

The Lebanon Boiler Works (J. K. Petty & Co., Inc.), Philadelphia, Pa., strike a popular note in their recent booklet dealing with their Uniflow boilers. The matter is presented largely by illustrations and by tabulated statistics which contain much information of value to the operating engineer. In the Uniflow boiler, the efficiency of circulation is insured, it is claimed, by a novel mean of tube arrangements. This arrangement, together with other specialties, is completely set forth in the booklet.

HINTS TO BUYERS

Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

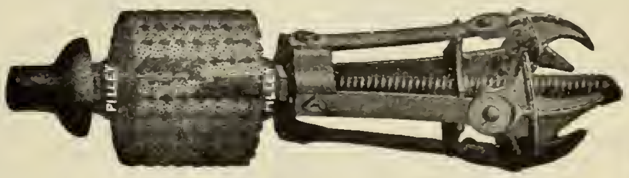
A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

OIL BURNING SYSTEMS.
INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.
LAURIE ENGINE CO.
(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper
Guaranteed not to break or the wires to pull out or lay over
A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens
For sale by leading Canadian jobbers
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo
Eastern Office: 71 Fulton St., New York

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars
Send Blueprints for Quotations. *Write for our latest catalogue*
Patterns Machine Work

GARLOCK
Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS
THE GARLOCK PACKING COMPANY

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T. J. CUNERTY** *Company*
Room 240 17, Queen St, East Toronto

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

ASBESTOS SPECIALTIES
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto. Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville, Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

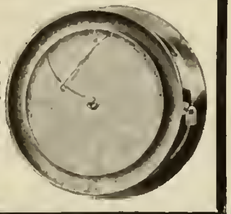
DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

SUPERHEATERS
ELESCO
DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES
FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.
MADE IN CANADA
THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal
WORKS AT SHERBROOKE, QUE.

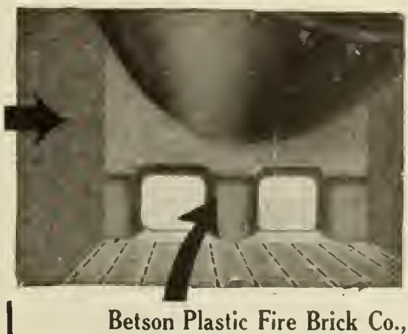
THE BROWN INSTRUMENT CO., PHILADELPHIA, PA., U.S.A.
Largest Pyrometer Manufacturers in the World.
Brown Thermometers
For Province of Quebec: La-Chapelle Eng. Co., 137 Mcgill Street, Montreal, Que. For Ontario: Brown Instrument Co., 1421 Ford Building, Detroit, Mich., U. S. A.
Send for Catalog No. 63



YORK Ice Making & Refrigerating MACHINERY
For Every Practical Purpose
Consultation on any Refrigerating Problem invited.
CANADIAN ICE MACHINE CO., LIMITED
Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial?
Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.
Send for Catalogue
THE GARTH COMPANY
Craig Street-MONTREAL, CAN.
WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.

Be Rid of Boiler Furnace Lining Troubles

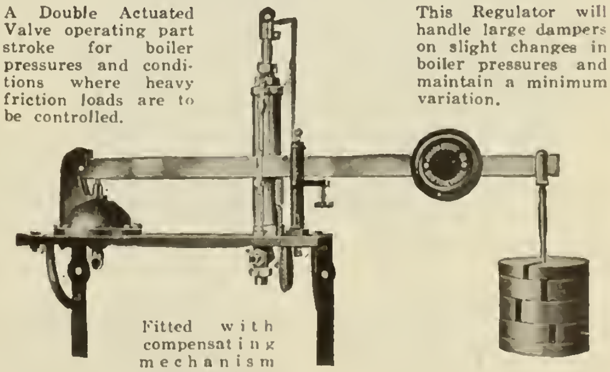


Arches and Furnace Linings in one piece. No brick, no joints. Any handy man installs it without special forms or tools.
Betson Plastic Fire Brick kept on hand for emergency repairs and for use in building sloping baffles always proves profitable. Write for instructive booklet.
Betson Plastic Fire Brick Co., Inc.
P. O. Box 386-6, ROME, N. Y.
CANADIAN DISTRIBUTORS: International Chemical Co., 26-6 Adelaide St. E., Toronto, Ontario, Canada

"Maple Leaf"
Brand
Stitched Cotton Duck Belting *and* Dressing

It is water-proof and economical; also more efficient than other belting. The standard of quality, "Maple Leaf" Brand, is always maintained. That is why the demand for this belting is steadily increasing. "Maple Leaf" Brand Belting and Dressing make a good combination—use both.
Write for prices and further information.
Dominion Belting Co., Ltd.
HAMILTON, CANADA
Quebec Branch: 51 Duluth Building, Montreal

D'ESTE
Hydraulic Damper Regulator
A Double Actuated Valve operating part stroke for boiler pressures and conditions where heavy friction loads are to be controlled.
This Regulator will handle large dampers on slight changes in boiler pressures and maintain a minimum variation.



Fitted with compensating mechanism which regulates opening and closing.
Our Catalogue No. 50 of CURTIS ENGINEERING SPECIALTIES sent on application.
Julian d'Este Company
Main Office: 26 Canal St., Boston 14, Mass.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Stephens Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa.

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome. N. Y
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co., Cleveland, Ohio.
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y
John Moncreif, Perth, Scotland.
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div-Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunbam Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

85% Magnesia

"Featherweight"

MAGNESIA
KEASBEY & MATTISON CO.
FEATHER WEIGHT
85%
AMBLER, PA.
SECTIONAL COVERINGS

Retains its
Coal-Saving
Qualities

It Never
Deteriorates

DON'T be misled! Many pipe coverings made in the past few years show up well under efficiency tests but in practice fail to stand up. Durable qualities are lacking. Cases are on record where such coverings have been shaken to pieces within a year.

You need pipe and boiler covering that holds its heat-conserving qualities for years. That is the only kind that pays. You want **K. & M. "Featherweight" 85% Magnesia Pipe and Boiler Covering.**

The same heat saving efficiency, the same saving of coal is registered, whether 85% Magnesia coverings have been on steam pipes for a week, a month, a year or a quarter of a century.

Let us explain more fully 85% Magnesia.

Keasbey & Mattison Company
25 Front St. East, TORONTO

Dunlop Belting and Hose

DUNLOP
BELTING

"Gibraltar RedSpecial"

—the High-Grade Belt for Transmission Service.

"Gibraltar"
Conveyor and Elevator Belts

—the Belts with the protective covering of Cord Tire Tread Stock that effectively resists abrasive action.

DUNLOP
Belting Hose Packing
And General Mechanical Rubber Products
For Every Purpose

Driving home a better way to line furnaces

Everywhere the mallet blows are driving home Plibrico and the idea behind it: better furnace linings that last longer and are easier to install and repair. The new booklet, "Modern Furnace Building," will start you on the road to better furnaces. Say where.

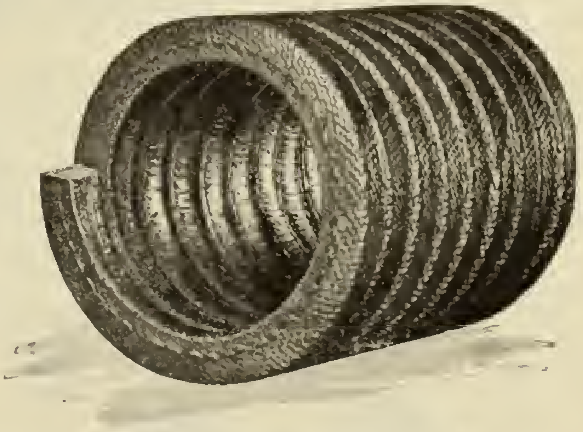
PLIBRICO
JOINTLESS
FURNACE LINING

—is delivered only in steel containers of distinctive appearance as shown below. Warehouse stocks in principal cities.

JOINTLESS FIRE BRICK C
1142 Clay St. CHICAGO, ILL.

DISTRIBUTORS: Beveridge Supply Co., Ltd.; Montreal: Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's Ltd., Calgary, Alta.

A COMPLETE SERVICE IN
"John Crane"
FLEXIBLE METALLIC PACKING



Style 400
Resilient duck channel with flexible metallic insert as wearing face. Suitable for hot or cold water, ammonia.

Recommended On
Plunger Feed Pumps, Triplex Plunger Pumps, Water Works Plunger Pumps, Ammonia Compressors.

Style 300
Resilient asbestos channel with flexible metallic insert as wearing face. Suitable for steam, air and hot gases.

Recommended On
Steam Rods, Vacuum Rods, Shot Gun Feeds, Niggers, Air Compressors.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
Beldam's Asbestos Packing and General Mfg. Co., Ltd., Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B.C.
"MADE IN CANADA"

PACKING, AMMONIA, STEAM AND WATER
Beveridge Suppy Co., Montrea.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Jenkins Bros., Limited, Montreal, Que.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor. Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co.. Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.,
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co. Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd.. Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd.. Montreal.

REGULATING VALVES
H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)
Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ili.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox. Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q

STEAM METERS
Bailey Meter Co., Limited, Montreal.

STEAM TRAPS
Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.

STEEL DRUMS
Smart-Turner Machine Co.. Hamilton.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co.. Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF
Waterous Engine Works. Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE
Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc.. New York. N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gaugs and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING
Grant E, Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

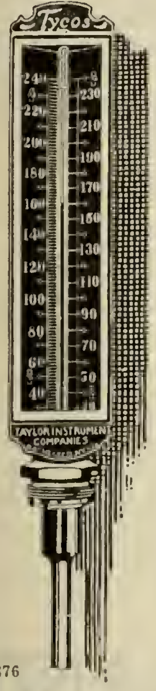
TURBINE WATER WHEELS
Engineering snd Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston. Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Shell Bar Boico Supply, Ld., Toronto.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Underfeed Stoker Co., Toronto, Ont.

WALKWAYS, (Irving Subway)
Irving Iron Works Co., Long Island City, N. Y.

Tycos and the Boiler House



Increase the efficiency of the Boiler Room when applied properly at the following points.

- Atmospheric Relief Valve
- Barometric Pressure,
- Blow-Off Lines,
- Boiler Room Temperature,
- Calorimeter Test,
- Condensers,
- Drafts,
- Economizers,
- Feedwater Pressure
- Flue Gas Temperatures,
- Furnace Fires,
- Heating Systems,
- Hot Water Tanks,
- Humidity of Boiler Room,
- Outside Temperature,
- Recording Boiler Pressure Gauges,
- Saturated Steam Line,
- Superheated Steam Lines,
- The Coal Pile.

Let us show you how *Tycos* Temperature Instruments will enable you to cut down your power cost. Send for *Tycos* Power Plant Catalog.

Taylor Instrument Companies
Canadian Plant, 110-112 Church St.
Tycos Bldg., Toronto

There is a *Tycos* or *Taylor* Temperature Instrument for every purpose.

Indicating, Recording and Controlling.

Tycos Rochester N.Y.

876

Use Logic in Buying Your Babbitt Metal

Protection from power waste, hot boxes and complete bearing breakdowns involves no particular increase in initial cost if you line your bearings with Magnolia Anti-Friction Metal, but you would effect a substantial ultimate saving, to say nothing of the more dependable service and relief from bearing worries.

If your supply man offers a substitute, write us direct.

Magnolia Metal Company
113 Bank Street, New York

Chicago	San Francisco	Montreal
Fisher Bldg.	Pacific Bldg.	37 Shannon St.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK

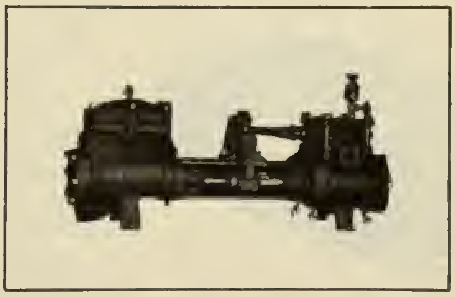
Everlastingly At It

It is a great source of satisfaction to have a pump that gives you no trouble under ordinary working conditions.

The pump that keeps everlastingly at it, is the pump you are looking for.

Smart-Turner Pumps are thoroughly dependable and give satisfaction everywhere. Figure No. 164 is one of our packed piston pumps with brass valve seats screwed in rubber, or brass valves depending upon the service.

We guarantee service on all Smart-Turner Pumps.



Write us for the name of our nearest representative.

The
Smart-Turner Machine Co.
Limited
Hamilton, Ontario

A Reasonable Saving of 5 to 10%

Should You Expect More?

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee St. PHONE G. 3660 Toronto, Ont.

The Physician
considers each patient separately

He doesn't give every one a pill out of the same box. Scientific training and practical experience have taught him that each case must be studied individually, for best results.

In the same way, the wise power plant engineer wants boiler feed water regulation that is exactly suited to the conditions of his plant. That's why he specifies the

COPES System of Boiler Feed Water Regulation

Every COPES is exactly fitted to the special service for which it is intended. In every case the type of boiler, size of feed lines, normal and maximum ratings, steam pressure, method of firing, and pump control are taken into account when the regulator is designed.

The COPES is succeeding every day on the hardest kinds of service—for instance rolling mills, waste heat boilers, dye houses, cement mills, paper mills, and flash type vertical boilers. We have been able to meet every difficult boiler-feed situation successfully, by carefully fitting the regulator to its work, in each case.

Our method of doing this—and the results obtained—are interestingly described in Catalog "D." A copy will be sent gladly upon request.

NORTHERN EQUIPMENT CO., 112 West 11th St., Erie, Pa.
BRANCH PLANTS: Hamilton, Ontario, Canada; Croydon, England; Paris, France; Cologne, Germany.

COPES
SYSTEM OF BOILER FEED CONTROL

The Basis of most Boiler compounds, often sold under special names, is nothing but Silicate of Soda.

It is a fact that straight Silicate of Soda, properly graded, will positively remove and prevent all boiler scale.

"Boiler Brand" is sold for what it is—just one of our many grades of Silicate of Soda. You'll find its action similar to the most expensive compound.

Keep Your Boilers Efficient

with

BOILER BRAND

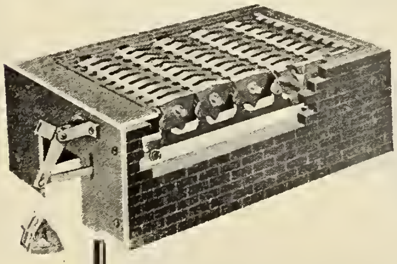
Silicate of Soda

No condition of boiler scale has yet been found that "Boiler Brand" will not handle if used in proper quantities. It stops pitting and corrosion by neutralizing the corrosive acids in the water. It protects and lengthens the life of packings and fittings.

No Mystery--Just Chemistry

Let a Technical Firm
Do a Technical Job

G. F. STERNE & SONS, LIMITED
Chemical Manufacturers, Consulting Chemical Engineers,
BRANTFORD :: CANADA



Anti-Clinker
SHELL-BAR GRATE BARS

Designed and built by men with practical experience, the Shell-Bar Anti-Clinker Grate Bars are built to

Get the last bit of heat out of the last bit of fuel

Write for full particulars

Maximum air space permits perfect combustion even of low-grade fuel. Nothing is burnt to waste—nothing is wasted in clinkers. Wherever they are used they are giving more heat with less fuel.

SHELL-BAR BOICO SUPPLY, Limited 1-15 Saunders Ave. **TORONTO**

SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

Annual Convention

of the

CANADIAN ASSOCIATION
of
STATIONARY ENGINEERS
OF THE DOMINION OF CANADA, INC.,

will be held in conjunction with

Annual Exhibition of Power Plant Equipment

June 25, 26, 27, 28

in the

Central Technical School
Toronto, Ontario

Remember it ! *Boost it !* *Come to it !*

For further particulars write

George J. Soucy, Chairman, 48 Moore Avenue
TORONTO

Established 1907

POWER HOUSE

Member A.B.C.

B. G. NEWTON, Manager

S. S. MOORE, Advertising Manager

CANADA—**Toronto** (head office): 153 University Ave., Tel. Ad. 5740. **Montreal:** A. E. Guidal, 128 Bleury St., Tel. Plateau 946. **Winnipeg:** 810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—**New York:** J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. **Chicago:** A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. **Boston:** C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN **London:** The MacLean Company of Great Britain Limited. 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A
Audel, Theo 45
Allen Feed Water Purifier Co... 56

B
Babcock & Wilcox, Ltd.......... 41
Betson Plastic Fire Brick Co., Inc. 49
Brown Instrument Co.......... 49
Bristol Co. 4
Boiler Repair & Grate Bar Co. 4
Buyers' Directory 48, 50, 52

C
Callard, Geo. 45
Canadian Fairbanks-Morse Co., Ltd., ... 10
Canadian Steam Boiler and Equipment Co. 54
Conveyors Corp. of America.... 46
Cory & Sons, Inc., Chas........ 6
Combustion Engineering Co.... 3
Cunerty Co., T. J.............. 47
Cole, Grant. E................. 14

D
Dart Union Co. 6
D'Este Co., Julian 49
De Laval Steam Turbine Co.... 13
Detroit Stoker Co.............. 2
Dominion Belting Co........... 49
Dunham Co., C. A............. 43
Durabla Mfg. Co. 10
Dunlop Tire & Rubber Co., Ltd. 51

E
Engineering and Mach. Works of Canada 8
Edward Valve & Mfg. Co....... 19

F
Fisher Governor Co. 9
Foxboro Co., Inc. 46
Flexible Steel Lacing Co....... 16
Flexible Metallic Packing Co... 51

G
Garlock Packing Co............ 47
Garth Co., The 49
Goldie & McCulloch 20
Gutta Percha & Rubber Co..... 5

H
Hays Corp., Jos. W............ 14

I
Irving Iron Works............. 16
Imperial Oil Co. ....Inside Back Cover

J
Jamieson Cold Storage Door Co. 11
Jenkins Bros. ....Front Cover
Jointless Fire Brick Co......... 51

K
Keasbey & Mattison Co......... 51

L
Laurie Engine Co. 47
Lunkenheimer Co. ....Inside Front Cover
Lammers & Maase, Ltd. 19

M
Magnolia Metal Co............ 53
McGowan Co., The John H.... 16
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncrieff, Ltd. 56
Mueller Mfg. Co. 12
McLaren Co., D. K............. 17

N
Northern Equipment Co. 54

P
Pilley Packing & Flue Brush Mfg. Co. 47

R
Refinite Co. of Canada........ 47

S
Superheater Co., Ltd.............49
Sterne & Sons, G. F........... 54
Sarco Co., Inc.................. 9
Sanford Riley Stoker Co........ 15
Shell Bar Boico Supply Co...... 54
Sterling Engine Co............. 8
Sturtevant Co. 45
Sexton Boiler Setting Co., W. R. 13
Stephens Chemical & Mfg. Co., Limited 7
Smart-Turner Machine Co...... 53

T
Taylor Instrument Co., The.... 53
Thomson-Gordon, Ltd.......... 47

U
Underfeed Stoker Co. of Canada 15

V
Victoria Foundry Co. 47

W
Wall, W. J. 56
Waterous Engine Works Co. ... 1
Watson & McDaniel Co. 49
Watson, M. Barry, M. E....... 45

Y
York Mfg. Co. 49
Young Pump Co. of Canada.... 14

Why Individual Boiler Feed Water Treatment

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)

Distributors : William C. Wilson & Co., 21 Camden Street, Toronto

Phone Adel. 1054 or write for full particulars.

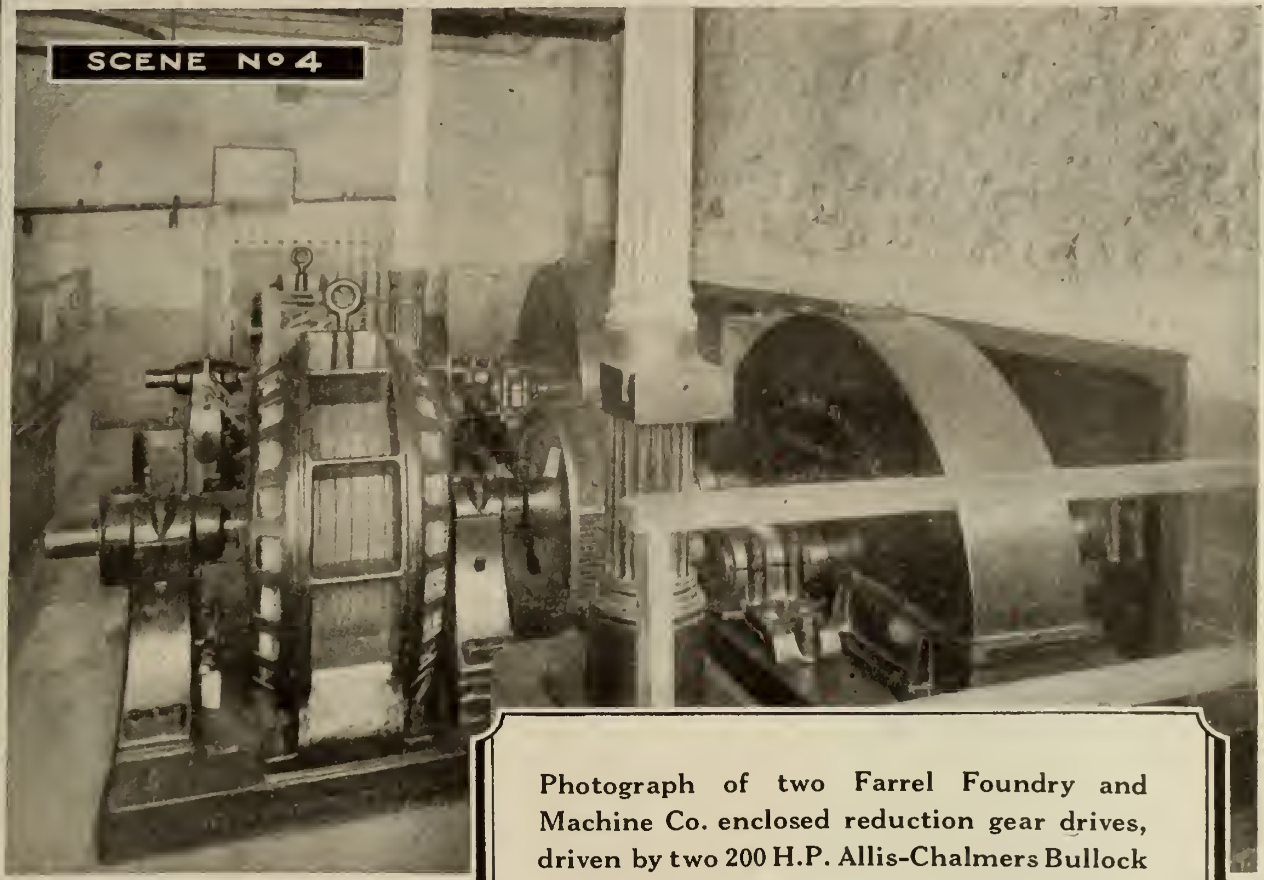
MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is **economical.** British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative; **W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA**



Photograph of two Farrel Foundry and Machine Co. enclosed reduction gear drives, driven by two 200 H.P. Allis-Chalmers Bullock A.C. Motors. Motor Speed 290 R.P.M.

Imperial Lubricants in use:—

Imperial Renown Oil.
Imperial Polarine Transmission Oil.

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

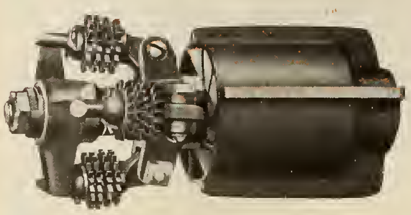
Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

It is not at all unusual for plant operators to report lubrication savings up to 35 per cent. following standardization on Imperial Lubricants. Economies which are immediately evident reflect our exhaustive study of industrial requirements as well as the scientific methods which govern the manufacture of our complete line of industrial oils and greases. Write our nearest branch for information on any lubrication problem. Your letter will be followed up personally by our expert lubrication engineers.

IMPERIAL OIL LIMITED

MORRISON

Devices for Effective Tube Cleaning

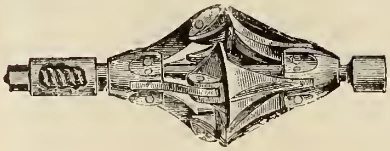


The "Turbina" Tube Scraper.
Driven by Water Pressure.

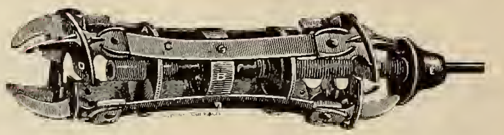
The Morrison line includes tube cleaning devices of an unusually wide range of styles and sizes for every purpose.

They represent the latest achievement of practical men and are designed and built to combine effectiveness with ease of operation in the least possible time.

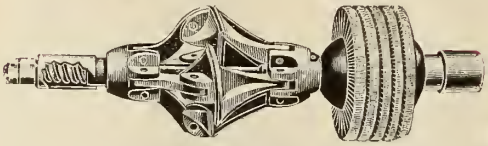
Let us send you detailed information of this line.



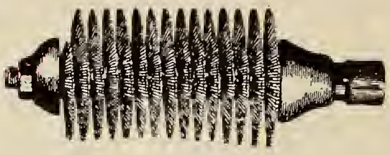
"Ingalls" Tube Scraper.



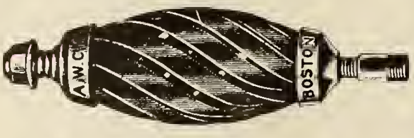
The Engineer's Favorite.
Tube Scraper.



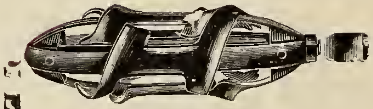
"Combination" Tube Scraper and Brush.



Wire Tube Brush.



The "Elliptic" Tube Scraper.



The "Ideal"
Tube Scraper.

The "X-L"
Steam Tube Cleaner.

The "Gem."
Steam Tube Cleaner.

Steam Soot Ejector

The James Morrison Brass Mfg. Co., Limited
93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Vol. XVI—No. 11
Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.
June 5, 1923

Removing ashes by the steam jet method insures lowest cost per ton of ash handled. American Steam Ash Conveyors have proven their economy in hundreds of plants. Cut your costs 50-75%. Economical operation guaranteed. Ask for booklet.

Conveyors Corporation of America
326 W Madison Street CHICAGO, ILLINOIS

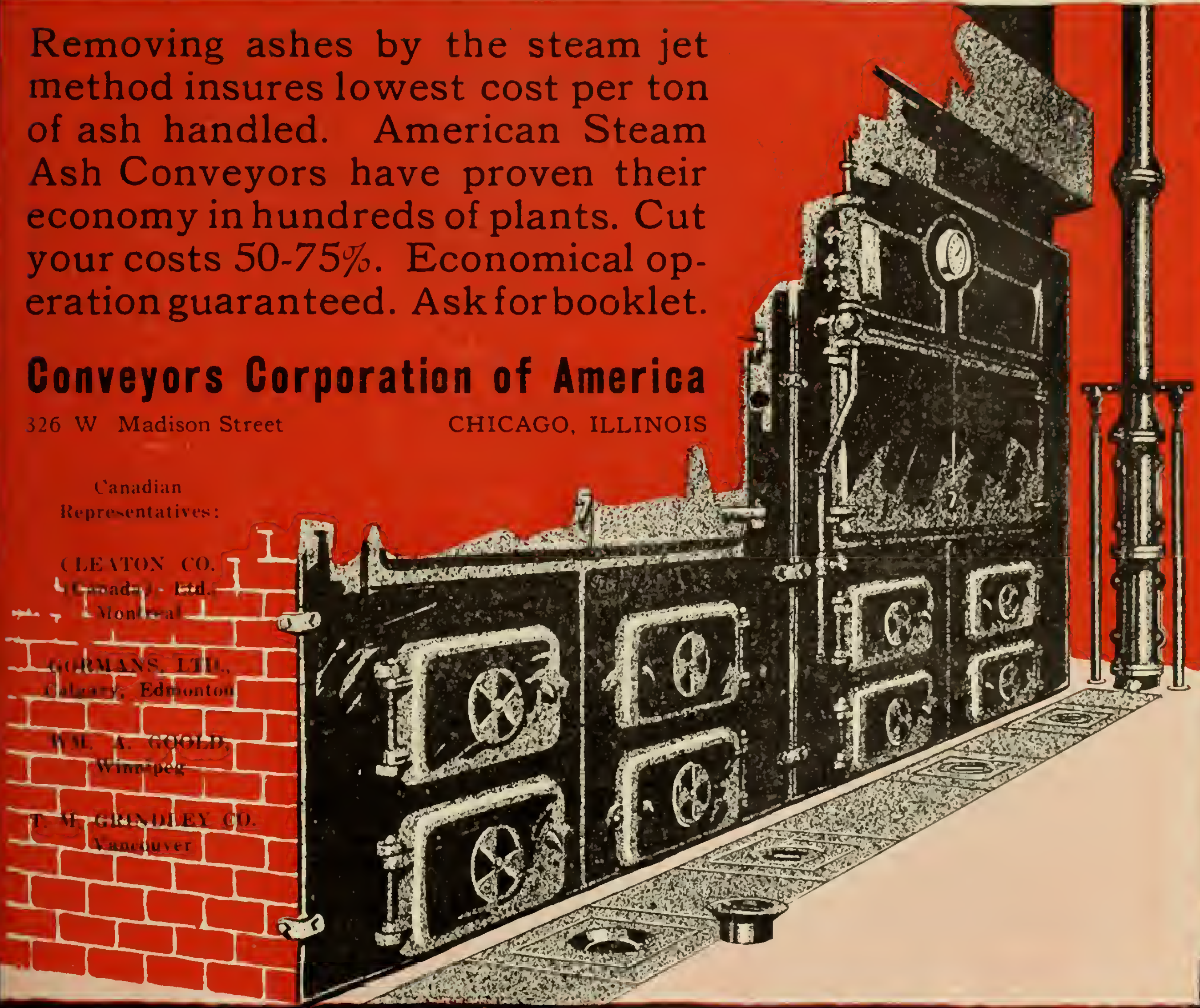
Canadian
Representatives:

CLEATON CO.
(Canada) Ltd.
Montreal

GORMANS, LTD.,
Calgary, Edmonton

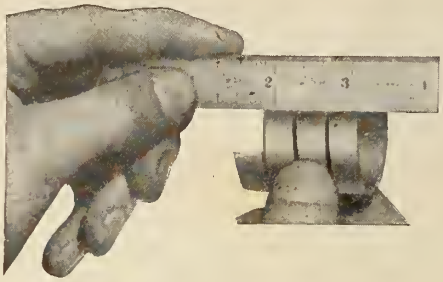
WM. A. GOOLD,
Winnipeg

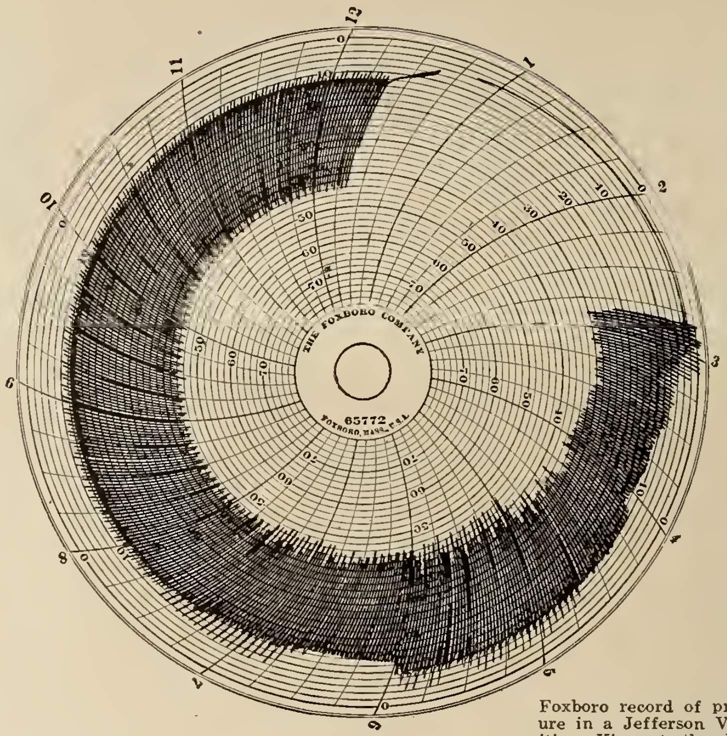
T. M. GRINDLEY CO.
Vancouver



AMERICAN
STEAM ASH CONVEYORS

15 Cents a Copy. $2.00 a Year.





Foxboro record of pressure in a Jefferson Vomiting Kier at the Lincoln Bleachery, Lonsdale, R. I.

FOXBORO

Helical Tube Movement

The unretouched photographs reproduced above show a Foxboro Helical Tube taken from stock. Note the uniformity of every convolution — striking proof of the superiority of the Foxboro method of drawing in the temper.

Foxboro Helical Tubes do not fatigue, split or leak. They are permanent in calibration and may be used constantly at maximum range without affecting their accuracy or strength.

The wonderful dependability of these tubes means much to users of Foxboro Recording Gauges, Thermometers and Psychrometers.

Up and Down 16,000 Times a Month!

What more exacting test could be made of the strength and elasticity of the Foxboro Helical Tube Movement than recording the pressure changes in this type of Bleaching Kier? Pressure in the kier is regulated by automatic controlling devices which raise and lower the pressure once every two minutes. The Foxboro chart record shown above was taken from one of several Foxboro Recording Gauges installed on Jefferson Vomiting Kiers at the Lincoln Bleachery, Lonsdale, R.I.

Up and down, 16,000 times a month, the pen arms of these gauges have accurately recorded the pressure changes for many months.

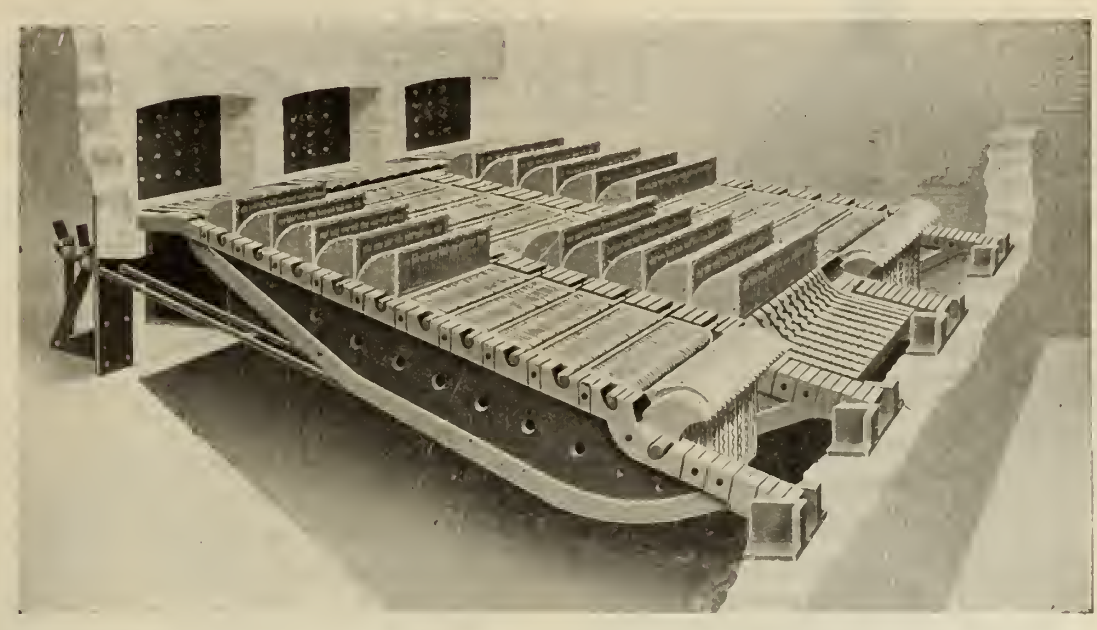
These gauges are identical in construction with the thousands of Foxboro Recorders that are performing less spectacular but no less dependable service in power plants the world over. Every Foxboro Recorder is built and tested to be fully worthy of its responsibility as "The Compass of Industry," no matter how severe the service it is called upon to give.

For full information write for Bulletin CF-98-2

THE FOXBORO CO.,Inc., FOXBORO, MASS., U.S.A.
New York, Chicago, Boston, Tulsa, Cleveland, Pittsburgh, Philadelphia, San Francisco, Rochester, Birmingham.
Peacock Brothers, Limited, 179 Delorimier Avenue, Montreal, Canada.

FOXBORO
REG. U.S. PAT. OFF.
THE COMPASS OF INDUSTRY

5301



THE FILES STOKER

Pays for Itself in One Year

Below is a copy of one of the many letters we have received, telling of the efficiency and economy of the Files Hand-Operated Stoker

The Waterous Engine Works,
Brantford, Canada.

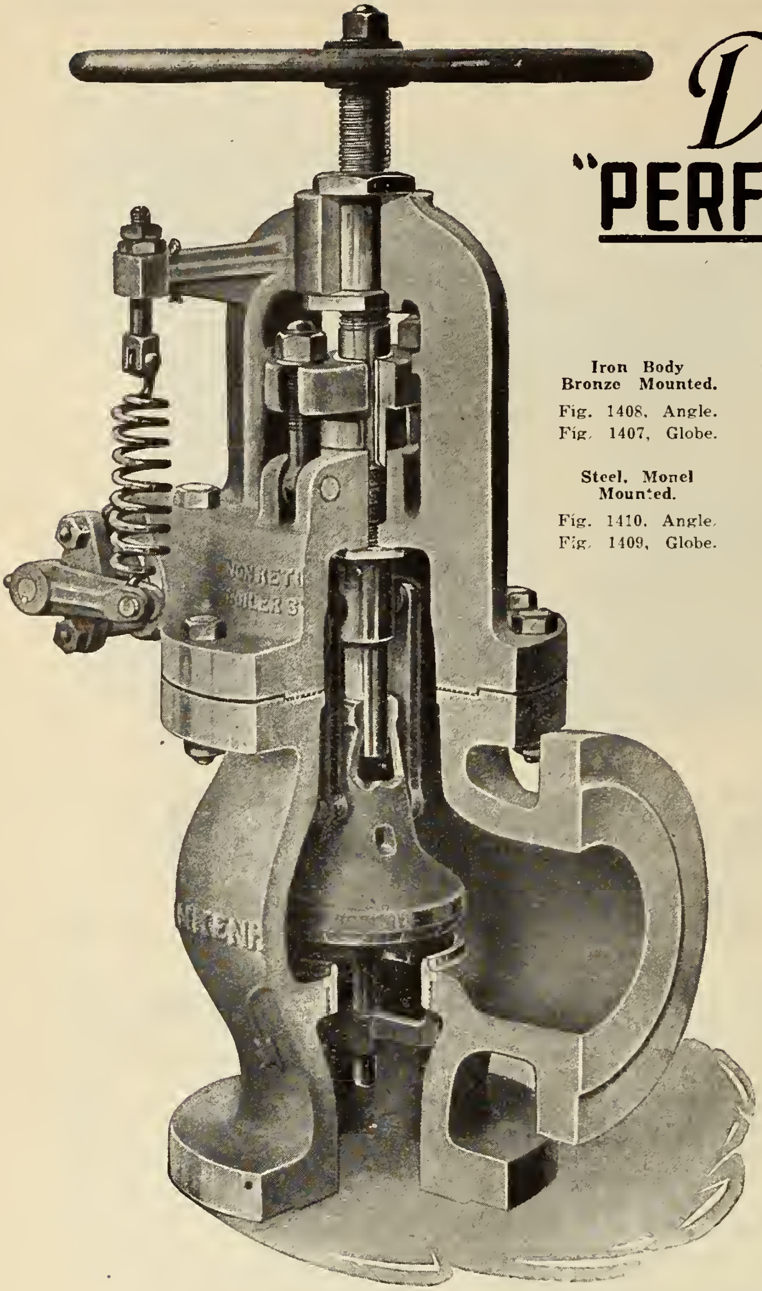
Gentlemen:

Replying to your recent letter. About a year ago we were using seven 150 H.P. Erie City Boilers, and were burning "Jellico" straight run of mine coal and could hardly keep up steam with it. In our coal preparation we get a fine screening known as "Bug Dust" and formerly threw this away, but recently we completed the raising of our boilers and the installation of Files Stokers, with the result that we never use over four boilers and burn the "Bug Dust" exclusively, and our power production cost is less than half of what it was formerly.

Waterous

BRANTFORD, ONTARIO, CANADA

Definition of a "PERFECT" Non-Return Valve



Iron Body Bronze Mounted.
Fig. 1408, Angle.
Fig. 1407, Globe.

Steel, Monel Mounted.
Fig. 1410, Angle.
Fig. 1409, Globe.

ONE that automatically and RELIABLY closes upon the sudden decrease of pressure in a boiler connected in battery to which it is attached and opens only when the pressure in the boiler equalizes with that in the header; that prevents steam from other boilers in battery escaping through a disabled one, thereby enabling the safe and uninterrupted operation of the plant through the medium of the live boilers; one in which the disc freely operates, does not stick and has external regulating means, conveniently and quickly adjustable, to eliminate chattering of the disc; one that facilitates assembling and disassembling for inspection, regrinding of seating surface, cleansing, or for renewing any part; and one that has a large factor of safety, offers the maximum service and economy of maintenance.

A better and shorter definition is

LUNKENHEIMER Safety Non-Return Valves

made in all standard sizes, Iron Body Bronze Mounted for 250 pounds pressure and 450° F. total temperature, or Steel, Monel Mounted for 350 pounds pressure and 800° F. total temperature.

Booklet 525 D.C. describes these Valves in detail. Write for a copy.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO **CINCINNATI, U.S.A.** LONDON
EXPORT DEPT 129–135 LAFAYETTE ST., NEW YORK

"America's Best since 1862"

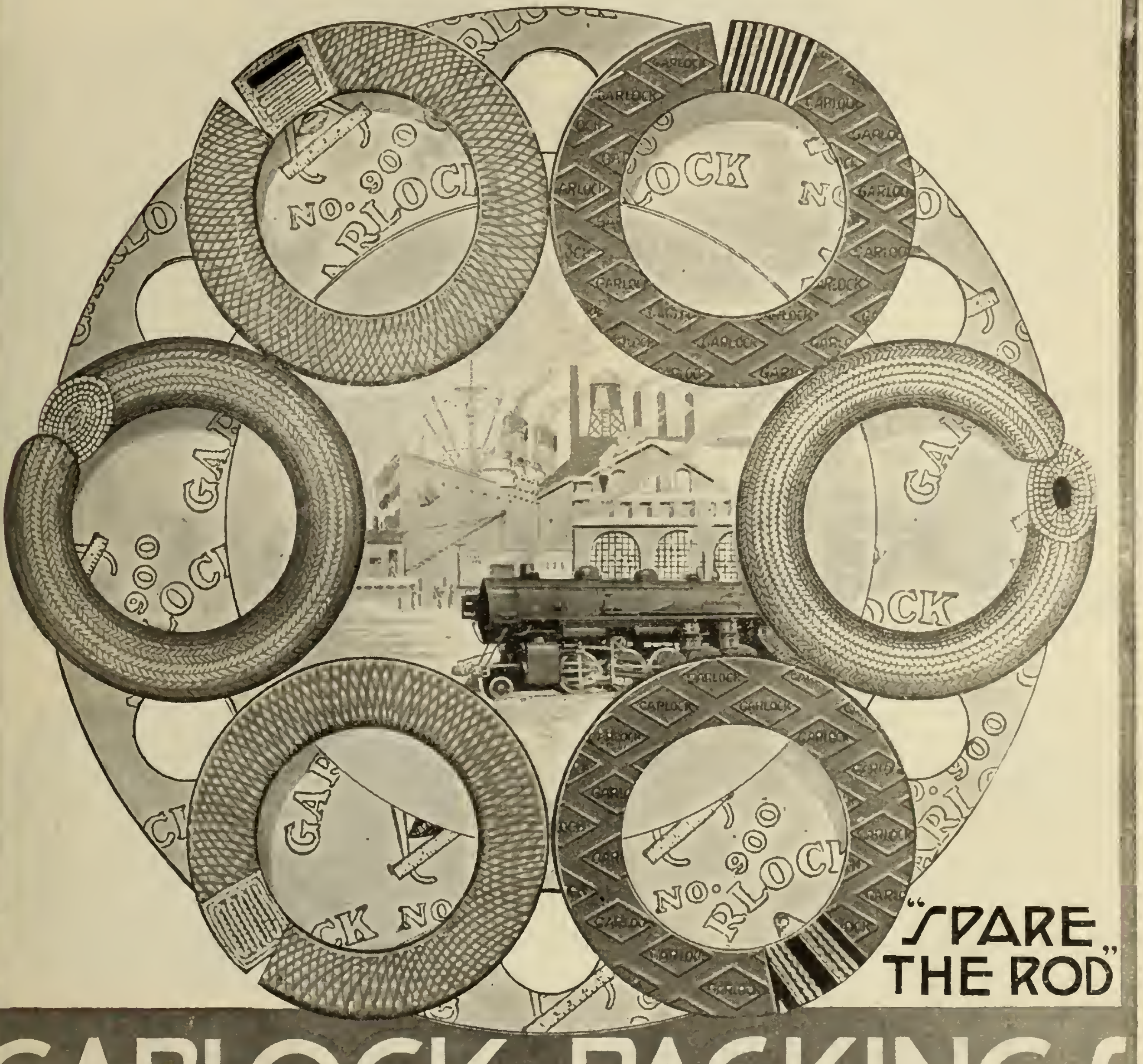
10-21-43

IN ENGINEERING CIRCLES

It is the operating engineer who most appreciates reliability.

Hours spent renewing rod packing and replacing gaskets, often in inaccessible places, have proved to him the fact that quality is the main consideration when purchasing packing. Added to this is the saving due to minimum rod friction and leakless joints.

On your next order specify GARLOCK, the packing of world-wide reputation and known reliability.



GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONTARIO

BRANCHES:

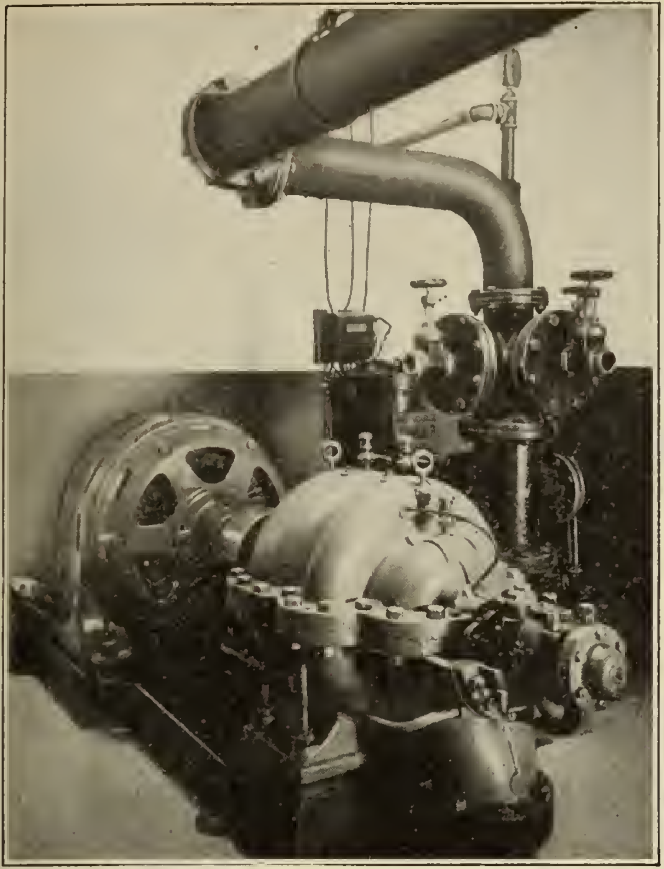
Montreal, Que.	Toronto, Ont.	Winnipeg, Man.
Calgary, Alta.	St. John, N.B.	Vancouver, B.C.

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Dependable!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast



A Pump for Every Purpose

Pumps for Municipal Water Supply, High Pressure Irrigation, Marine Service, Hydraulic Elevator Service, water supply for mills, office buildings and apartment houses, etc.

These renowned pumps have a long record of continuous satisfactory service. They are of extra rugged construction, and all bearings are renewable bronze, while they may be opened quickly for inspection without disturbing pipe connections.

We supply practically every type of pump, be it Air, Boiler Feed, Centrifugal, Fire, Marine, Gasoline, Heavy Oil, Irrigation, Rotary, Hydraulic or Typhoon, etc., and our engineers will gladly recommend the proper type for your conditions, without charge or obligation. Write our nearest office for Pump data.

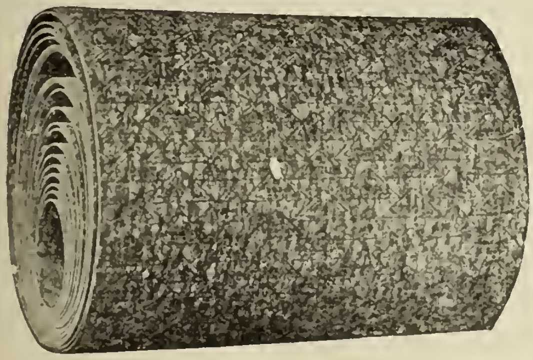
101

The Canadian Fairbanks-Morse Co., Limited

Montreal, Toronto, St. John, Winnipeg, Quebec, Ottawa, Windsor, Vancouver, Calgary, Regina, Victoria.

Durabla Gaskets Make Tight Joints

Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.



Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

DURABLA

TRADE MARK REGISTERED

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in. long.

In thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Let us send you a trial order.

CANADIAN DURABLA LIMITED, MONTREAL

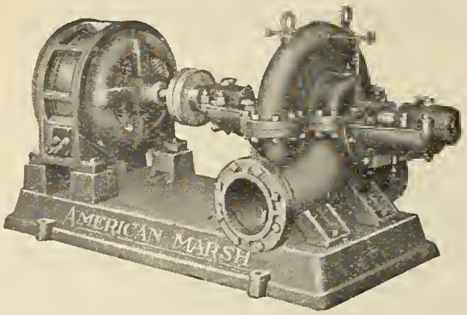
Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

AMERICAN-MARSH PUMPS

Centrifugal and Direct Acting



Designed for use in power plants where absolute reliability and high efficiency are essential. For over thirty-five years American-Marsh Pumps have been recognized as standard throughout the Dominion. There are over 160,000 in successful operation.

The sturdy rugged construction and heavy cast bronze fittings insure long life and a minimum repair expense.

American-Marsh Centrifugal Pumps are built with the same painstaking care that characterizes the construction of the direct acting line.

The Line includes :

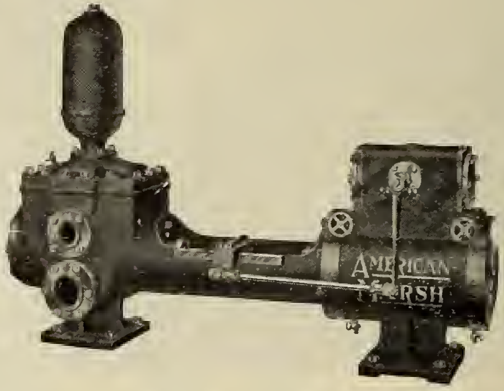
- Boiler Feed Pumps
- Air Compressors
- Deep Well Engines
- Centrifugal Pumps
- Jet Condensers
- Vacuum Pumps
- Condensation Pumps
- Sump Pumps

May we send you our general Catalog ?

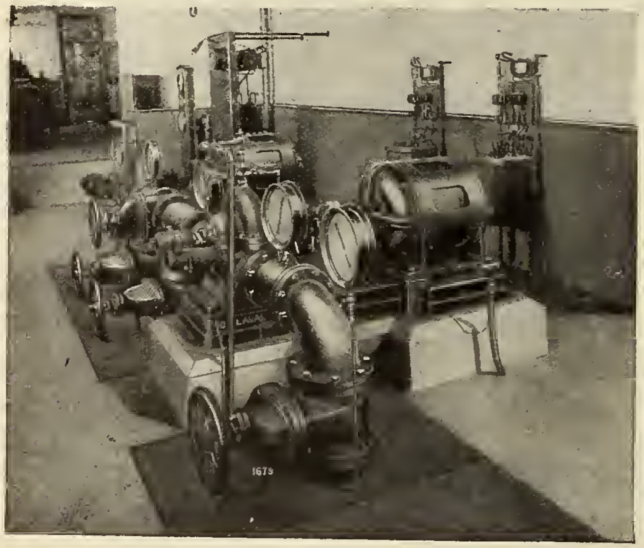
AMERICAN STEAM PUMP CO.

BATTLE CREEK, MICH.

CANADIAN AGENTS:—A. R. Williams Machinery Co., Ltd., Toronto; **Williams & Wilson, Ltd.**, Montreal; **London Engine Supplies Co., Ltd.**, London; **A. R. Williams Machinery Co., Ltd.**, Winnipeg; **Mechanics' Supply Co., Ltd.**, Quebec; **Gorman's Ltd.**, Edmonton and Calgary; **J. T. Allan Ritchie**, Vancouver.



Collingwood Uses De Laval Motor Driven Pumps for Both Domestic and Fire Service



THE two De Laval motor driven pumps in the photograph were installed by the City of Collingwood, Ont., to provide both domestic and fire service. The pumps are each designed to deliver 1,200 gal. per min. against 165 ft. head at 1,740 r.p.m., but the piping is so arranged that the two pumps can be operated in series to give 330 ft. head.

De Laval centrifugal pumps are ideal for electric drive because of their high efficiencies and their power-limiting characteristics. The size of the motor can be selected to give the highest efficiency at the normal delivery of the pump, and the motor will not be overloaded even though the pump be allowed to discharge free against no head. This is also favorable to high power factor in induction motors, as is likewise the low starting torque required.

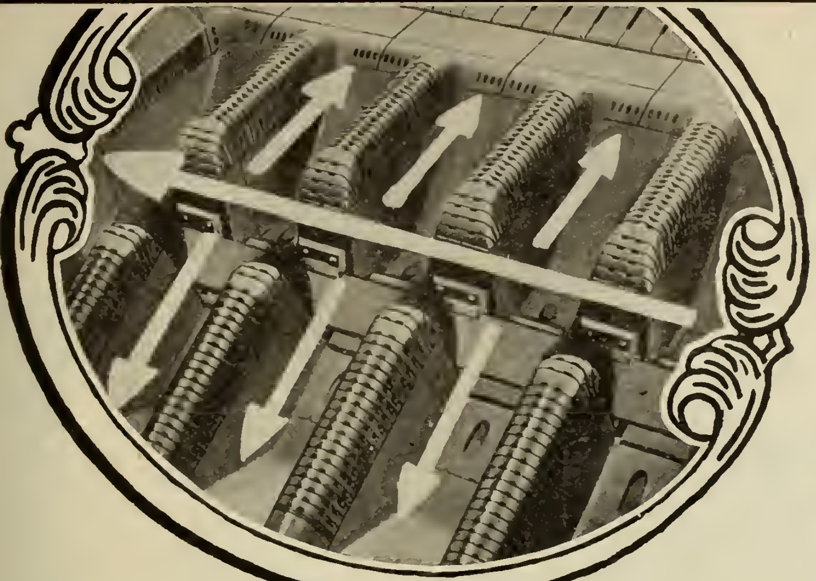
All De Laval pumps are guaranteed as to efficiency, capacity and power characteristics, and each unit is tested before it leaves the shops.

State your pumping requirements so that we may send specific information.

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.



The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.

RILEY JONES MURPHY

It introduced a new era in underfeed stoker firing—

THE coming of the **"Lateral Retort"** Stoker brought a new epoch in stoker building—and a welcome one. It made available for every plant the high efficiency and high capacity of the multiple retort stoker at the installation and operating cost of the single retort stoker.

Although the **"Lateral Retort"** is multiple retort in effect, in construction it is a simple, single retort stoker. Coal, following the path of the arrows, is first underfed to the main retort and then, actuated by lateral pusher blocks, is underfed into the **"lateral retorts."** Finally, the ash is deposited upon easily operated side dump plates and is dropped into ash pits only 6 to 18 inches below the floor line—so shallow that no expensive ash pit construction is needed.

Ask for the **"Lateral Retort"** Bulletin that shows how this stoker is multiple retort in everything but price—how perfect coal distribution is obtained because of the control of the fuel bed afforded by the main ram and the auxiliary ram—how high efficiency is obtained because of the application of the underfeed principle—how heavy overload capacity is secured by great reserve capacity—how automatic control of fuel and air is given by the use of the Cole Automatic Valve—how features of construction give long life and freedom from excessive maintenance costs.

Your Copy of the Booklet awaits your postcard

The Under-Feed Stoker Co. of Canada Ltd.
146 King Street, West - Toronto

Sales agents for: "Jones" Stokers, "Riley" Stokers, and "Murphy" Automatic Furnaces

Alta. & West. Sask.:
Mr J. Twomey, Camrose
Alberta.

Man. & East Sask.:
W. W. Hicks & Co.,
Winnipeg.

British Columbia:
E. A. Earle, Ltd.,
Vancouver, B.C.

Quebec:
The Cleaton Co., (Can. Ltd.,) Montreal, Que.

Advantages of the *"Lateral Retort"* Principle

Coal is underfed throughout—not overfed on to side grates. This is the only truly *underfed* side-cleaning stoker.

One simple moving unit for five or more retorts—The feeding mechanism of the *"lateral retorts"* is controlled independently of main feed, permitting ideal fuel distribution under all conditions.

Simplest cleaning mechanism—a perfectly balanced dump plate easily operated by hand.

No need for basement ash pits—A trench 6 to 18 inches below the floor line is sufficient excavation for ash pits. This greatly reduces installation cost and makes the stoker adaptable to boilers already in service.

Plate tuyeres—reduce siftings and lower replacement cost.

High air cooled front and rear tuyere blocks keep fire and clinkers away from front wall and bridge wall, reducing furnace maintenance.

The "Lateral Retort" Stoker

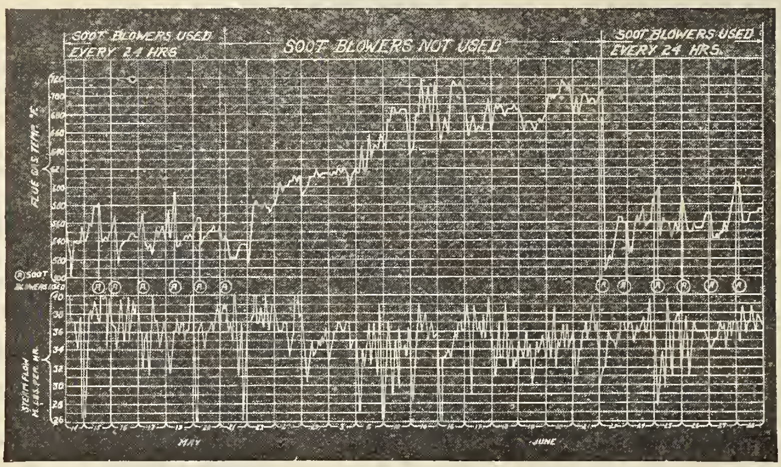
TRADE MARK

For Cheaper Steam Production Use Diamond Soot Blowers

The chart below covers the result of a test made by a public utility on a 780 H.P. vertical water tube boiler, 225 lbs. pressure, 130° superheat.

The soot blowers were used once a day for a period of eight days, after which the boiler was allowed to go without cleaning for thirty days.

It will be noted that as soon as operation of the soot blowers was discontinued, the temperature rose daily from an average of about 545° to about 680° at the end of the nineteenth day, after which it maintained this same average for the succeeding eleven days. When the blowers were again operated an immediate drop in temperature occurred from 680° to an average of 560° for the succeeding eight days. It will be seen that the load was fairly uniform throughout the test.



The extent to which Diamond soot blowers thus reduce the cost of steam production is obvious. The fuel saved by reducting the flue gas temperatures may be estimated at 1% for each 20° to 30° drop in flue gas temperature, depending upon the amount of excess air in the chimney gases.

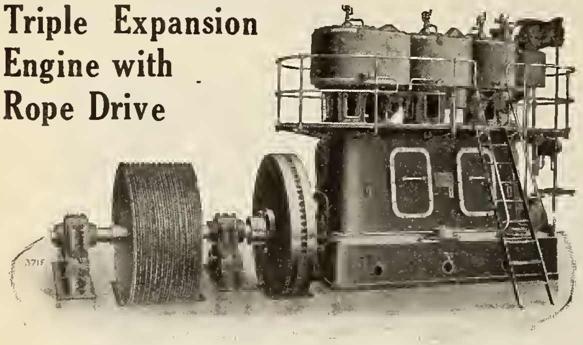
On the basis of fuel saving, Diamond soot blowers are one of the best paying investments in the power plant. They pay for themselves many times over during their period of service.

Send data regarding your boiler equipment and write for full information. Ask for Bulletin 287.

DIAMOND SPECIALTY LIMITED
Windsor, Ontario

Diamond
Soot Blowers - Save 4 to 8% Fuel

Triple Expansion Engine with Rope Drive



Belliss & Morcom Ltd.
Birmingham, England

Builders of:

STEAM ENGINES
AIR COMPRESSORS
STEAM TURBINES
CONDENSERS
CRUDE OIL ENGINES

Packing for Centrifugal Pump Spindles will not cut

Maxim Silencers

for Air Compressor Suction, Gas Engine Exhausts, etc.

Welldeck Steam Traps

do not get out of order

AGENTS:

LAURIE & LAMB, Board of Trade Bldg., **MONTREAL**

D.K. McLaren's

Genuine British Oak Tanned LEATHER BELTING

Look for the Oak Leaf It's Your Guarantee

All hides used in the manufacture of D. K. McLaren's Belting are specially selected by men whose experience with hides guarantees the rejection of any that fail in any way to come up to the rigidly set McLaren Standard of quality.

In the manufacture of D. K. McLaren's Leather Belting, only the backs of the hides of the choicest steers are used. These are subjected to the Genuine British Oak Tanning Process which adds considerably to the original toughness of the hides and at the same time imparts a flexibility and a stretchless quality that is unequalled by any other process.

It is only after every inch of belting has been put to the severest tests that the Oak Leaf is stamped upon it as the D. K. McLaren Guarantee of efficiency, even under the most adverse conditions—your assurance of Belting with a grip that never slips.

GENUINE OAK

D·K·McLAREN
LIMITED

GENUINE OAK

Head Office and Factory: 351 St. James Street, Montreal, P.Q.

BRANCHES:

Toronto
194 King St. W.

St. John, N.B.
90 Germain St.

STOCK DEPOTS:

Vancouver, B.C.
Gormans, Ltd.,
1158 Homer St.

Calgary
Gormans, Ltd.

Edmonton
Gormans, Ltd.

REFRIGERATION DEPARTMENT

LINDE

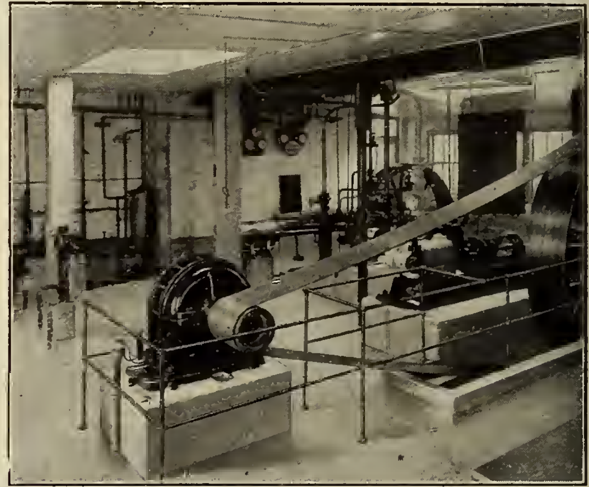
Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants
Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

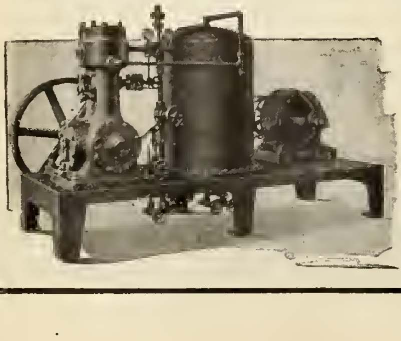


This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.
37 St. Peter Street, MONTREAL, Que.
TORONTO WINNIPEG VANCOUVER

VILTER

ICE MAKING AND REFRIGERATING MACHINERY

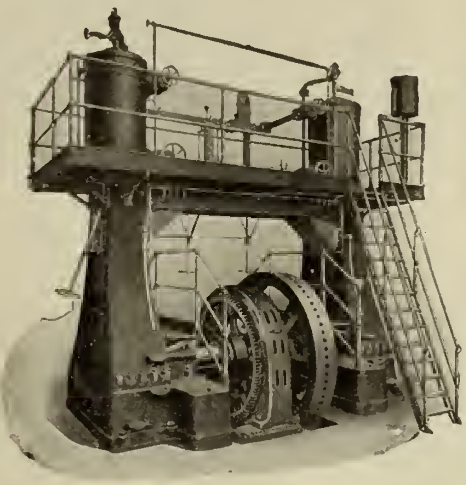


A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada

QUALITY YORK CO SERVICE

YORK Semi-Enclosed Refrigerating Machine



WHERE electric current is available at a reasonable cost, our Semi-Enclosed Machine, with direct motor mounting, makes a neat, clean and highly economical plant—no belts, no engine or steam lines.

The machine occupies a comparatively small floor space.

All the power developed by the motor is delivered to the crank-shaft of the machine. Built in sizes from 30 tons refrigerating capacity upwards.

Complete data and prices upon application.

CANADIAN ICE MACHINE CO.
LIMITED

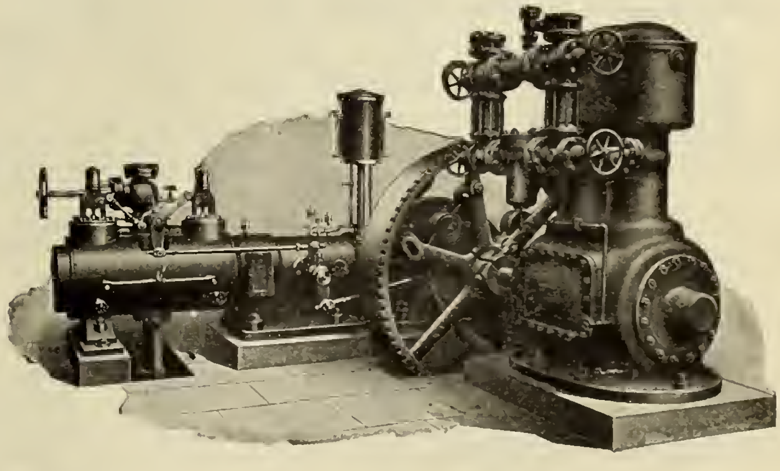
Toronto: Villiers & Munition Sts., Eastern Harbor Term'ls.
Montreal: 324 Craig St. West; Winnipeg: 1415 Whyte Ave.;
Vancouver: 1158 Homer St.

Representing
YORK MANUFACTURING CO., YORK, PA., U.S.A.

FRICK CO. INC. TRADE MARK FRICK WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical



Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

KERR

"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

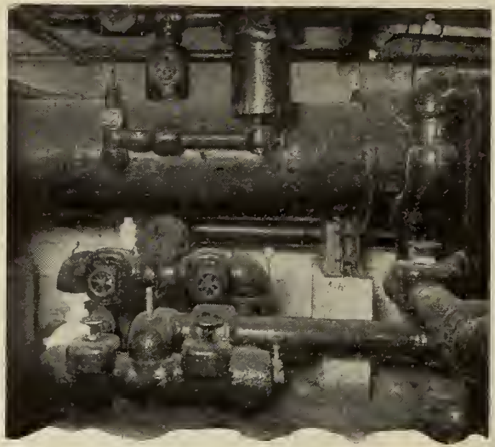
It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited

Valve and Hydrant Manufacturers

Walkerville Ontario



Illustrating the adaptability of Nonpareil Cork Covering to a great variety of equipment. Gatesworth Hotel, St. Louis, Mo.

These lines are *insulated*, not just covered

REFRIGERATED lines are not covered for appearances, or to protect the metal, or for any other purpose than to insulate them from the higher temperatures surrounding them. Though various materials are used to *cover* cold lines, mark this: Cork is the only material that will *insulate* them and continue to insulate them year after year without loss of efficiency. And certainly that is what you expect of your pipe covering—permanent insulation.

Nonpareil Cork Covering

For Brine and Ammonia Lines

is permanent insulation because it is moistureproof and frostproof. Being cellular in structure, not fibrous, Nonpareil Cork Covering has no capillary attraction for moisture. In addition, it is protected inside and outside by an impervious coating of mineral rubber. Properly applied and given reasonable attention, Nonpareil Cork Covering stays dry. Frost cannot get into it or under it.

Year after year, Nonpareil Cork Covering not only covers, but *insulates*, unchanged in structure, undiminished in efficiency and requiring no more maintenance than an annual inspection and painting.

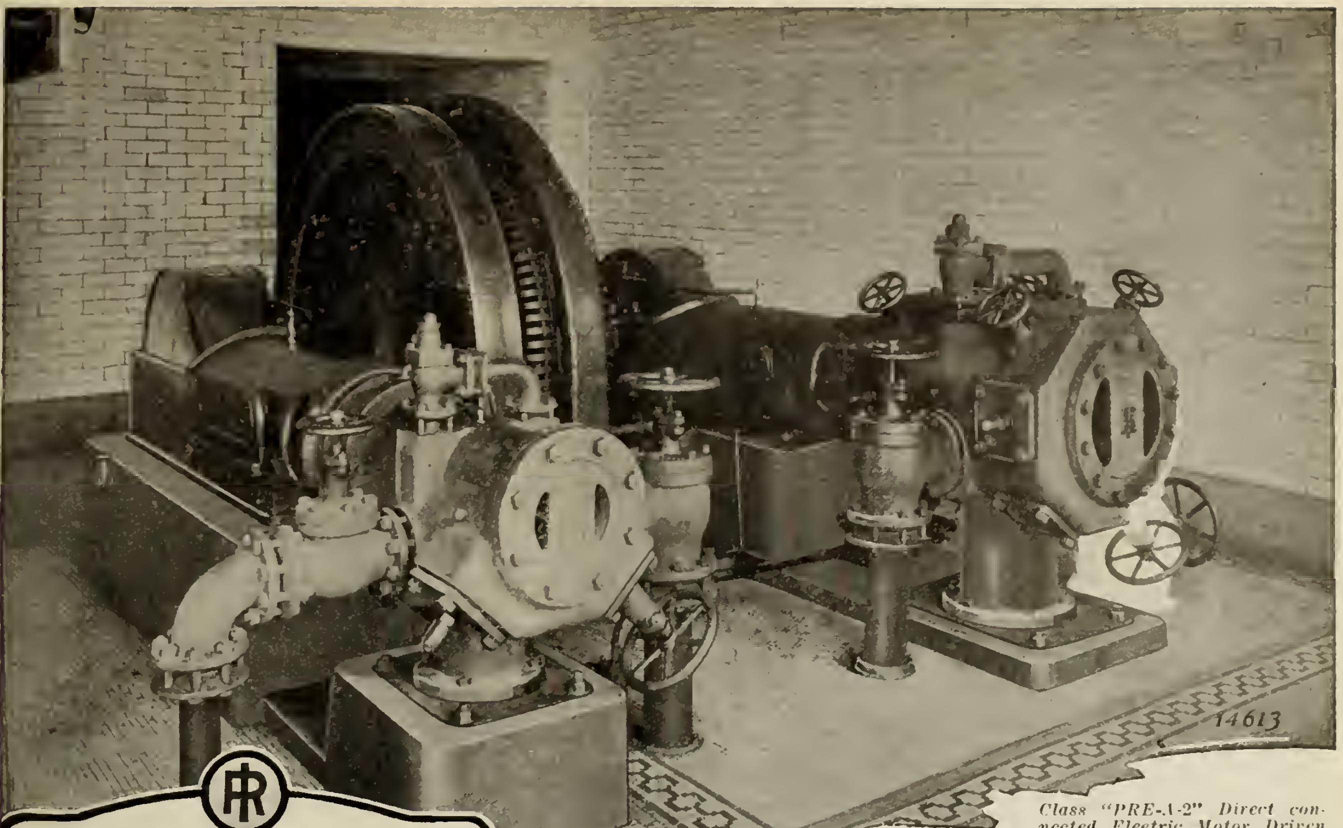
There is a Nonpareil Cork Covering for every temperature, for every pipe size and for every fitting.

◆

Write for the new 32-page book, "Permanent Covering for Refrigerated Lines and Tanks," just off the press. It is sent free on request, with a sample.

ARMSTRONG CORK & INSULATION COMPANY, LTD.

903 McGill Building, Montreal, Que.
11 Brant St., Toronto, Ontario, Can.



Class "PRE-A-2" Direct connected Electric Motor Driven Ammonia Compressor in one of the largest ice cream plants in the world.

Ice and Refrigeration Plant Equipment

Ammonia Compressors

Built for either single or two stage operation, and for belt, steam, oil engine or direct connected electrical motor drive.

Air Compressors

Can be furnished in all sizes and for any commercial discharge pressure. These units are particularly suitable for supplying air for agitation, air lift pumping or for general power purposes. Any type of drive.

Air Hoists

Built in five sizes for from 1,000 to 10,000 pounds capacity. These hoists are extensively used for lifting ice cans and for general hoisting work. They are easy to move about the plant, and simple to operate.

Pneumatic Tools

A complete line of riveters, drills, grinders, etc., for erection, assembly and repair work.

Cameron Pumps

For pumping brine, water and other liquids. These can be furnished in direct-acting type for steam or compressed air drive, or in centrifugal type for belt, motor, steam, oil or gas engine drive.

Price Oil Engines

Of the direct-injection, four-cycle type. Horizontal, single cylinder types of 50 and 100 H.P., and vertical, multi-cylinder types from 105 to 1,000 H.P. AC-3

Two-Stage Direct-Connected Electric Motor Driven Ammonia Compressors

Ingersoll-Rand Ammonia Compressors are ideally adapted to the needs of modern raw water ice manufacturers and cold storage plants.

Their two-stage compressing cylinders are fitted with I-R plate valves. Gas passages are unrestricted and valve areas are unusually large, guaranteeing maximum compression efficiency and consequently lower power cost per ton.

These compressors can be furnished with or without a water intercooler for cooling the ammonia gas between stages. This intercooler is of simple construction and easy to clean. Its use increases the efficiency of the system.

Clearance Pockets cast in the cylinder permit efficient unloading of the compressor to three-quarter or one-half capacity. Provision is made for completely unloading the machine during the starting period.

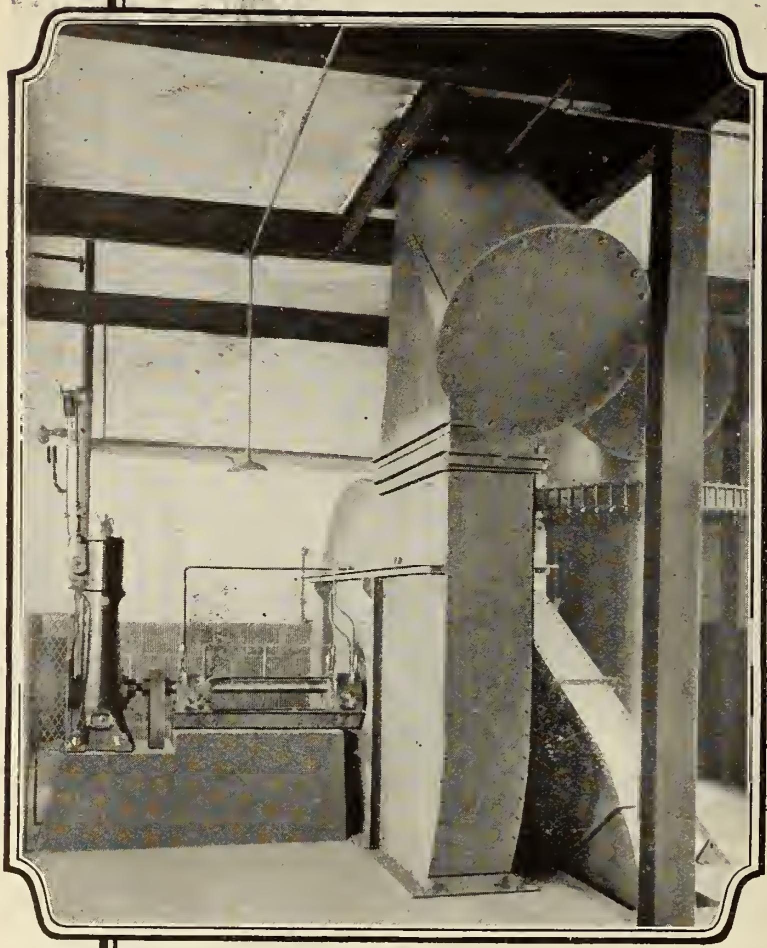
The Class PRE-A-2 Compressor shown above has the rotor of the synchronous motor, direct-connected to the compressor shaft. Ingersoll-Rand Ammonia Compressors are also furnished for belt, steam or direct-connected oil engine drive.

Write for descriptive literature.

Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

Ingersoll-Rand



An Installation of Canadian Sirocco Induced Draft Apparatus

Individual Application of Equipment is the Vital Factor in Mechanical Draft

In the selection of mechanical draft apparatus, the proper selection of the blowing equipment to meet the individual demands of the plant it serves is second only to operating reliability. Control of capacity, pressure and speed, method of drive, economy of operation, etc., are a few of the factors that must be considered.

The wide use of Canadian Sirocco mechanical draft apparatus is due largely to the fact that there is Canadian Sirocco equipment of rugged design and maximum efficiency for every requirement. This, with definite and accurate knowledge of its performance, enables Canadian Sirocco Engineers to cooperate with you in the solution of any problem involved in mechanical draft installations.

Our engineers will be glad to submit recommendations covering your particular requirements.

CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONT.
BRANCH OFFICES IN ALL PRINCIPAL CITIES (299)

"Sirocco" Products

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING,
AIR CONDITIONING, MECHANICAL DRAFT

JENKINS
Bronze
Swing Check Valve

Equipped with Disc Holder and Composition Disc

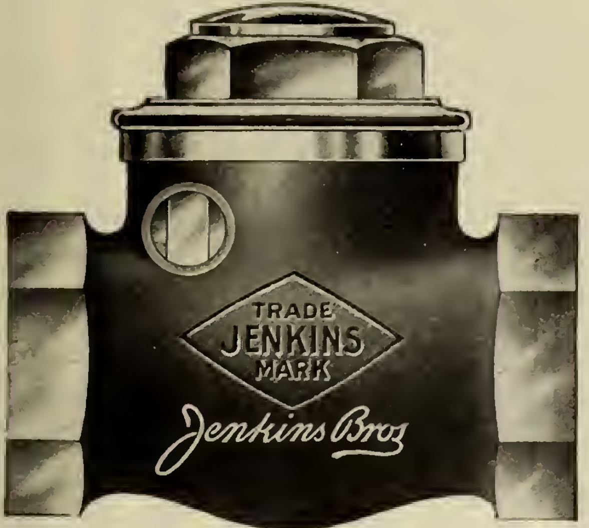


FIG. 475

Perfectly adapted for use in either horizontal or vertical position.

A strong, durable valve that will function satisfactorily. Angle of seat assures valve opening readily at low pressures while the shock of closing in the most severe service is absorbed in the line piping.

These Bronze Swing Check Valves have the Jenkins Renewable Disc feature. Disc lifts well out of passage. Hanger is heavy and has large bearing surface for carrying disc holder. Hanger pin is long and provides ample wearing surface.

Fig. 475, shown above, is the standard pattern made for 150 pounds working pressure. Flanged end valves, Fig. 476, can be supplied if desired.

This and the other Diamond-marked valves in the complete Jenkins line are fully described in Catalog No. 9—free on request.

JENKINS BROS. LIMITED

Head Office and Works: 103 St. Remi St., Montreal.
Sales Offices: Toronto, Vancouver.
European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, Eng.
Factories: Montreal, Bridgeport, Elizabeth.

Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

Make it easy for your firemen to maintain regular temperature

For upon this, the efficiency of the whole feed heating equipment depends.

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

RECORDING THERMOMETERS

are an incentive for your firemen to maintain a regular temperature because the charts show every temperature variation and exactly when it occurred. The men know that the chief knows just what is going on, and strive for a record of efficiency.

Bristol's Thermometers are installed on both the inlet and outlet sides of the feed water heater and of each economizer. They also record temperature of gases leaving economizer.

Bristol's Recording Instruments will help you to reduce power cost either in the large central station or small plant. Write for Bulletin 1202-A.

THE BRISTOL COMPANY
Waterbury Conn., U.S.A.

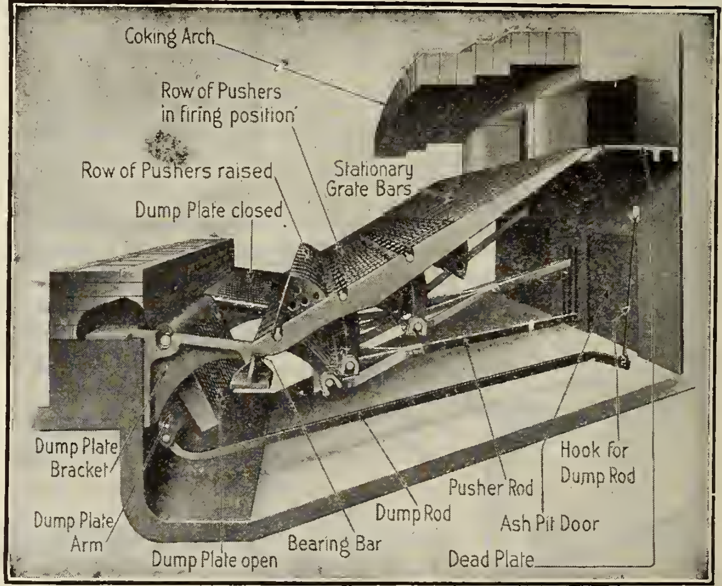
Canadian Distributors:
Eastern Territory — Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory — Gorman's Ltd., Edmonton.

Big Savings in Fuel - - - - - -

are yours with the use of the National Stoker

The special coking arch construction, possible only with the downward slope of our fire grates, is the most successful smoke consuming device you can use. Yet this arch is only one of several features that make the National Hand Fired Stoker a wonderful fuel and labor saver. The downward sloping banks of grates operated by convenient Pusher Rods from the front of the furnace enable even "green" help to get perfect stoking results with almost any grade of fuel.

The National can be installed with your present Boilers. Send for illustrated booklet.

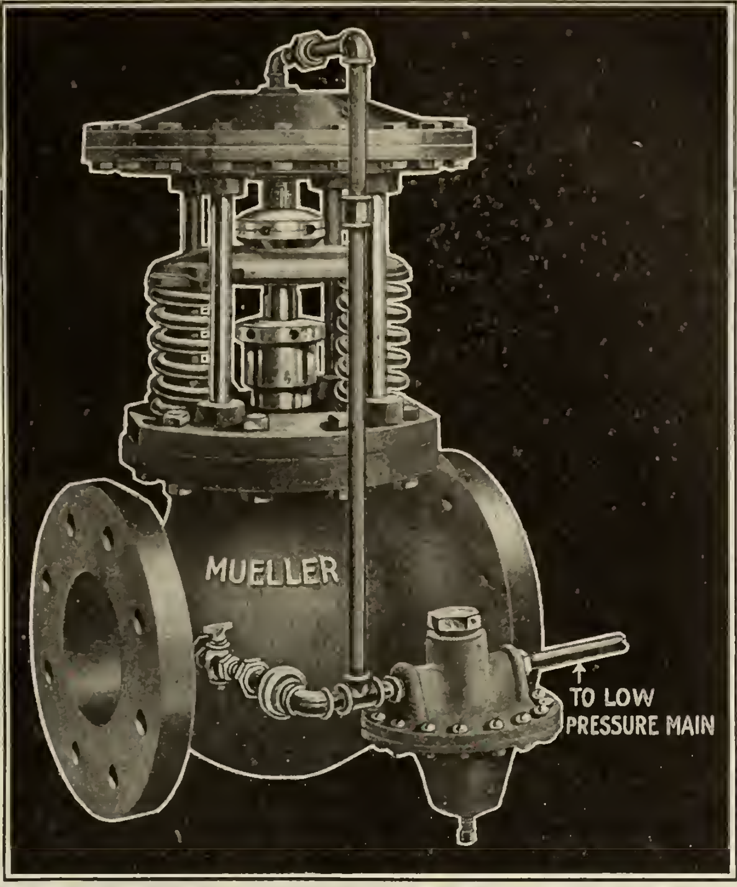


Engineering & Machine Works of Canada, Limited

St. Catharines, Ontario

Eastern Sales Offices: **Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal**

Make Canada Prosperous by Buying Canadian Products



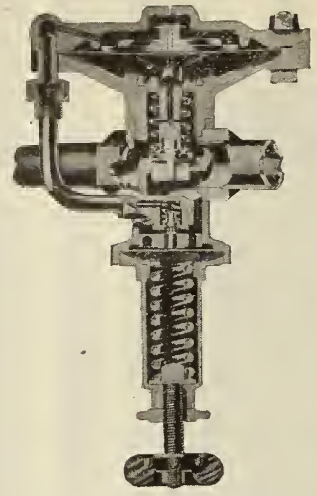
MUELLER Reducing and Regulating Valves

This valve — No. A-5030 — will make any desired reduction and will maintain a constant delivery pressure regardless of fluctuations in initial pressure. For water, air, steam or oil, it has no equal.

When valves are installed under our supervision, we fully warrant their performance. There is a *MUELLER* stock valve to meet practically every need. Tell us your problems—and we will help solve them.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Ill., U. S. A. Branches, New York and San Francisco

Mueller Metals Co., Pt. Huron, Mich., Makers of "Red Tip" Brass Rod: Brass and Copper Tubing: Forgings and Castings in Brass, Bronze and Aluminum: also Screw Machined Products



Fisher Pressure Regulator.
(Type 90.)

A Money-Saver—WHY?

1. Because Fisher Pressure Regulator, Type 90, delivers to an operation or process exactly the amount of low pressure required—no more—no less. It maintains the desired low pressure without fluctuation, regardless of variations in high pressure.

2. When an operation or process is interrupted, this valve automatically cuts off the low pressure and remains closed until the demand at that point is renewed, when it automatically releases just the required low pressure.

Thousands are in use for curing, drying, bleaching, dyeing, vulcanizing, evaporating and similar processes in textile mills, cotton seed oil mills, sugar refineries, tobacco and rubber plants, lumber mills, etc.

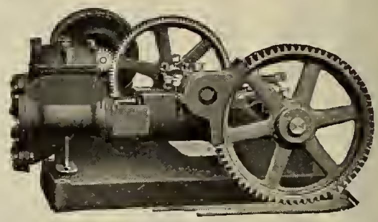
Fisher Pressure Regulator, Type 90, saves enough to pay for itself in a very short time.

Send for Bulletin 210, which gives complete information about this wonderful valve.

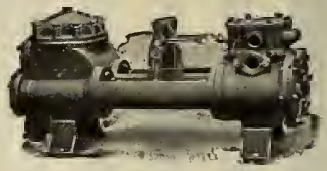
The Fisher Governor Company

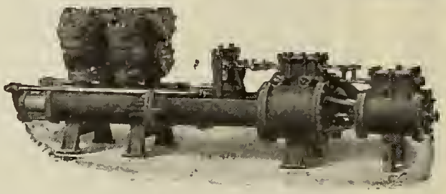
944 Fisher Avenue
Marshalltown, Iowa, U.S.A.

THE JOHN H. McGOWAN CO.
Builders of Pumping Machinery
CINCINNATI, OHIO, U.S.A.



We have been in business for 70 years—there must be some reason for it. We judge it is that we have continuously and consistently endeavored to please our customers and improve our line.





For all Conditions of Service

STERNSON
No. 40 Monolith

As a refractory for industrial furnaces and boiler fire boxes Sternson No. 40 Monolith has proved itself not only more satisfactory and economical but is actually lower in cost than the old method of fire-brick and mortar.

A Solid One-Piece Fire-Brick

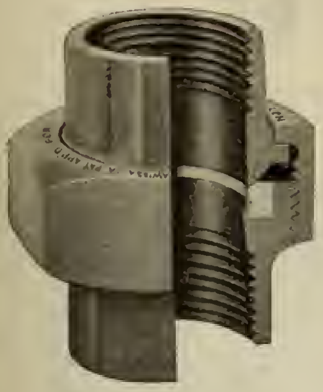
It is a plastic ceramic mixture which can be molded by inexperienced workmen into a jointless, gastight furnace or fire-box lining. When vitrified it makes one great fire-brick able to withstand over 3,000 deg. F.

Try it for repair work and you will always use it for construction.

"Let a Technical Firm Do a Technical Job"

G. F. STERNE & SONS, LIMITED
Chemical Manufacturers
Consulting Chemical Engineers
BRANTFORD :: CANADA

No More Union Trouble



Let us send you some interesting details of the "CATAWISSA."

THE "CATAWISSA" Forged Steel UNION is smaller and takes up less space, yet is stronger and will carry higher pressures than any other union.

All parts of the "CATAWISSA" are forged from refined steel bars, the forging process giving more than ordinary toughness and strength. Being made of the same material as the pipe to which it is attached, it expands and contracts WITH the pipe, preventing leaks. The forging process also renders it absolutely free from sand or blow holes which means that you lose no time in tearing down lines on account of union troubles. This union is made with ordinary Forged Steel, Brass or Monel Metal Seats, as desired.

MONEL METAL SEAT—The "wire-drawing" or cutting effect of the steam results in frequent leaks where ordinary unions are in use. The Monel Metal Seat of the "CATAWISSA" offsets both this and the danger of leaks from small cutting particles, besides being non-corrosive. It is the seat for high pressure temperature.

Every union is thoroughly tested under water with compressed air—the best known method.

Railway & Power Engineering Corporation, Limited

133 Eastern Avenue - Toronto, Ont.

Branches: Montreal, Que.; Winnipeg, Man.

Some of the 83 Yarway Seatless Blow-Off Valves in service at the Lakeside Station.

One of the Most Talked-of Power Plants in the the United States has

83

Yarway Seatless Blow-Off Valves

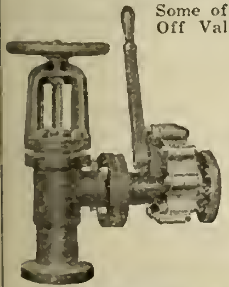
The Lakeside station at Milwaukee is the largest power plant in the world using pulverized coal exclusively. Since it was put into operation in December, 1920, probably no other plant has created such wide-spread interest among power plant engineers.

Frequent tests have indicated a remarkably high degree of efficiency attained by the Lakeside station.

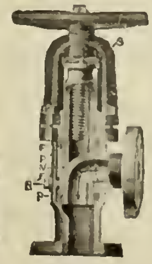
Yarway Seatless Blow-Off Valves—83 of them—are in service on the big 1,300 H.P. boilers, doing their part to uphold the record of efficiency.

Their patented "no-seat-to-leak" construction particularly fits them for long service under difficult conditions.

The Yarway Seatless and its tandem mate, the Yarway Double-Tightening Valve, are fully described in Booklet B-410. A copy is here for you.



Yarway Tandem—Yarway Seatless and Yarway Double-Tightening Valves in combination. Described in Booklet B-410.



Yarway Seatless Blow-Off Valve. (Formerly the Simplex). Described in Booklet B-410.

YARNALL-WARING CO.

Mermaid Lane & Ardleigh St., Philadelphia

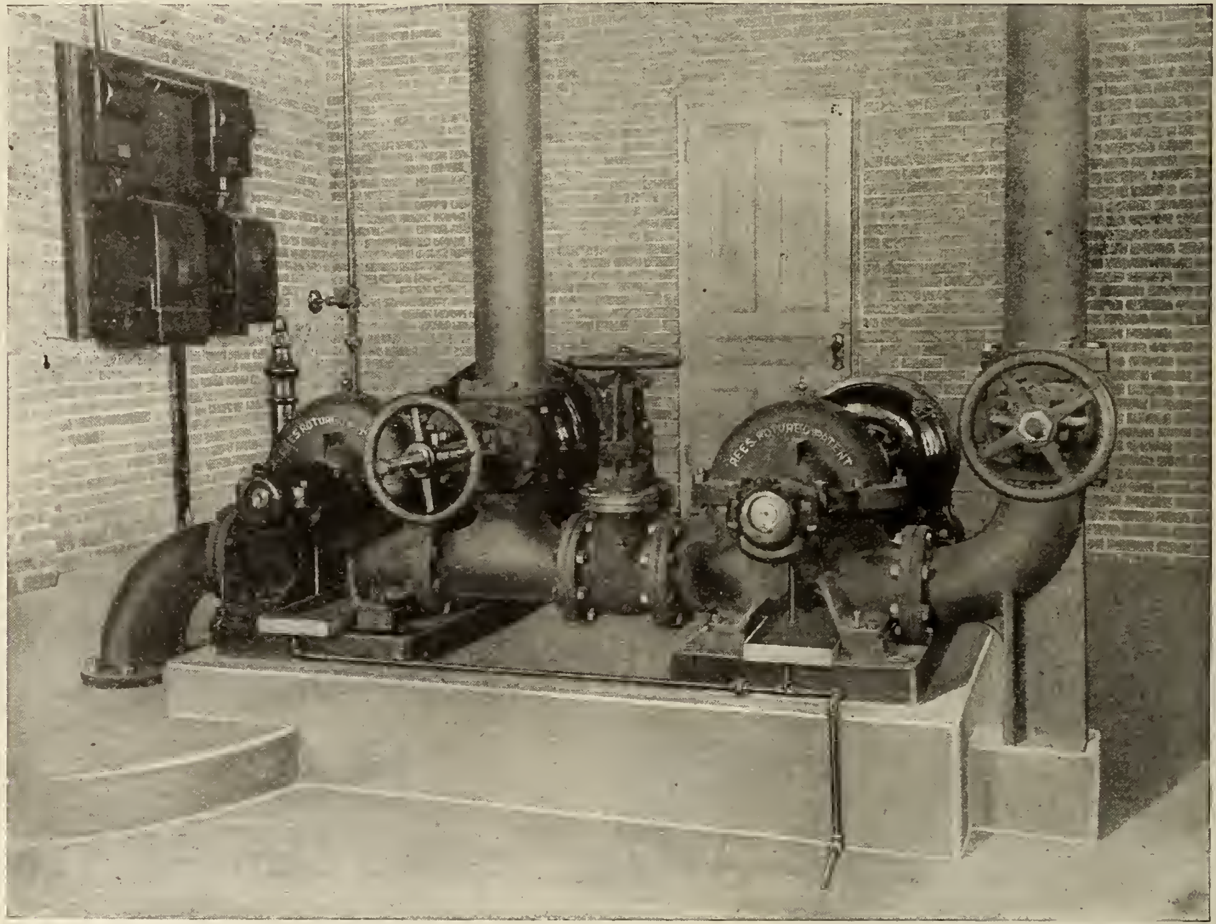
207 St. James St.
MONTREAL

400 Penobscott Bldg.
DETROIT

YARWAY

POWER PLANT DEVICES *to save fuel*

THE REES RoTURBo *A Centrifugal Pump for Any Service*



Showing two REES RoTURBo Pumps at the Waterworks Pumping Station, Carleton Place, Ont.

REES RoTURBo PUMPS ARE SELF REGULATING

They automatically adjust themselves to sudden Drop or Overload without injury to themselves or the prime mover, and they assure a high and constant efficiency over a wide range of duties. 'Municipal and Industrial Plants all over Canada are installing REES RoTURBo PUMPS.

The above installation has been so satisfactory that a third pump of the same make has since been installed.

Catalogs and further information on request

The GOLDIE & McCULLOCH CO. Limited

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2
Bank of Hamilton Building.

WESTERN BRANCH:
248 McDermot Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Grieg
400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.
Vancouver, B. C.

POWER HOUSE

ESTABLISHED 1907 *Toronto, June 5th, 1923* A SEMI-MONTHLY NEWSPAPER

Burning Up Public Money As Boilers Explode!

By CAMPBELL BRADSHAW

Minister of Labor Rollo Too Busy These Days to Heed Charge of Canadian Engineers That "Holes" in Ontario Inspection Law Make it Poorest in Dominion

ENGINEERS fortunately, live and learn, unlike certain officials at Queen's Park who apparently live only to waste public money.

A "system" of government which champions the ridiculous and expensive division of authority in boiler inspection in Ontario, an anomaly which everyone admits has transformed a good law into the poorest legislation on the American continent, clearly shows how far public servants can shelve their avowed purpose of safeguarding life and property in order to retain their clutches on the spoils of "political war."

The inter-provincial boiler code has now been in operation since June, 1922, in the majority of the provinces of the Dominion, largely as the result of the splendid labor over a number of years of D. M. Medcalf, chief inspector of steam boilers for Ontario.

It has proven an excellent thing from the point of view of both the boiler manufacturer and the boiler purchaser, yet inspection remains the plaything of politics, to the amusement of all who know its value when made by properly qualified men.

From the point of view of the operating engineer, the more stringent the law the better, because adequate inspection safeguards his life, lessons his responsibility and protects the property under his care.

All Pleas Ignored

Boiler manufacturers, city officials, members of the Canadian Association of Stationary Engineers, of the Councils of the Universal Craftsmen, and of the International Union of Steam and Operating Engineers have time and again asked Minister of Labor Walter Rollo to amend the present law by bringing all inspection under one department, in order to reduce expense and promote efficiency. The only results have been "courteous promises of consideration" from J. H. H. Ballantyne, Deputy Minister of Labor; J. M. Brown, Chief Examiner of Engineers; and J. T. Burke, Chief Inspector of Factories.

And so the Steam Boiler Inspection Branch continues to supervise capably the construction of new boilers and the sale, exchange or extensive repairs of used boilers, while the Factory, Shop and Office Branch continues to flounder hopelessly on the inspection sands of boilers in operation, giving at least some credence to the proud boast of a few supporters of the government that efficient inspection of steam boilers is unnecessary, as Ontario is "immune from boiler explosions."

It is strange that even where representative government prevails, the interpretation of the time honored "serving the people" apparently reads differently in the case of the politician and the taxpayer. The official sometimes presumes upon his own size and sees himself as a wise and judicious censor although "ignorant" taxpayers had looked upon the man they salary as their responsible deputy. Deputy Minister of Labor Ballantyne refused to furnish Power House with photographs similar to those accompanying this article.

What political bunk! The records show that since the Boiler Act became effective in July, 1913, twenty-one explosions have resulted in a loss of twenty lives and serious injury to thirty-nine persons, in addition to a property loss of approximately half a million dollars. Yet everyone knows the explosion of a boiler is seldom an accident in the true sense of the word, because it usually proceeds from a cause which can be foreseen and the defects remedied.

Defects Easily Seen

A brief examination of the present law at once shows the "holes"—failure to place annual inspections under the proper department similarly to all other provinces in the Dominion, as well as Great Britain and the United States, and —a dearth in the Factory Branch of men qualified to make any power plant inspection.

Reference to the act, however, quickly shows that no reflection can be cast on any member of the department, as no engineering qualification whatever is necessary to serve as a factory inspector, Section 17 simply stating that "The Lieutenant-Governor in Council may appoint as many inspectors as may be deemed necessary, one of whom he may designate as chief inspector."

To demonstrate clearly the inconsistency of the existing law, take, for example, a boiler which has been constructed under the supervision of the Steam Boiler Branch, and a certificate of inspection issued. After a year has elapsed, the owner or operator of the boiler may carry any pressure he thinks fit or may alter the steam piping or any of the safety devices, and the Steam Boiler Branch has no authority to interfere in the matter.

"Scrap" Best Part

A little less than ten years ago the original act looked fine on paper, and met with the approval of boiler builders, boiler purchasers, stationary engineers and insurance companies. But alas, 'twas soon "scrapped," for shortly after its passage the government issued an order-in-council which nullified its most important feature.

This regulation of the Ontario cabinet placed on the Factory, Shop and Office Branch of the Department of Public

Works the responsibility of annually inspecting all boilers in the province, leaving to the inspectors, who possess the necessary qualifications and experience as a result of years of study in the construction, maintenance and operation of boilers, only the supervision of newly-constructed boilers, boilers which need extensive repairs, and second-hand boilers about to be sold. Further, these inspectors, according to the ruling, were adjudged incompetent to make inspections, although competent to specify the details of construction and test new boilers.

What an anomaly! When it is remembered that the regulations regarding new boilers are stringent in the extreme. Plans have to be submitted for approval, then after the parts have been inspected the boilers are given a hydrostatic test before being stamped with the amount of pressure to which they may be submitted.

This red tape ruling placing the inspection of operating boilers under the Factories, Shop and Office Branch of the government did not, however, make it incumbent upon these inspectors, many of whom are women, to crawl inside a boiler and see if any corrosion has taken place; to see if any of the plate has become so thin that a paper knife could be shoved through it, or to find a leak repaired by placing tar paper between two pieces of metal.

Oh no, factory inspectors do not make that kind of an inspection because they are not called upon to make it and could not if they were.

All they are required to do is to see that the "regulations" have been observed and that once in a while there hangs on the wall in the boiler room a certificate showing that the boiler has been inspected by a stationary engineer with license; even that, however, is not essential.

This Disaster Resulted in the Death of Two Men.

It must be noted that the order-in-council advanced the "original" idea of allowing any man with a stationary engineer's certificate, who has had charge of a stationary boiler and engine for a period of at least five years, to inspect any boiler—not, of course, his own boiler, but the boiler in the plant across the street.

Now, if Bill Jones across the street is a good friend of his, isn't it natural for him not to insist on letting the fire out, opening the back hand hole, or the manhole, to see if there is any scale inside?

Stands by Duty

Should the boiler subsequently explode, of course the owner cannot be censored because the legal "regulations" have been observed. The factory inspector has not failed in her duty, because when she last called everything was lovely, in fact, here and there a certificate was hanging on the wall in a nice little frame. Little solace to those, for example, who mourned the death of Clarence Edmonds, in the explosion on the Edmonds Farm in Houghton Township, or satisfaction to the jurors at Delhi who demanded, after investigating the tragedy, that adequate inspection of steam boilers must be provided in the province and must include those used for agricultural purposes.

Yet this boiler of 25 horse power, built 35 years ago, so far as is known had never been inspected since it left the factory.

It is needless to enumerate the many other catastrophes, such as the boiler explosion in a cheese factory at Joiceville, which resulted in the death of two men, or the tragedy at Howick Hall, in Ottawa, in which four were killed, twelve seriously injured, and the damage amounted to $100,000, all as the result of one defective valve.

It is no reflection on the ability of engineers in the province to say that 75 per cent. of them know little about boiler design and construction, although the majority are well able to remedy defects after they develop.

A man in charge of a boiler or an engine can operate them in a highly successful manner without possessing the qualifications necessary to make an intelligent inspection of a boiler under his care, to say nothing of the "competency" of the women whose inspection certainly must be defined under the Factories Inspection Act as legal.

May Screen Negligence

It might be well to point out that another reason why inspection by the friend of an operating engineer is undesirable, is because any damage existing in the plant is likely to be concealed with the object of screening negligence.

Buildings Demolished When Boiler Split in Twain.

Return Tubular Boiler After Explosion

The damage might be small but extremely dangerous, while on the other hand, of course, it might not be at all important.

There is, of course, no intention of disparaging the absolute capability of engineers in charge of large steam plants to inspect their own boilers, but as a matter of fact, of 87 stationary engineers interviewed, every engineer without exception declared flatly that he disapproved of any system of inspection which allowed a brother engineer to examine a boiler.

The consensus of opinion gathered from conversations with these men may be summed up in the statement that they believe the Act should be revised so as to bring not only the construction of all steam boilers including those used for agricultural purposes under the Steam Boiler Branch, but also that the same branch would be entirely responsible for the working pressures that boilers should be allowed to carry from time to time.

Finds System Wrong

J. E. Fitzgerald, of the T. Eaton Co., is emphatic in declaring that it is wrong for an engineer to inspect the boilers of a brother engineer, as it frequently happens in the smaller communities that the poorest operating engineer in the district does most of the inspecting. Mr. Fitzgerald suggests it might be possible for the chief boiler inspector to appoint a capable operating engineer to an inspectorship in isolated districts should emergency arise requiring his services.

Robert McLaren, of the Massey-Harris Co., firmly believes that all boiler inspection should be under the direct control of one man. He flatly disapproves of any method of inspection which allows the engineer of a nearby plant to inspect his friend's boiler. Mr. McLaren thinks such a regulation places engineers in an awkward position, as at times the ties of friendship might interfere with his best judgment.

Norman Smith, of the Brunswick-Balke Co., says that an inspector who is qualified to examine a steam boiler during construction is certainly capable of inspecting it while in operation. He also states that he has seen boilers in operation in Ontario which he would not consider at all safe. He thinks that the present system of grading licenses could be improved and that no operating engineer should be allowed to inspect any boiler.

Babcock and Wilcox Limited, pioneer manufacturers of water tube boilers, when asked for an expression of opinion, promptly replied:

"We certainly think that the inspection of boilers in operation should be directly under the jurisdiction of the Steam Boiler Branch, who have to pass on and inspect all new boilers. We believe in having one definite control in such matters."

E. Leonard & Sons, Limited, of London, Ontario, boiler manufacturers in business in the province since 1834, state quite frankly that the Act should be revised so as to bring, not only the construction of steam boilers under the Steam Boiler Branch, but also so that the annual inspection of steam boilers would be carried out by the Steam Boiler Branch in the same way as obtains in the Provinces of Alberta, Saskatchewan and British Columbia. In this way the Steam Boiler Branch could be made entirely responsible not only for the construction of a boiler, but also for the safe working pressures that they are allowed to carry from time to time.

Present System Dangerous

As one large factory owner puts it, the present system is worse than no inspection, since it makes everyone believe everything is all right and safe when it is all wrong and dangerous.

"The department, which is fully competent to guard human life, has had nothing to do with a boiler after it leaves the shop, indeed, does not see it at any time."

With regard to the charge heard in legislative halls that boilers are rapidly being replaced by hydro power, the records of new boilers constructed in Ontario in the past ten years is convincing proof that the boiler industry is not a declining one.

From July, 1913, to June, 1923, approximately 8,900 new boilers and pressure vessels were constructed, and of the 32,000 boilers at present in operation in the province, probably more than sixty per cent. are insured. A fortunate thing for the Drury government that so many owners of boilers, recognizing the loose form of government inspection, have insurance experts make capable inspections, otherwise the annual toll in human life might be incalculable.

Let those who defend the present system of boiler inspection remember that explosions in Ontario are more numerous than in any other province of the Dominion, despite the fact that the modern steam boiler as manufactured in Ontario, according to the best methods of design, if periodically inspected in a capable manner during operation, is perfectly safe.

Connecting rods are made larger at the crank end to overcome the resistance due to friction, which acts with a greater leverage on the crankpin than on the crosshead pin, the latter being smaller in diameter than the former. The stresses due to the inertia of the rod also call for a larger section of the rod at the crankpin end than at the crosshead pin.

The addition of lap will generally prevent the steam valve from opening sufficiently for the proper admission of steam, hence when the lap is increased it becomes necessary to increase the travel in order to provide the proper port opening. An increased travel of the valve also opens the port more rapidly, which is an important consideration.

A small storage battery may be charged from a 110 volt direct current circuit, by placing it in series-parallel with several incadescent lamps, the number depending on the charging rate of the battery. A 16-cp.. 110 volt carbon lamp will allow about half an ampere to flow through it. If the charging rate of the battery were 5 amperes, this would mean 10 lamps in parallel series with the battery. Be sure to connect the positive wire with the positive terminal of the battery.

Economies Result by Using Standard Feed Water

Impurities Cause Scale and Corrosion, Resulting in Excessive Heat Losses, Repair and Low Boiler Ratings, Despite All Efforts of the Engineer to Cut Costs

THE modern tendency in boiler plants to heat the feed water to above 200 deg. F. causes the lime and magnesia to separate and clog the heater and feed pipes.

The substances commonly found in feed water may be divided into six general classes, namely:

Suspended Matter:—Solids finely divided and held in suspension; mud, silt, silica, etc.

Temporary Hardness:—Chiefly soluble bicarbonate of calcium, magnesia and iron; which decomposes and precipitate on heating.

Permanent Hardness:—Any soluble substances which do not precipitate on heating, such as the sulphates, chlorides and nitrates of calcium, and magnesia. These have a tendency to react with the temporary hardness, concentration of these substances resulting in precipitation of calcium or magnesia, forming a very hard scale, or in some cases liberating corrosive acids.

Soluble Sodium and Potassium Salts:—These are permanently soluble and do not cause scale or corrosion.

Miscellaneous Soluble Substances:—Oxide of iron, alumina, silica and vegetable and mineral matter.

Evils of Impurities

Heater and feed pipes are clogged by precipitation of substances, causing temporary hardness. Scale in the boiler is largely due to temporary hardness.

Scale is also caused by permanent hardness, and in many cases accompanied by corrosion.

Acids cause excessive corrosion in feed pipes, heaters, boilers and steam lines.

Sodium and potassium salts tend to cause priming, especially if any oil or vegetable matter should happen to be in the boiler.

Scale, unfortunately, is an extremely poor conductor of heat; experiments show that the loss from scale 1/16 to ⅛ in. thick is from 10 to 12 per cent., scale ¼ inch thick often causing a loss as high as 30 per cent. The boiler acts as a catch basin for impurities in the feed water; a 500 h.p. boiler containing about 40,000 lbs. of water, when operating at 150 per cent. of rating, uses about 26,000 lbs. of water per hour.

Assuming that the feed water contains 17 grains of impurities per gallon; with the boiler operating at 150 per cent. of rating every 10 hours, there are introduced into the boiler 26,000 x 17 or 442,000 grains of impurities. The 4,000 gallons on starting with 17 grains per gallon of impurities would then contain 110 + 17 or 127 grains per gallon, of which 52 are encrusting solids.

Little wonder then that boilers scale up, unless care is taken in keeping the feed water comparatively free of impurities.

Causes Trouble in Steam

No boiler makes dry steam, always carrying some moisture over to the steam lines or the superheaters. If the steam carried only 1 per cent. of moisture, about 26 gallons of water per hour would be carried out of the boiler and with it approximately 63 grains per gallon, or in ten hours about 3 lbs. of encrusting solids would be deposited in the superheater or carried into the steam lines.

These scale-forming substances are extremely hard on turbine blades.

The soluble potassium and sodium salts react with any organic substances of vegetable or animal origin, forming compounds not unlike soap, which cause resistance to the liberation of steam evidenced by the formation of bubbles that agitate the surface, and in extreme cases violent upheaval of the water in the whole boiler.

The mild surface agitation is called "priming," the more violent is known as "foaming."

Corrosion by Acids

Corrosion is the most dangerous of all ills resulting from impurities in the feed water, especially when deposits of scale hide the extent of the action of the acids causing it. Feed water may contain no free acid, but the breaking down of unstable compounds of iron, calcium, or magnesia, may form acids within the boiler.

The use of stokers and large water tube boilers, operated at high ratings, has compelled power plants to purify the boiler feed water, if they wish to maintain high efficiencies or prevent excessive cleaning and repair bills.

The Ideal Feed Water

A good water for boiler feed purposes would include:

Complete removal to zero of oil, grease, iron, free carbonic acid, and carbonates as well as all suspended matter.

Complete removal of substances causing permanent hardness.

Complete removal of substances causing temporary hardness to such a point that the residual calcium and magnesia are below their solubilities in water at 212 deg. F.

Complete conversion into harmless substances of all acids or acid-producing substances such as certain compounds of iron, alumina, manganese and magnesia.

A reduction of slightly soluble silica and other compounds.

The concentration of soluble compounds and the precipitates in suspension in the boiler can be kept within the limits for good steaming by blowing down and changing the water at proper intervals; there is then no danger of priming or foaming.

Saves Money

At the present time it is not enough to define a boiler feed water as free of acids, without visible suspended matter or with incrusting solids not over three grains per gallon. Water softening apparatus with continuous flow can give only an average reduction in encrusting solids; there is left a high percentage of suspended solids and soluble substances, tending to produce priming and foaming unless the boiler is blown down and water changed at frequent intervals.

That standardized softened water for boiler feed will save money is shown by the two following cases:

In an industrial plant with 4,000 boiler H. P. using 100 per cent. make-up, where formerly a compound was introduced in a water containing about 12 grains of scaling solids per gallon, the following are the savings for the first year of operation:

Heater and Boiler Cleanings ..	$1,650.00
Tube Renewals and Repairs ..	6,000.00
Fuel	3,215.00
Total	$10,865.00

Total steam production increased 13 per cent.

Cost of steam production reduced 25 per cent.

Another case shows not only a saving in the boiler room but also in the turbine. This 6,000 boiler H. P. station uses about 20 per cent. make up containing 16 grains of scaling solids per gallon. After changing to a standard feed water from a softening machine, which gave an unknown variation in the amount of scale-forming solids left in the water, the following savings were made during one year of operation:

Boiler Cleanings	$ 950.00
Tube Renewals	1,050.00
Elimination of turbine blading lowered water rate with dry steam	8,800.00
Fuel saving from increased efficiency in boilers	3,000.00
	$13,800.00

Draft Usually An Expensive Thing To Produce

Proper Design of Stacks and Passages Essential for Maximum Economy and High Ratings; Excessive Draft Almost as Bad as Insufficient Draft in Reducing Efficiency

DRAFT, to many engineers, is something to be forgotten except when an unusually bad shipment of coal makes it impossible to keep up steam, or when it is desired to carry an extra overload for a short time.

Few plants are designed with any reserve capacity in draft and when the passages become filled up in time with soot, the condition becomes worse. The cost of providing sufficient capacity is negligible compared to the cost of a reserve boiler. The engineer who is in charge of an installation with good draft must exercise his best judgment in the use of the damper or he may turn a blessing into a curse by pulling large amounts of excess air through the fire, resulting in low CO_2.

Draft can be defined, precisely speaking, as the flow of air through the boilers and flues; but as it is usually out of the question to measure this directly, it is inferred from pressure measurements at various points.

Most modern plants have well proportioned and arranged stacks and flues, but many older plants were not so carefully planned. Where changes and additions have been made, plenty of chance for trouble exists.

It will therefore pay an engineer on taking over a new job, to make a survey of the draft pressures from chimney to ashpit, taking pressures in each individual boiler until he is satisfied that the readings obtained are really representative of average conditions. If a number of inclined tube draft gauges are available, they are very convenient for this work.

To Take Readings

Reliable results can, however, be obtained with a single U-tube gauge filled with water, as readings can be estimated to within .02 in. of water. It is best to drill holes in the flues at the proper points. Through them a short piece of 1/8 in. pipe, connected to the gauge by rubber tubing, can be entered so as to extend about six inches to a foot inside the flue.

Boiler drafts can be measured through cracks or openings in fire doors, soot-blowing doors, etc. To obtain the best results, the pipe used should be cut off square at the end and held at right angles to the direction of flow. Where possible, openings for taking drafts should not be located at a bend in the flue as the eddies are almost sure to give inaccurate results.

After the readings have been obtained and the averages tabulated for different conditions, it can easily be seen from the drop in draft pressure where the greatest resistances are. That part of the gas passage should be specially examined to locate the trouble.

To Figure Draft

Very complete tables and curves, from which the available chimney draft and probable friction loss may be figured for any set of conditions, are given in the handbooks issued by the larger boiler manufacturers. However, these are usually predicated on more accurate knowledge of quantities, etc., than is generally available.

There is a prevalent idea that the purchase of advertising space carries with it an unwritten right to notice in the editorial pages. This may have been so in the bad old days but it certainly is not so to-day. Reputable publishers are proof against blandishments of this kind, for very little thought will make it evident that such a policy would be an extremely destructive one for an advertiser to follow. Were this plan put into effect newspapers would be filled with matter selected not for its news interest but for its revenue-earning capacity. Lack of interest means loss of circulation, and as after all, the advertiser is primarily concerned with circulation, particularly circulation of the right kind, it is evident that by retaining the interest of the best type of reader the editor indirectly best serves the advertiser.

An approximate rule, therefore, of ½-in. of water available draft at the base of the stack for each 100 ft. of chimney height, and a friction loss of 0.10 in. of water for each bend in the gas stream, neglecting friction in the straight runs of the flue, will be a good working guide for the average plant where there are no excessively long runs.

The friction loss in the boilers themselves varies widely with the type and size of the boiler and the baffling, but if more than .15 to .20 in. of water resistance is found between the firebox and damper for two or three pass boilers up to 500 h.p., operating at rating, there is probably an excessive accumulation of soot in the tubes or dust chambers. For other rates of driving, this draft loss will be in proportion to the square of the capacity developed.

That is, at 150 per cent. the resistance would be 2¼ times the above, or .34-in. to .45-in. of water; at 200 per cent., 4 times, or .60 to .80-in. of water.

True Friction Loss

The measurement of the true friction loss in draft through a boiler is complicated by the hot gases inside the setting. Just as in a chimney, due to their lesser density, these give a difference of pressure as compared with the outside air when they are measured at different loads. Where the friction loss is small and the difference in level considerable, as in a vertical fire-tube boiler at low ratings, there may be an apparent paradox in that higher draft may be found in the fire-box than in the smoke connection.

This is noticeable in burning high-sulphur oil in boilers without ash-pit door air regulation. When the flue damper is closed enough to bring the air supply down to a reasonable amount, there is a positive pressure in the smokebox, and the sulphur dioxide almost drives the working force out of the boiler room.

In general, however, the worst draft troubles will be found in the flues.

A convenient rule for proportioning gas passage areas for boilers which are not to be forced over 200 per cent. of rating is: damper area 1/6 grate area, flue area 1/7 grate area, and the stack area 1/8 grate area.

Typical Example

In one plant which had a self-supporting steel stack, 7 ft. 6 in. in diameter, 200 feet high, with a steel flue entering on one side by an opening 5 ft. wide and 7 ft. 9 in. high, served two boilers of 375 h.p., two of 240 h.p., and two of 330 h.p. each. Boiler brickwork and flue joints were in good condition, the flues were clean, yet not over 125% of rating could be carried. The grate area of all boilers was 378 sq. ft., flue area 62.2 or 1:6. 24, opening into stack, 36.7 sq. ft., or 1:10.30, and stack, 44.2 sq. ft., or 1:1.855.

It is seen that the trouble lay with the opening in the stack. After this was enlarged to 5 ft. by 9 ft. 10 in., giving an area of 49.1 sq. ft. and a ratio of 1:7.68, it was found to develop 160 per cent. of rating where 125 per cent. had been the maximum before.

No matter what the rating of the boilers a certain intensity of draft is required to operate at a given rating; a corresponding height of stack being required to furnish this.

In a street railway power house, when stokers were installed, the stacks were found to be too short to give an appreciable increase in rating. After the stacks were heightened, a much greater capacity was secured from the same boilers.

Vacuum Necessary

It is essential to keep a vacuum of at least .10 in. in the firebox at all times if the firebrick is to be protected, savings in repairs from 50 to 75 per cent. may result, comparing with a steadily maintained positive pressure of .02 to .03 in.

With a slight vacuum there is always a small infiltration of air through the pores and crevices of the brickwork, tending to cool it and preventing rapid burning of the wall; on the other hand, if pressure is in the furnace, the flow is outwards, tending to keep the brickwork excessively hot.

This is one of the difficulties of the very high furnaces found on certain types of boilers, since, owing to the high temperature of the furnace gases, the chimney effect of the setting is nearly .01-in. of water per foot of height. Consequently if there is a vacuum in the furnace at the grate level of .10-in. of water, this has all disappeared at a height of 10 ft. above the grates. Above that there is a positive pressure which is very hard on arches unless ample precautions are taken for proper cooling.

Different Air Supply

Another tendency where draft is limited is to run with a somewhat deficient air supply and this causes furnace temperatures at comparatively low ratings which would not be reached with ample draft and air supply at much higher ratings. There is consequently much greater clinkering of the coal ash and burning of it into the walls.

In considering the disadvantages of insufficient draft, no one should think that there cannot be too much. Excessive draft is almost as bad in its effect on economy. This is chiefly due to the very large quantities of air drawn in through every crevice and opening around fire, tube, and cleaning doors.

This takes up heat to raise it at least to steam temperature and passes off to temper the surrounding climate. Besides the larger volume of gases passing through the boiler reduces the heat absorbed from those which came from the fuel bed. This also decreases the boiler efficiency.

Steam is Wasted

When this condition is due to unregulated chimney draft, it is bad enough. In a great many plants with induced draft fans, however, steam is being wasted to create this excessive draft.

One power plant which had both a 175 ft. brick stack and also an induced draft fan, installed on account of a very long, double economizer, reduced coal consumption per kilowatt hour 10 per cent. by enforcing a regulation that the fan was not to be run except when the load rose above a figure determined by careful tests.

Sometimes it is possible to turn such excess of draft to good account by rebaffling the boilers to increase the gas velocity and thereby the absorption of the heat. Induced draft fans should always have variable speed control, whether steam or electric driven.

Modern tendencies toward large units, high capacities with correspondingly high pressure drops through the boiler settings, and, often, economizers in addition, undoubtedly call for induced draft fans. It must be remembered, however, that such apparatus calls for a much higher degree of intelligence for economical and safe operation and that the field of such designs is a public service station load with comparatively short high peaks which must be carried without a prohibitive expense for boilers and buildings to house them, usually in an expensive location.

Factory Load Varies

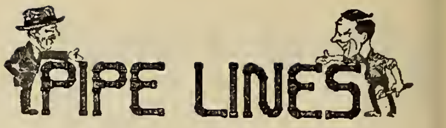
Conditions for the average uniform factory load, particularly if it is a 24-hour day plant, are quite different. In the latter case the investment charge becomes a smaller proportionate item compared with the fuel bill, and the plant should be designed with a view to operation at its point of maximum efficiency both in heat absorption and repairs.

For such service the choice and arrangement of the equipment must be determined by the fuel supply offering the most heat units for a dollar, the power required, and the size and shape of the space available. Where these are rather limited, a satisfactory solution will often be a return to the old arrangement of individual stacks for each boiler, or at least each battery, supported on the boiler framework and cross braced between themselves. This has the further advantage of extreme flexibility in case changes in capacity are required, since the individual stacks can be heightened or new batteries added without crowding the capacity of one old stack or the flues.

In general it must be borne in mind that draft is an expensive thing to produce, whether by steam power direct on a fan, or by a chimney which any thermodynamics book will prove is a very inefficient heat engine. It should be used as economically as possible by making the flue passages short, straight and of nearly uniform area, possibly contracting slightly in proportion to the cooling of the gas to keep the velocity constant.

The nearer we approach these conditions, the higher capacity can be obtained from our present equipment, or if we are arranging a new installation, the less it will cost to provide for proper draft facilities.

A small piston rod can be removed from the crosshead without scoring with a Stillson wrench by using two hardwood blocks hollowed out to fit the rod and bolted to it by means of four ½ in. bolts. A piece of sandpaper should be placed between the rod and the blocks which, when clamped to the rod, have a space between them. The blocks afford a place to put a wrench and turn the rod out of the crosshead.



PIPE LINES

UNCOVERED IN ANY OLD SPOT

In packing a flange or cylinder with a rubber gasket, all oil and grease should be wiped from the surface of the metal.

* * *

There's a fireman in Guelph who wears his girl's picture in his watch case because he thinks he will learn to love her in time.

* * *

The length of a connecting rod depends much upon the design and duty of the engine. For large stationary engines the length of the rod is 2½ to three times the stroke of the piston, if space permits; on smaller engines the ratio is sometimes reduced.

* * *

If a bathing beauty were looking for a date would the water-meter?

* * *

The cut-off valve on the low pressure cylinder is used for adjusting and equalizing the work performed by the steam in the high and low pressure cylinders.

* * *

"Income tax," grumbled the carpet, as the engineer got busy with his hammer.

* * *

An ordinary cross-compound engine can be started without prying on the flywheel by admitting steam to the low pressure piston by means of the bypass valve on the receiver, in case the high pressure crank is on the center.

* * *

F stands for furnace and fireman, too; when both tend to business the coal man looks blue.

* * *

The dashpot of a Corliss engine should have a plentiful supply of machine oil or oil of a heavy grade or glycerine. The temperature of the engine room will determine to some extent the heaviness of the oil.

* * *

When your boiler efficiency refuses to "fish" examine the heating surfaces.

* * *

Frequently the sight-feed glass of a lubricator fills with oil. If the oil is removed from the body of the cup and it is filled with water and started up in the usual way, the water will float the oil out of the glass without further trouble.

* * *

Within a bar magnet the flux runs from the south to the north pole, and without the magnet from north to south.

Steam Turbines Cut Cost of Auxiliary Drive

When Low Initial Cost, Reliability and Limited Space Are the Deciding Factors, This Type of Drive Becomes a Real Power Plant Economy

DURING the last few years the use of the steam turbine for driving the auxiliaries in a power plant has kept pace with the progress made by its larger brother, the main turbine, more especially in its application in the boiler room proper.

Speaking first of fans for induced draft, it is, of course, necessary either to drive them electrically or by steam.

In the past, the steam engine, with its low speed, has been used to drive fans of very large diameter. But that type of drive is gradually giving way to the small, high speed turbine driving the fan of small diameter.

The results of this, as far as volume of air is concerned, and economies, are usually good. The advantage of the small set, however, is found in the limited space required for it, both in floor area and head room, the comparatively few working parts, the low first cost and upkeep.

There are mighty few parts to get out of order in a turbo-fan where there is only one rotor in the turbine and one rotor in the fan. These are usually connected through a flexible coupling unless some special requirement calls for a reduction gear between them. Such cases are comparatively rare.

Two Points to Pack

With only one rotating element, it might be said, there are only two points to pack against leakage. The turbine is packed against steam leakage with carbon non-leaking ring packing, which will last a long time. The fan needs no packing; hence the plant has a unit which merely requires unskilled labor when it comes to turning the throttle valve of the turbine on or off.

In the boiler feed pump, however, there is more to be said. The old style reciprocating pump, of course, is large. The matter of packing it is more or less troublesome, as the plunger action is reciprocating and therefore a wearing one upon the packing, as against the turning motion of the centrifugal pump shaft with its tendency to "wear in" the packing so that it will hold tight.

Another fact—centrifugal pumps have no valves, whereas, reciprocating pumps have them on the suction and discharge.

Simple Control Equipment

A turbine pump can be allowed to operate until boiler pressure is reached and the pump is working against what is called "shut off pressure." This is usually about 1.2 times the operating head. The pump is developing no water but is really balancing a column of water against the boiler pressure. The only effect is that the impeller of the pump churns the water but uses very little power in doing so.

This type of pump, of course, requires little head room. The turning action of the pump impeller shaft is such that it wears the packing in and really makes it tighter than when it is first placed in position.

Speaking generally of steam driven auxiliaries in the boiler room, as against any other type such as electrically driven, it has been found advisable by some engineers, to install not only electrically but steam driven auxiliaries. In other words, it is good practice to install a "break-down" unit in a power plant of any size.

Every engineer knows that an overcoat does two things. It keeps the heat in and the cold out. But engineers forget once in a while that steam piping needs an overcoat just as much as they need one. And for the same reason. An overcoat on piping keeps the heat in and the cold out. The name of this overcoat is "insulation." Pipes that are uncovered waste much heat, which means that they waste much coal. To do without an overcoat, cut to fit your piping, is to waste about one fifth of your fuel. And at present day prices you can't afford that, can you?

Auxiliaries Must Not Fail

It is often the case that the electric power will fail, for some reason or other, or be turned off, and when that is true, then the auxiliaries, such as the boiler feed pumps, which are vitally necessary to operation, must cease, and the boilers must be shut down.

On the other hand, with steam driven auxiliaries, the electricity may fail in the main generating-unit, but the auxiliaries go on just the same as ever and the boilers are kept operating at normal, ready to take the load just as soon as repairs have been made to the generator.

Practically all boiler auxiliary drives operate non-condensing against a back pressure. In other words, the steam is required for feed water purposes. Such being the case, economy in the turbine is not paramount but consideration is given to the construction of the turbine, its ability to operate under severe conditions in, usually, very dirty "un-get-at-able" locations. They must be designed for continuous operation with practically no attention.

Maintains Heat Balance

In some plants where it is required, the question of heat balance enters and in such cases both electrical and steam auxiliary units are operated. Often a motor and turbine will be connected to one centrifugal pump, the turbine at one end, the motor at the other. The turbine is on the thermostatic control.

When the temperature of the feed water drops, the turbine operates, the exhaust from which goes to the heater and raises the feed water temperature to the desired point. It then shuts down.

At this point the motor begins operating, and drives the pump. Hence no heat is lost—all exhaust steam is consumed either in the steam auxiliary or the main generating unit. This, however, is not a matter of first consideration if there is use for exhaust steam from the turbine auxiliaries. If such is the case, then it behooves the engineer for one of several reasons, as above given, to be somewhat sure that his auxiliaries will operate for all conditions, that his boilers will always be regularly fed and that his induced fans will rotate just as long as is necessary.

Bleeder Type Useful

It is only within the last year or so that the "bleeder" or extraction turbine has been commercially possible for use in sizes small enough to be used for auxiliary drive purposes. This type of turbine furnishes the ideal method of heat balance in the boiler room and replaces the combination motor-turbine drive of the pump or fan.

In practice, the "bleeder" turbine is direct connected or geared, as necessity dictates, to the centrifugal boiler feed pump or fan. Steam at boiler pressure expands through the velocity wheel stages of the "bleeder" as the case may be, to the desired back pressure. An automatic diaphragm "bleeder" valve operated from the "bleeder" pressure system regulates the volume of back pressure steam which is "bled" to the feed water heater. The governor valve regulates the high pressure steam flow to the turbine.

Steam which is not needed in the back pressure system expands through the remaining pressure stages of the turbine to the condenser vacuum, thereby furnishing additional power with which to drive the pump or fan. This automatically decreases the amount of boiler pressure steam used in the auxiliary.

(Turn to page 44)

Slavery Man's Original Conception of Power

By **PAUL T. BRADY***

Take Power Away From Us—Leave Us With Nothing But Our Bare Hands, and We Could Do Little More Than Keep Ourselves Alive

WHO was the founder of civilization?

This may appear to be one of those idle questions which anyone can ask and no one can answer; but I have an answer to it, and I am sure you will all agree that I am right. The founder of civilization was that prehistoric leader who first said in effect, "Boys, I have an idea. After we have beaten up that outfit across the river, we won't eat the prisoners this time—we'll make them work for us."

Here was the original conception of power—the means for doing work. Though the inventor did not know it, he had hit upon the one thing that enables men to rise above savagery. Take power away from us—leave us with nothing but our bare hands—and we can do little more than keep ourselves alive. Give us power, and there is no apparent limit to our achievements.

First Labor of Slaves

The earliest form of power was the labor of slaves. This was, of course, deplorable; it was highly inefficient; and it possessed the great drawback that the engineers were liable at any time and without notice to become the machinery. Nevertheless, had not men been enslaved, Thebes, Babylon, Athens, and Rome would never have existed, and we would still be living in camps and caves.

The use of draught animals was a great advance over slavery, and gave us the Europe of Shakespeare, Montaigne, and Goethe. Then came Watt with his steam engine, and Fourneyron with his hydraulic turbine, and Edison with his central electric power station; and with each improvement in the methods of generating and distributing power, society made immense strides forward. Today we are living in the age of the long-distance transmission of alternating-current electricity, the age of modern miracles.

But were the great inventor alive today, he would be the first to warn us that we must not stop here. He was always a generation ahead of his time, and it would be clear to his far-sighted vision that the work he did forty years ago has reached fruition and that we must now plan anew for the benefit of our children's children.

Fortunately, we know what the next step should be, and we are fully equipped to take it. We must now give everyone in Canada and the United States an abundant supply of electricity; and we must do this by putting our water power to work and, pouring all of this energy into a single great international network, distribute it to practically every inhabited portion of the continent.

It may be safely said that readers of Power House direct all progress in power plant operation in Canada, for few men in the field fail to realize that the broad, constructive policy of that newspaper is of inestimable value to the engineer wherever he may be. The best efforts of Power House are in its editorial pages and not in its advertising solicitations—which probably accounts for the position of leadership it steadily maintains.

This plan, which is known as the "super-power" plan, represents the consensus of the opinion of all competent engineers who have studied the subject; and though gigantic as the task may be, we can rest assured that it will eventually be carried out.

But as man cannot live by bread alone, neither can a power system live on water alone. With few exceptions all rivers vary greatly in their seasonal flow. The upper waters of the Hudson, for example, are able to generate 500,000 horse power at high water, but in dry seasons, the flow is greatly diminished. Similar conditions obtain with the Chippawa and all the others. It is recognized, therefore, that the most economical and reliable method of generating power is by means of a system using both water power and steam power. When water is abundant, the water-power plants carry the main load of the system, and only enough steam power is used to take care of demands in excess of the capacity of the water-power plants.

In this way, the consumption of fuel is reduced to a minimum. But in dry seasons, operation is reversed. The steam plants now supply the main load, while the water-power plants are shut down for the greater part of each 24 hours so that they can accumulate enough water in their storage reservoirs to take care of peak and emergency demands. In this way a continuous supply of power to meet all requirements, is provided.

To Supplement Water

Hence, to take the next step in social progress, not only must we utilize our water-power resources to the fullest extent, but we must also use huge steam plants which will supplement the water powers. The ideal location for these steam plants is beside the rivers, where fuel can be delivered to the boilers with a minimum of transportation and where ample supplies of condensing water can be obtained. But there is a tendency on the part of certain power engineers connected with plants thus favorably located to take a short-sighted view of the power situation.

"Why should our plants co-operate with water-power plants?" they ask. "We can gain nothing by becoming part of a larger system, and are therefore not interested in the project."

These people forget that outside the narrow limits of their own systems there are millions of people who are either paying high prices for electricity or are unable to get it at any price.

They forget that their properties form an essential element in any plan to supply the country as a whole with power at the lowest possible cost. They forget that, if their plants become a part of such a system, they will have the widest possible market for their excess power and their surplus coal. They forget that after all their systems are not absolutely self-sufficient, and that, unless connected with other sources of power, they may fail to give service in event of serious accidents. And finally, they forget that it is precisely this attitude of self interest that forms one of the strongest arguments for the governmental ownership of the unified power system.

They must see the larger picture. Up north in Canada, there are 18 millions of horsepower of the finest water power in the world; down here in Pennsylvania, West Virginia, and Ohio there are billions of tons of coal. Employed separately, each will indeed benefit many people; but used together to the best advantage, they will bring ever increasing prosperity to all of the people in Northeastern North America— in other words, they will usher in the next age in the history of civilization.

---

*Special Representative, Westinghouse Electric and Manufacturing Company.

*Address at Spring Convention of American Institute of Electrical Engineers.

Production and Possibilities of Lignite Char

By O. P. HOOD, A.S.M.E.*

Lacking Abundance of the Best, Manufacturers Are Impatient With the Limitations of Lower Grade Fuels Forcing Canadian Output to Compete With Anthracite

THE greatest difficulty with lignite is the fact that in nearly every district where it should be the natural fuel it is put in competition with high-grade fuel. We are all spoiled by having been blessed with an abundance of the best, so that we are impatient with the limitations of lower-grade fuels.

If we had been obliged to go down 2000 ft. or more and win good coal from thin seams in scattered districts as they do in Europe, we would have long ago worked out a successful technique for utilizing our lignites.

Canadian and North Dakota lignite must compete with anthracite and with Pittsburgh and Illinois bituminous coal; Texas lignite must compete with gas, oil, and Oklahoma bituminous coal. It is evident, however, that there must be a price at which the lower-grade fuel will begin to be attractive.

In round numbers the ratio is somewhere in the neighborhood of half the price of good coal. With the rising price of bituminous coal we are fast approaching the time when this ratio will be common.

The handicaps of lignite are well known, but not always properly valued. The heating values of high-moisture fuels are somewhat misleading. The heat carried by the moisture is recovered and measured in the calorimeter, but is not fully utilized in a boiler furnace. The B. t. u. ratios, therefore, do not give the relative possible steaming values of the fuels if comparison is made between a high-moisture lignite and a low-moisture bituminous coal. Although the ash percentage may be low, there is usually a larger total amount of ash to handle in a plant using lignite.

The fusing temperature of the ash is usually low, making high rates of combustion difficult and requiring larger grate areas and furnace volumes than with higher-grade coal. Notwithstanding these handicaps, with present technique, raw lignite can be used in large operations, and good efficiencies and reasonable capacities can be obtained. The problem is largely an economic one. When raw lignite is cheap enough in comparison with better coals it will be used in large steam-raising operations.

Search Must Continue

The search for a means to improve the fuel, however, must continue. A fuel classed as lignite in Northern Bohemia, and weathering much as does our lignite, is as carefully prepared for market as is our anthracite. Seven prepared sizes are offered to the market. Raw lignite can probably be somewhat improved for steam raising by sizing the product more closely than is common practice. It is probable, however, that an improved lignite product must first cater to a special trade that will pay a special price.

This is illustrated by the vision that has been so frequently held of improving the lignite by some process involving briquetting.

Unlike the German "Braunkohle," lignites do not make a stable and satisfactory briquet simply by drying the lignite and briquetting by heat and pressure. They lack sufficient inherent binder to consolidate and waterproof the mass. The necessary added binder increases the cost and hardly improves the quality. A quite satisfactory fuel can, however, be made by briquetting lignite char, and it is probable that some day such a fuel will be in common use.

Lignite char is lignite which has been dried and distilled in an oven especially designed for the purpose. About two and one-half tons of raw lignite reduce to one ton of char, the heating value of which is about 12,000 B. t. u. per lb. While raw lignite can be used satisfactorily in large steam-raising operations the author believes that the search for a means to improve the fuel must continue. Lignites do not briquet well without the addition of a binder, and the Bureau of Mines has therefore been led to investigate the possibilities of an inexpensive carbonizing process and the use of the resulting lignite char direct without briquetting. This process is briefly described in this article.

May Cut Costs

There have been hopes that through the recovery of by-products sufficient credits might be obtained to materially lessen the cost of briquets. Profit can be shown on paper, but such a process is essentially a large-scale operation requiring a large investment and very substantial financial backing by those familiar with technical enterprise. It is difficult, therefore, to start such an industry, for there is no opportunity to begin small and grow up, returning profits into an improved plant. Capital familiar with technical enterprise finds less hazardous ventures, and capital unfamiliar with such enterprise is apt to be misled and lost.

With these facts in mind, the Bureau of Mines is investigating the possibilities of a somewhat different program which has for its main features an inexpensive carbonizing device and the use of the lignite char direct, without briquetting. If a market for the char can be developed, and the small mine can produce char, there would be provided means for a natural evolution of an industry that in time might realize the larger vision of briquetting and recovery of by-products.

To Describe Char

Lignite char can best be described in a few words as a fuel rather than in analysis with anthracite coal, but softer, with a little more volatile matter, and thus kindling easier. In size it grades from pea coal to smaller sizes, and is a stable product. Whether a market can be developed for such a fuel at prices around five dollars a ton at the mine, remains to be shown, but it is at least encouraging to know that Germany used last year 400,000 tons of similar material for domestic heating and cooking.

This fuel burns well with natural draft where a thin fuel bed, about 1½ in. in thickness can be maintained. Base burners, cook stoves, and other heaters can be adapted to use the fuel satisfactorily. The Germans have developed a special stove, burning the fuel on a bed of ash in an enclosed drawer. There is no loss of fuel in the ash and lignite char used in such a stove heats an oven sufficiently for baking operations and will boil water. It makes a very clean fire, is smokeless, and the chair is clean to handle. It is, however, slow in getting under way as compared to a gas range.

Devise Simple Oven

To produce the char a very simple oven has been devised that greatly reduces the investment from that needed for ovens heretofore proposed. If lignite be passed through a combustion zone, moisture is first driven off; then combustible gases are distilled, and finally the solid carbon is burned. There is considerable shrinkage in volume and a complete absence of caking quality. These steps are fairly distinct, one from the other, so that the flow of lignite through the combustion zone may be so regulated that but little of the fixed carbon is burned.

(Turn to page 44)

---

*Presented at the Spring Meeting in Montreal, May 28 to 31, 1923, of the American Society of Mechanical Engineers.

C. A. S. E. Notes

At the last regular meeting of the C. A. S. E. No. 9, on Friday evening, May 25th, a lecture on steam turbines was scheduled, but owing to the lengthy discussion of different resolutions, the lecture was postponed until the next meeting. Bro. Nelson Levan, formerly assistant engineer at the Waterloo Water Works, is now assistant to Bro. Walker, of the Kitchener Water Works. W. Hirst is assistant to Bro. Beam, taking Bro. Levan's place at the Waterloo Water Works.

C. OTT, Rec. Sec.
Kitchener, Ont.

Book Reviews

Mechanical testing.—Testing of Prime Movers, Machines, Structures and Engineering Apparatus. By R. G. Batson and J. H. Hyde (both of the National Physical Laboratory, Teddington, England). Published by E. P. Dutton & Co., cloth, 5½ x 8½ in.; 446 pages; 313 illustrations. $10.

This volume covers its field in a thorough manner. Considerably more than half of it is of direct interest to engineers concerned with the testing of power equipment. The discussion of dynamometers, which occupies 127 pages and is accompanied by nearly a hundred illustrations, is particularly comprehensive. Absorption, transmission and traction dynamometers are treated separately and in detail.

Steam Turbine Principles and Practice. By Terrell Croft. Published by McGraw-Hill Co. Cloth, 5½ x 8½ in.; 347 pages. $3.

This book was written for those who operate steam turbines or manage properties containing such machinery. The subject matter has been designed to supply the man who operates with the necessary facts to do so economically, and those who purchase steam turbines, with the information that would lead to making a wise choice. The fundamental principles are described and connections to some of the basic formulas illustrated.

The advantage of running an engine over is that the pressure of the crosshead is always downward upon the guide. If the engine is run under, the thrust of the crosshead would be upon the top guide on both the outward and inward strokes, and unless the crosshead is properly adjusted, it will lift when subjected to thrust and fall by its own weight on the centre, making the engine pound.

The thinner the packing between a cylinder head and the cylinder, the better. Thick packing is more likely to blow out, and the additional thickness unnecessarily increases the clearance in the cylinder.

Operating at a 3,200 Lb. Pressure

New Method Now Being Tried in England to Increase Power Plant Efficiency

A METHOD, looked upon as promising by engineers who desire to increase the thermal efficiency of steam-power plants, is to raise the pressure and temperature of the steam and so design the prime movers as to utilize efficiently the increased energy drop thus made available.

Experimental plants have been satisfactorily operated with steam pressures ranging up to 1,500 lb. per sq. in. and the chief difficulty found at such pressures has been in the generation of the steam rather than in its use in the turbines.

Extraordinary precautions must be taken in design to guard against priming, or the passing over of water in gulps, on account of the violent boiling of water at this pressure and it has been principally due to the seriousness of this factor that pressures above 800 lb. per sq. in. have been attempted in only a very few cases. The likelihood of priming increases as the pressure is raised so long as steam is generated by methods that require the addition of latent heat with the consequent boiling.

One hundred years ago James Watt assailed Richard Trevithick as a "murderer" for proposing to operate boilers at the "dangerous" pressure of 60 pounds. To-day, there is nearing completion at Rugby, England, a plant designed to operate at a minimum pressure of 3,200 lb. Perhaps the most interesting feature of this plant from the Canadian engineer's point of view will be the generation of steam without boiling, by operating the steam generator in what may be termed the "super-pressure" region; that is, the region above the "critical point."

Favors Big Jump

The tremendous advance, however, made recently in the production of high-tensile steel and steel alloys has induced an English designer, the Benson Engineering Company, Ltd., of London, to introduce a super-pressure plant using steam at a pressure of 3,200 lb. per sq. in. and a temperature of 706 deg. F. The tremendous jump to 3,200 lb. being due to the fact that at any pressure below this, latent heat must necessarily be added, with the consequent troubles from boiling and priming.

This experimental test plant, soon to be erected in the works of the English Electric Company, at Rugby, England, is equivalent to a 1,000-k.w. commercial plant. Steam will be generated at a pressure above 3,200 lb. per sq. in., then throttled to 1,500 lb. and, after being superheated to 788 deg. F., will be passed through a high-pressure turbine exhausting at 200 lb. per sq. in.

To Reheat Exhaust

The exhaust of the high-pressure turbine is to be reheated to 662 deg. F. and then expanded in a standard normal-pressure turbine to 29-in. vacuum. The builders of the plant predict not only that it will consume about 28 per cent. less fuel than a high-grade plant of the same capacity operating at 250-lb. pressure, but that it will be cheaper to build and maintain.

As a matter of fact the actual test generator, complete with feed pump and fan, has cost less than a normal water-tube boiler of the same kilowatt capacity even though every part has been special.

The plant exemplifies one of many possible arrangements using steam generated at the critical point. The fundamental ideas involved in this method of steam production are covered by patents granted to Mr. Benson.

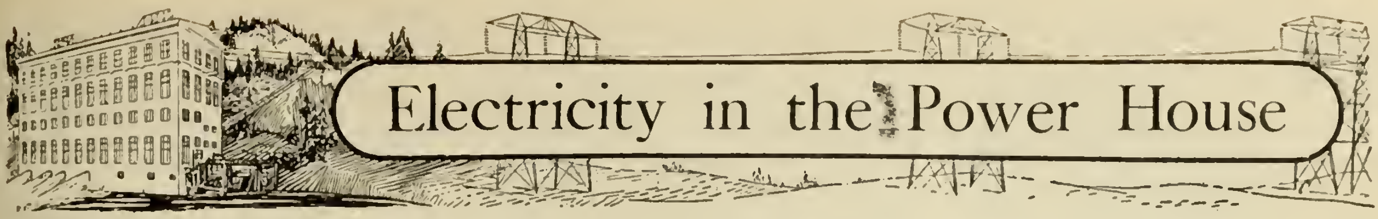
Owing to novel features in the high-pressure turbine, details of the design are not available for publication, but it may be said that the experimental turbine will have only one impulse wheel of a very small diameter, which will rotate at from 20,000 to 25,000 r.p.m.

Expansion will take place in the nozzle of this high-pressure turbine from 1,500 lb. and 788 deg. F. down to 200 lb., corresponding to an adiabatic heat drop of 196 B.t.u. The high-pressure turbine will eventually be gear-connected to a standard low-pressure turbine which will run at 6,000 r. p. m.

On account of the very high pressures and temperatures carried, special provision had to be made for the shaft and valve-spindle packings and attention has been given in the design to the restriction of windage and friction.

When the length of a connecting rod is reduced by constant keying-up, it results in the piston travelling much nearer to the front of the cylinder head. To prevent this shims are used back of the brass, next to the crankpin and the wristpin centre is lengthened by keying-up, and the shims should be placed between the brass farthest from the rod; that is, between the brass and strap.

An automatic cut-off engine regulates its speed by cutting off the steam supply according to the load, thus using a greater degree of expansion than when, as in the throttling engine, the cut-off is late enough to carry the maximum load. The slide-valve throttling engine regulates its speed by throttling the steam between the boiler and the cylinder.



Electricity in the Power House

CARE OF TRANSFORMERS

THE increasing utilization of electrical energy, cheaply generated in either large efficiently operated steam plants or hydro-electric stations, renders it now almost always necessary for large consumers to obtain their current at high voltage and transform it down to a suitable one for general works transmission.

In itself, the modern transformer, having no moving parts is a comparatively simple piece of apparatus, at the same time care is called for in its installation and maintenance.

As a rule the makers despatch transformers, when of moderate size, as complete units, and presuming these are oil cooled, as is now generally the case, they may be sent in their tanks with sufficient oil to cover the coils or without oil, the latter being sent separately.

In order to prevent movement during transit, however, wood packing frames are inserted between the transformer core structure and the tank in order to prevent movement of the transformer itself during transit. It is the business of the makers to see that these packings are quite free from shavings or sawdust which might find its way between the windings.

Bolted In Position

Finally the tank cover is bolted into position. Whether the whole comes in a crate is a matter for the makers to decide, but exposed terminals outside the tank are protected by a wooden cover.

It is important that this be done in a dry situation, because damp or moisture in a transformer is a very troublesome matter. The whole affair should be lifted from its tank and the windings, terminal leads and insulators carefully examined for any signs of abrasion, breakage and the presence of moisture.

If the tank arrives without oil it should be thoroughly cleaned out. All nuts should be gone over, tightened and locked. Where the transformer is fitted with adjusting tappings care must be taken to ascertain that the various connections are made in accordance with the diagram of connections. After a complete examination the transformer may be replaced in its tank and if necessary dried out.

All transformers, wound for high tension pressures of 6000 volts and over, should be dried out immediately prior to their being placed in commission, and the oil should be dried out also.

For lower voltages if despatched out of oil it is well to dry out if delayed in transit.

The drying out of a transformer is a job that requires care. Both the oil and insulating materials are liable to absorb moisture, which it cannot be too strongly impressed is detrimental.

There are two general methods of performing this important operation, that is:—

(a) By Oil Immersed Resistance Heating.

(b) By Short Circuit.

Method (a) consists of drying out the transformer and oil simultaneously in the transformer tank by means of specially constructed resistance units which are lowered between the windings and tank to the bottom of the latter. It is first necessary to clean down and make sure there are no foreign bodies in the tanks; the transformer is placed therein and oil poured in to the working level, or in the case of tubular tanks just below the top of the cooling tubes.

Do not grumble too much! If you do, your employer will think you are too busy with your own grievances to think about cutting down his fuel bills. Never say, "It is not my job." If you are wrong, it is inexcusable; if you are right, it is intolerable. Do not do your best to keep your plant running economically only because you fear you may lose your job. Such an engineer should be "fired" at once. The only place for him is in the South Sea Islands, where no one wears clothes and food grows on the trees.—With apologies to Lord Beaverbrook.

The oil should be allowed to stand for an hour or so. Having raised or removed the cover and lagged round the sides of the tank with sackings or any other handy stuff, the resistances should be spaced as symmetrically as possible round the inside of the tank so as to evenly distribute the heat.

Banked In Series

They should be banked in series or parallel according to the pressure available and should be connected to the outside pressure source by means of suitably insulated leads.

Either single phase A. C. or D. C. may be used as the exciting source.

It is necessary to choose the drying out resistance values so as to maintain "Ordinary" oil at a temperature of 175 degs. Fahr. or "Non Sludging" oil at a temperature of 212 degs Fahr. The temperature is taken at the top of the tank.

Although during heating up larger currents may be employed so as to hasten the process it must be remembered that too high a temperature is liable to disintegrate the oil and the heat near the resistance units is the limiting factor.

The average temperature should, however, be maintained at the figures stated, and if the resistance units have to be arranged to pass a higher current than is necessary continuously, it should be applied intermittently.

Readings Essential

During the drying out process the following readings should be frequently taken.

(1) Insulation resistance between H. T. and L. T. windings and between each winding and frame.

(2) Time. (3) Temperature. (4) Power Input.

The process should be divided into three stages, that is:

(1) A preliminary heating up stage of short duration increasing to the maximum. During this period the insulation resistance of the windings falls.

(2) The longer period of drying out at constant temperature. The insulation resistance then becomes practically constant.

(3) A shorter cooling period during which time the insulation resistance increases.

Curves can be plotted of insulation resistance and temperature as ordinates with time as abscissae, such curves giving a graphical indication of the drying out operation.

When the insulation resistance curve commences to rise the moisture may be considered to be removed and the supply to the resistance is cut off. Normal excitation may be applied to the primary side with the secondary windings open circuited in order to dry the core, but on no account should this be done till the windings and oil have been thoroughly dried out.

When Bubbling Ceases

On the cessation of bubbling at the top of the oil, drying out may be considered as effected. The foregoing method has several advantages inasmuch as by drying out the windings, oil and tank at the same time, labor and expense is saved.

The heat being generated at the bottom of the tank where the most moisture is to be found, the maximum temperature is applied where it is most needed, while there is no fear of local heating taking place in the interior of the windings.

With the short circuit method the same preliminary precautions are taken as before. The L. T. winding is then short circuited and low pressure three phase or single phase current applied to the H. T. windings of a value approaching the impedance voltage of the transformer.

The pressure available, if not suitable for application to the H. T. winding, may be applied to the L. T. with the H. T. winding short circuited. Special care, however, must be taken in this case to avoid breakage of the short circuiting connection, otherwise in the event of fracture, high voltage being induced in the H. T. winding, the operator will be in danger.

Temperature should be measured by a thermometer in the oil, preferably a spirit one, and by the resistance of the windings. If the latter cannot be taken, thermometers (spirit ones are essential) should be placed in the vertical oil ducts between the H. T. and L. T. windings.

Gives Heat Formula

If the resistance method is used the temperature corresponding thereto is given by the formula:

$$T = \frac{R(234.5+t)2-34.5\,r}{r}$$

T being the HOT temperature of the windings.
t being the COLD temperature of the windings.
R being the HOT resistance of the windings.
r being the COLD resistance of the windings.
Temperature rise $= T - t$

The value of T should not exceed 212 degs. Fahr.

If a transformer is dried out of its tank, the procedure electrically is the same as described, but the voltage applied must be lower. The transformer should be protected from draught and the steady drying out temperature must not exceed 212 degs. Fahr., when measured by resistance, and 194 degs. Fahr. when measured by thermometer.

If at all possible drying out without oil should be avoided. It has several disadvantages, such as the possible occurrence of local heating in the centre of the windings, and the maximum heat just where it is not wanted.

The transformer and oil having been put into satisfactory condition, the latter if despatched separately can be poured into the tank to the level indicated on the oil gauge.

Oil In Chamber

If expansion chambers are fitted, sufficient oil should be poured in so that at normal temperature there is about 2" of oil in the expansion chamber. The oil should be allowed to stand 6 hours, so as to allow the air therein to disperse. This may be rendered more effective by agitating the oil. External insulators should be cleaned with a dry cloth, and the breather, if supplied, charged with the necessary calcium chloride.

After switching in, it is desirable to leave it on no load as long as possible so that it will become warm from the heat of iron losses which mitigates against the absorption of moisture, assists in the expulsion of air and allows the windings to settle down. When, however, a transformer has to operate in parallel it must be "phased in" before the full primary pressure is applied.

At first it might appear that a transformer would be a piece of apparatus which could well take care of itself, but as a matter of fact intelligent inspection at intervals is well worth while.

It is wise to remove a transformer from its tank every six months, at which time the coils should be tightened up, all nuts examined and a sample of the oil taken from the bottom of the tank and tested for dielectric strength. If sludge has been deposited, the whole of the oil should be run off, filtered and the tank cleaned out. Any moisture tapped at the bottom of the expansion chamber should be drained off, say once a month, and clean dry oil introduced to replace any wet oil taken out.

The breather, if any, should have its supply or drying agent, usually calcium chloride, replaced every week. Periodically the insulators should be wiped down with a dry cloth.

It is necessary to permanently earth, in a direct and positive manner, the tank covers. The core itself should also be well earthed, and it is necessary to make a periodic examination of the paper disc between the electrodes to ascertain if it has deteriorated.

Finally, it is hardly necessary to remind those having access to transformers that to approach the tanks with a naked light when removing the cover is dangerous, the gas generated in the enclosed spaces being sometimes of an explosive nature. —Mayor Johnstone-Taylor.

Convention Notes

The American Society of Mechanical Engineers held their spring meeting in Montreal from May 28 to 31 inclusive. Among the industrial plants inspected by the visitors were the Cedar Rapids Manufacturing and Power Company, the Dominion Engineering Works, the Laurentide Power House and Paper Mill, the plants of the Shawinigan Water & Power Company, and the La Gabelle Power Development.

Julian C. Smith, vice-president and general manager of the Shawinigan Water & Power Company, had prepared a very important paper on "Hydro Electric Possibilities in the Province of Quebec," but was detained in Winnipeg on business and so his assistant, P. S. Gregory, handled it for him.

An explanation of various watershed precipitations in the province preceded the statement that "the potential water-power of the province, due to the precipitation, is about ten per cent. higher per square mile of area than the average potential water-power of the United States." Owing to the present stage of development, under which, in the matter of distribution of hydro-electric power, "only those sites near industrial centres, and at which water-power exists in considerable quantities, are capable of being developed."

In rehearsing the progress of water-power and hydro-electric, it was shown that water power was first developed by the French in Quebec in 1650.

H. R. Naylor, assistant works manager at the Angus Shops of the C.P.R., explained steel car construction at the shops. A description of the machine equipment was followed by an illustration of the method of construction and assembly, which led up to the explanation of the final erection and assembly of the car.

Frederick E. Gaby, of Toronto, chief engineer for the Hydro Electric Company of Ontario, read a paper dealing with the development of hydro-electric plants in Ontario.

Many places of interest were visited, including St. Anne de Beaupre, Mount Royal Park, Art Gallery and the Lachine Rapids. The engineers left Montreal on the night of June 1st.

The Eugenia Electric Association held its annual meeting at Owen Sound on May 30th, and elected officers as follows:—President, John Legate; vice-president, D. Sewall; second vice-president, Dr. Hacking; secretary-treasurer, C. C. Eldridge. Hydro engineers explained proposals for extensions and changes, which received endorsement. A tie line connecting Eugenia with the Niagara system will be built between Harriston and Mount Forest and a second flume will be built at Eugenia, increasing the plant's capacity to 8,000 horsepower.

The Fourth International Congress of Refrigeration will meet in London, England, in June, 1924. This congress was founded by J. de Loverdo, and that it has had such an important bearing on the industry is largely due to the valuable services rendered it by President Andre Labou, former French Minister of Colonies.

Indications are that the 1923 convention of the National Electric Light Association in New York, June 4 to 8, will be the greatest in point of attendance and interest ever held. It is estimated 10,000 members will be on hand.

If the governor belt should break, will your engine stop? If you do not know this to be the case, see to the adjustment of the safety cams on the Corliss engine and to the automatic stops on other types of engines, and make sure that they are adjusted to operate. They are likely to get out of their proper position and should be examined at least once a week, and tested to see if they control the engine.

Editorial Comment

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

NITA C. SHATFORD
News Editor

Boiler Inspection a Joke

BOILER inspection in the province of Ontario is a joke; indeed, many boilers have never had any inspection at all. There is a division of authority by means of which error, responsibility and waste may be shifted around by the minister of labor until it finally rests upon the waste paper basket.

The work at present is under the jurisdiction of two departments of the government—the Factory Inspection Branch whose duty it is to see that factories are provided with adequate machinery guards and sanitary arrangements; and the Steam Boiler Branch charged with the inspection, during construction, of all steam boilers and pressure vessels as well as second hand boilers offered for sale and repairs to boilers to be used later in the province.

It is well known that the province has had and will continue to have able and conscientious service from the Steam Boiler Branch, while alone is sufficient reason for the present absurd system being scrapped and this department given control of all boilers in the province.

A consolidation clearly indicated as the requirement of efficiency and economy.

* * * *

Solving Coal Problems

THE report of the Dominion Fuel Board for the ten years ending in 1921 which shows that Canada's bill for imported coal in the period investigated exceeded $580,000,000, is more likely to aggravate than to alleviate the coal situation.

Talk of a wider use of British Columbia, Nova Scotia and Alberta coals without offering any solution of the problem of getting such coal to Quebec and Ontario at a price that can compete with American coal, is worse than useless.

The trouble apparently is that everybody at Ottawa is eager and ready to talk ahout what might be done to solve the coal problem but that nobody is doing anything worth while.

If there is danger, as charged, in the present easing in the anthracite supply it should not be beyond the power of the government to solve the transportation problem.

Alberta coal must be carried some 2,000 miles for use in Ontario as compared with the four or five hundred mile haul from the American fields, but if all Canadian railroads were given some form of freight subsidy on coal shipments so as to reduce Sir Henry Thornton's $9 a ton demand to $6 a ton Alberta coal could at least compete with American.

The Fuel Board also urges the use of peat but fails to advise the public where it can be purchased in quantities sufficient to warrant its use.

Such a report serves no purpose except perhaps to advertise the participants. The coal problem is not going to be solved by a declaration of intentions. Surely with all the boards, divisions, commissions and other governmental agencies at work obtaining the facts somebody will do something yet for a change.

* * * *

Simply Chemical Reaction

COMBUSTION is merely a chemical reaction by means of which fuels when combined with oxygen liberate large amounts of heat. The method of combustion which liberates the greatest amount of heat in the smallest volume of clean gas, is the most effective. This means that fuel should be ignited and burned as quickly as possible in order to allow the required proportion of time to bring the hot gasses in contact with the work in hand.

The method of combustion which releases the maximum amount of heat in the smallest volume of carrying medium and increases the time that this hot gas will be kept in contact with the work is the most effective and efficient method.

* * * *

Buy Coal Now

THERE are several reasons which will appeal to every engineer who studies the question, why coal should be bought in the summer months.

One is that there is usually a surplus of bituminous coal in summer and as operators are obliged to keep their mines in operation, there are frequently opportunities for buying up fuel at advantageous prices if it can be stored.

Then there is the fact that the quality of coal on the market in summer is usually better than in fall or winter. This is due to the fact that mining is done under less pressure and greater care is taken in preparing the product.

The cost of unloading frozen coal is another argument in favor of doing as much of this work as possible in summer. The steam required to thaw frozen cars and the extra labor involved add considerably to the cost of coal received in winter.

Depreciation of coal in storage is not a serious matter. No accurate figures have been obtained for the loss of heat units in different parts of the pile but tests have indicated that it is slight.

The cost of handling the stored coal from pile to boiler house usually increases with the amount stored, but the cost of storage equipment becomes less per ton as the quantity is increased.

Each plant requires special study to determine the method best suited to its needs but an investment in coal storing equipment, if wisely made, will rarely be regretted.

* * * *

Beware of Ruts

THE engineer who gets into a rut is likely to get into a ditch. And both are bad things to get into. So, to begin at the beginning, it is well to keep out of a rut. For a rut, if travelled in regularly, becomes a ditch. It is all right to have ideas, and plans, and policies. They cut fuel bills and bring increases in salary. But beware of ruts.

The cure for ruts is variety. The operator of a power plant needs variety every bit as much as three meals a day.

Do the unusual thing. What if it hasn't been done before? Who cares? The engineer must see new things, read new things, hear new things, and have new things.

Gosh! It's tough to do the same old thing day in and day out.

* * * *

It Will Come

THE higher coal goes, the quicker will come a new fuel. It may be oil, or gas, or something else. But it will come.

Whatever the fuel may be, and whenever it may arrive, it is sure to result in changes in power plant methods and, therefore, it is imperative for every engineer to keep fully informed of the latest developments.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

THIRD-CLASS CERTIFICATE

What qualifications are necessary to obtain a third-class stationary engineer's certificate, also is one obliged to obtain a fourth-class certificate before a third?—A. Simpson, Brampton.

Answer:—A candidate for third-class certificate shall be required:

(a) To be at least 21 years of age;

(b) To be a holder of a fourth-class Ontario certificate of the current year or its equivalent from one of the other provinces of the Dominion;

(c) To take an affidavit on a form supplied by the Board to the effect that he has had at least two years' experience in a stationary steam or gas plant, showing at least six months' experience in a boiler room and six months' experience in an engine or compressor room;

(d) To pay a fee of five dollars at the time of making application for examination. (This fee shall not be returned to the applicant should he fail to pass the examination);

(e) To answer the questions on the examination paper and secure at least 60 per cent. of the marks.

A candidate for examination for third-class stationary engineers' certificate is required to possess:

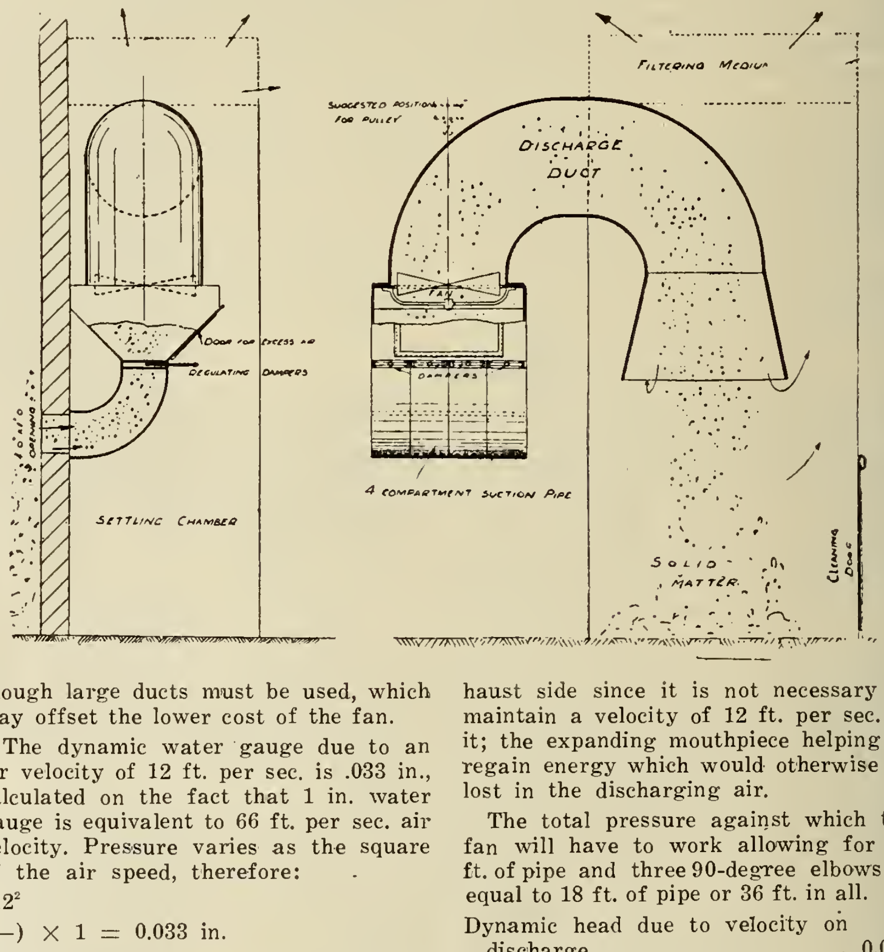
A general and practical knowledge of fuels, combustion, boilers, boiler setting, piping, steam engines, steam turbines, condensors, auxiliaries, electrical equipment, oils, heating and ventilation, hydrostatics, refrigeration, water softening, some arithmetic, and knowledge of injectors, boiler feed pumps, pumps, valves, steam traps, steam separators, reducing valves, expansion joints, lubricators, and any other apparatus commonly used around an ordinary steam plant.

* * * *

TYPE OF FAN

I desire to maintain an air velocity of 12 ft. per second through a vertical stream of material falling across an opening 4 ft. wide by 1 ft. deep. The products to be separated by the air current vary within narrow limits in the air velocity required to float them, but no other satisfactory means of separation presents itself. The velocity of the air across the whole width of the 4-ft. stream of material must be uniform. Efficiencies are of secondary importance. The material to be separated weighs 9 lb. per cubic foot, and an exhausting fan must be used. This material must therefore, be drawn into the fan, and discharged into a settling chamber of ample size to ensure that the fan would deliver at practically atmospheric pressure. I understand that I cannot use any type of fan except a diametral-flow. Kindly give me your opinion of the type of fan.—J. S. M., Vancouver, B. C.

Answer:—The propeller type of fan should be quite suitable for the job, and not as costly as a diametral-flow type although large ducts must be used, which may offset the lower cost of the fan.



The dynamic water gauge due to an air velocity of 12 ft. per sec. is .033 in., calculated on the fact that 1 in. water gauge is equivalent to 66 ft. per sec. air velocity. Pressure varies as the square of the air speed, therefore:

$$\left(\frac{12^2}{66}\right) \times 1 = 0.033 \text{ in.}$$

This is purely dynamic head due to actual air speed, allowance must be made for friction in ducts, bends, etc.

A 30-in. propeller fan of any reliable make should do the work, if fitted up as illustrated, an even flow being maintained by dividing the rectangular suction pipe into compartments, fitting each compartment with a sliding damper, in this case four divisions have been made. The damper can be so regulated to control the air speed over the whole surface of the opening. A propeller fan will not work against a head much exceeding one half an inch water gauge, so small ducts must not be used on the exhaust or the suction side.

The area of a 30-in. fan is 5 sq. ft.; the suction pipe leads into a fan box which is 4 ft. by 2 ft. 9 in. The total air to be handled over the area with an air velocity of 12 ft. per sec. is 12 × 60 × 4 × 2.75 = 7,920 cu. ft. per min.

A 3-ft. diameter pipe would do in the exhaust side since it is not necessary to maintain a velocity of 12 ft. per sec. in it; the expanding mouthpiece helping to regain energy which would otherwise be lost in the discharging air.

The total pressure against which the fan will have to work allowing for 18 ft. of pipe and three 90-degree elbows is equal to 18 ft. of pipe or 36 ft. in all.

Dynamic head due to velocity on discharge	0.08
Static loss in duct system	0.279
Resistance through filter, say	0.15
Total inches of water-gauge	0.509

* * * *

BOILER PLATES

What is the thinnest plate that may be used in power boilers?—R. S. M., London.

Answer.—According to the A.S.M.E. code (revised 1923) the minimum thickness of any plate under pressure shall be ¼ in. The minimum thickness of plate in stayed surface construction shall be 5/16 in. These safety factors are also the minimum allowed by the Canadian Interprovincial Regulations.

* * * *

STEAM FOR STOKERS

How much steam is required to drive underfeed stokers and fans?—L. T. J., Windsor.

Answer.—The amount of steam required to drive underfeed stokers varies with the type and method of drive. Mechanically driven stokers are claimed by the makers to use less steam than other types. From 2 per cent. to as high as 5 per cent. of the steam produced may be used in driving the stokers and the fans for forced draft.

* * * *

CORRECT POWER FACTOR

What is the most convenient method to correct the power factor in a plant which has several large induction motors?

Answer:—Induction motors cause low power factor due to a lagging current. Power factor with induction motors may be improved by loading the motors to the full rated load. If this is not possible and the power factor must be improved, part of the load should be taken by synchronous motor with an over excited field causing a leading current which counteracts the lagging current of the induction motor, thus helping towards unity power factor.

* * * *

STEAM VELOCITY

What velocities should be used in pipe lines with superheated steam and what are the advantages of high velocities?

Answer:—The usual velocities for saturated steam 3,000 to 6,000 ft. per min., may be greatly exceeded with superheated steam since there is no moisture present to cause water-hammer. For high steam pressures 10,000 to 12,000 ft. per min. is advisable for lines over 5 inches in diameter, with a continuous steam flow as for instance when used in turbines. 12,000 to 15,000 ft. per min. can be and have been used in larger pipe lines without any trouble. The pressure drop with superheated steam is much less than with saturated, due to its lower density, the absence of moisture, the dry pipe walls and the reduced amount of foreign matter. Higher velocities may be used, resulting in smaller pipe lines for the same capacity.

The use of smaller pipe lines also cuts down the radiation losses. A chemical company had an 8 inch pipe line 1,400 ft. long in the plant conveying steam from the boiler room to a process house. An increase in production required double the amount of steam, a second pipe line was planned. Superheaters were installed in the boilers after which it was found that the old pipe line would carry all the steam necessary, the radiation losses per pound of steam being decreased 36 per cent.

DUPLEX PUMPS

In a direct acting duplex pump, if one piston bumped at the right hand end of its stroke and ran short at the left end, how would you correct it?

How many thousands of an inch small must a ring be bored which is to be shrunk on the 8-inch diameter boss of a flywheel when heated to 500 F. in a workshop temperature of 60 deg. F?

Answer:—The striking of the piston at one end of its stroke and running short at the other is a result of faulty setting of the valves. On all duplex pumps there is an adjustment provided, with some on the linkages which operate the valves, on other pumps by means of the lock-nuts on the valve proper.

To reset the valves of a duplex pump locate the steam piston in the centre of the cylinder. This can be accomplished by pushing the piston to one end of its stroke against the cylinder and marking the rod with a scriber at the face of the stuffing box, and then bringing the piston in contact with the opposite end, and again marking with the scriber.

Divide exactly the distance between the two marks on the rod, then shove the piston back to this mark, bringing it in the centre of the steam cylinder.

Perform the same operation with the other side of the pump, then place both slide valves in their central positions, passing each valve stem through the stuffing box and gland. Locating the pistons in the centres of their cylinders brings the levers and the rock shafts in a vertical position. Next screw the valve stem through the nuts until the hole in the eye of the valve stem comes in line with the hole in the links, connecting the rocker shaft, then put the pins in their places and adjust the nuts on both sides of the lugs, leaving about one-eighth to one fourth of an inch lost motion on each side.

Answering the second part of your question and assuming that the ring is of mild steel and that it is to be heated from 60 deg. F. to 500 deg. F. With the co-efficient of expansion for steel as .000,006 the diameter on heating would increase .000,006 x 8 x 440 = .021 of an inch. To allow for the slight cooling of the ring when fitting to the boss, it should not be bored more than .016 of an inch smaller than the boss.

* * * *

STOPPING COMPRESSORS

How would you stop a compressor?

Answer:—First close the main expansion valve and keep the machine running until the back pressure drops to about 2 pounds, then close the throttle on engine and shut the machine down. Close oil valve and stop valves on suction and discharge lines; then shut the cooling water off the condensers and compressor cylinder.

* * * *

REFRIGERATION

How would you start a compressor?

Answer:—First start the cooling water on the compressor cylinder and condenser, then open the valves on compressor discharge line and the oil valve. Next gradually open the engine throttle until the machine is at its proper speed. After the first few revolutions, the stop valve on the suction line is opened gradually. When the suction valve has been open full and the back pressure reduced to about 10 pounds, the expansion valve is opened slightly, allowing some of the charge to go over. When the charge is about right and the expansion valve properly adjusted, the secondary expansion valves on each of the coils should be adjusted until each of the coils frost alike. The back pressure to be carried varies with different machines from 15 to 25 pounds and is determined by the marner in which the outlet from the expansion coils frosts back.

* * * *

HOW GAS TRAVELS

Explain how the gas travels from the discharge to the suction of a compressor.

Answer:—Through the discharge line to the oil trap, from the oil trap to the condensers; where it is cooled and liquefied. It is now a liquid and drains into the receiver and on to the expansion valve. It is controlled through the expansion valve and passes through the evaporating coils, absorbing the heat from the surrounding space or brine; it passes out of the coils through the scale trap and to the suction of the compressor.

Antifriction metals, so called, are useful for lining bearings chiefly because of the ease with which they can be forced (poured) and their ability to permit crushing and abrasion without great increase in friction, not because they have a lower co-efficient of friction, hence antrifriction is a misnomer.

If the polarity of a generator becomes reversed, it may be corrected by lifting the brushes clear of the commutator, opening the circuit-breaker and shunting its terminals with small fuse wire. Then close the main switch for a few seconds and the generator fields will become energized in the right direction from the busbars. Before opening the main switch, however, it is well to cut in the field-rheostat resistance.

The Graver Corporation, East Chicago, are circulating a booklet dealing with the employment of waste steam in the treatment of water for purposes of softening. Various curves are given for the general conditions occurring in feed water together with the beneficent effects to be obtained by the application of heat to the softening process. The publication is comprehensive and clear.

Babbitt metal should not be used over and over again for the reason that every time babbitt metal is melted some of the tin and antimony is burned out.

Practical Ideas From Practical Men

TREATING COILS

Having read the article by W. McKenzie on page 34 of the May 5th "Power House," perhaps a description of the process used by a large electrical manufacturing company to treat motor and dynamo coils with a varnish or compound, might be of interest to readers.

After the coils have been wound with cambric and tape which has been properly treated, they are placed in a large tank with a removable cover that can be made air tight. With the coils in the tank and the bolts of the cover tightened up, a vacuum pump is operated for half an hour or so, so as to form a vacuum inside the tank, as well as to extract any air which may be collected in the coils. The valve on the air pipe is then closed, and another valve opened which permits a varnish or compound to be drawn by the vacuum into the tank.

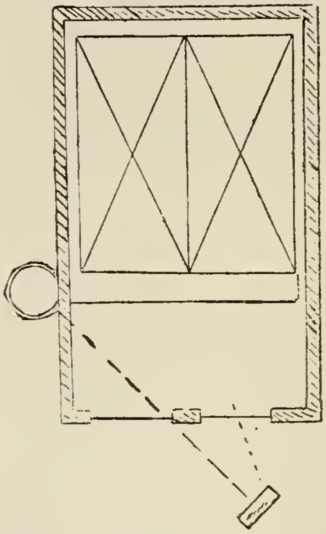
The apparatus is so arranged that it is known when enough varnish or compound has entered the tank to cover the coils. The compound valve is then closed and a valve on a pipe from air compressor is opened and an air pressure of 90 pounds placed on top of the compound. It is obvious that it is impossible for any space not filled with compound to exist in the coils. What the vacuum does not draw in the pressures forces in. Before the air pressure is cut off the compound is blown out of the coil tank into a receiving tank so as to be ready for the next batch of coils, the connecting valve is closed, the air pressure cut off, the pressure in the coil tank allowed to drop, the top removed, and the coils taken out and baked as described by Mr. McKenzie. —JAMES E. NOBLE.

MIRROR A SAVING

While the little kink of using a mirror placed in such a position as to make it convenient for the fireman to watch the condition of his smokestack is not a new one—in fact 'is a very old one—it is worthy of repetition because of the limited extent to which engineers in general have availed themselves of it.

Perhaps no other feature of power plant operation offers as great possibilities for saving as does that of firing and combustion, and one of the factors entering into this is the matter of smoke, usually one that is overlooked because the man doing the firing is unable to tell just what conditions he is producing in the way of smoke.

This mirror arrangement, installed so that it reflects the image of the stack top, usually makes it possible for the fireman to note the effect of his firing on the smoke, and all without leaving his post in front of the boilers, and this little kink is therefore strongly recommended for use in those plants where a serious attempt is made for improvement along these lines. The same idea, of course, can be used in watching the exhaust from atmospheric relief lines, vent lines from receivers, etc.



LEAKING WATER

A 300 h. p. iron tube closed heater commenced to leak badly, installed in a location where it was impossible to make any repairs on it unless considerable equipment was removed. The heater was supplied by a cold water feed pump which forced the water to the boiler, thus the heater was always under boiler pressure.

A second pump was installed between the heater and the boiler, acting as a boiler feed pump, the cold water pump then serving only to supply the heater. A ¼ inch pipe 16 feet high was placed on a high joint on the discharge from the heater, to assist in keeping the heater under atmospheric pressure. A pressure gauge was also placed on top of the heater.

By adjusting the speed of the two pumps by hand control of the valves it was found to be an easy matter to keep approximately atmospheric pressure on the heater, resulting in very slight leakage of the heater.

D. R. McNally, Callender, Ont.

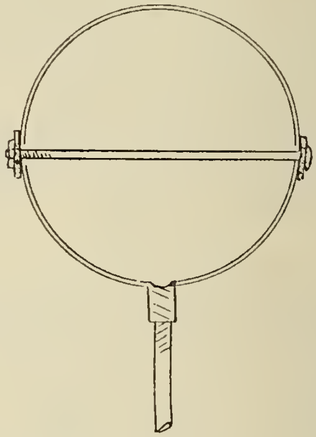
LUBRICATOR TROUBLE

A lubricator with a bull's eye sight feed glass persisted in cracking. It was found when replacing the glass that if a thin mica disc was placed on the inner side of the glass and the packing nuts tightened, the trouble from breakage ended. The mica can be readily cut with shears or a sharp knife.

D. R. McNally, Callender, Ont.

REPAIRING A FLOAT

Probably no other thing in the power house gets cussed as much or as frequently as floats—those used in a multitude of capacities about the plant, mostly in connection with control valves of various kinds. They seem to leak with almost unfailing regularity, and seem to resist equally well most attempts to repair them by soldering, etc. We recently ran into a case where a 6-inch diameter round float on our make-up tank valve sprang a leak, and for three successive Sundays we had it out for repairs, but each time the hole could not be effectively plugged with soldering methods. In desperation our repair man, who apparently was anxious to get at least one Sunday off, rigged up a cure as shown in the attached sketch, which seems to have done the trick. He accomplished it by putting another hole in the float opposite from the original one, and then putting through a long narrow specially made bolt, which served to pull together a packing ring around each hole. This float, fixed in this manner, has now held up for three months, and perhaps some other engineers will want to try it on one of their hopeless cases of float leakage.



INCREASES LIFE OF BRUSH

The usual life of brushes can be greatly increased by placing fibre discs between the brush and the spring, in order to maintain sufficient pressure of the brushes on the commutator. When buying new brushes engineers should make sure that the pig-tails or other connectors will allow the brush to be worn till it is thin. With some types of connections a brush three inches long when new may have to be discarded when not more than one half of the brush has been worn out; with others it can be worn down to less than ½ inch thick.

The brush holders should be adjusted so that the brushes wear evenly on both sides. In our plant we place fibre discs between the brushes and the springs and thus are able to wear them down to about ¼ inch; the softest brush gives the best service, as well as being the easiest on the commutator.

A little care given to brushes and commutator will save considerabie money in a short time.—JOHN DAVIS.

TIGHT STEAM JOINTS

To make tight steam joints, take white lead ground in oil, incorporate as much manganese (black oxide) as possible, adding a small portion of litharge. Knead it with the hand, dusting the board with red lead. The mass is made into a small roll, and laid on the plate, first rolling the plate with linseed oil. It then can be screwed and pressed into position.

Power Notes

The report that the American Radiator Co. was negotiating for the purchase of the Dominion Radiator Co., Toronto, has been confirmed by the New York office of the former. The current rumor to the effect that the purchase price would approximate $2,000,000, is incorrect. It is expected that details of the merger will be made known in a few days.

The Canadian Power Co. is building at Niagara Falls, an outdoor transformer station. This will cost approximately $150,000 and when completed will have a capacity of 60,000 horsepower.

The Imperial Oil, Ltd., have let the contract for the building of their new plant at Owen Sound to Schultz & Co., Brantford, and work will be commenced shortly. There will be a number of separate buildings, including office, warehouse, pump-house, stables and garage. Two large storage tanks and two shipping tanks will also be erected. The buildings, etc., will cost in the neighborhood of $70,000.

Ratepayers of Thornbury, Ont., recently endorsed a by-law for issuance of debentures to construct and install a waterworks system. The by-law provides for the construction of a pump-house, filter, water tank and pumping machinery. The town is utilizing its own electric energy.

Sealed tenders will be received by Fred B. James, Walkerton, Ont., to Monday, June 18th, 1923, for the following works at the County Buildings, Walkerton, for the Bruce County Council; the erection of addition to County Council building; the erection of central heating building and trenches for pipes, and the installation of central heating plant.

G. A. Maguire, salesman, has resigned from Canadian Tube and Steel Products, Ltd., it is claimed, to organize a company for the purpose of manufacturing wrought iron pipe. It is understood the new concern will operate under the name of Tube Products, Ltd., in a plant on the old Dominion Shipyard property at foot of Bathurst Street, Toronto, for which a lease has already been granted by the Harbor Commission. A new process of manufacture, it is claimed, is the chief stimulating influence behind this project. It is said that a process for the manufacture of seamless wrought iron pipe was recently submitted by a Toronto inventor to the United States Steel Corporation, but according to H. C. Scholfield, vice-president of Page Hersey Tubes, Ltd., no purchase or agreement materialized.

Premier Greenfield and Attorney-General Brownlee, of Alberta, who have been in Ottawa in consultation with the house committee on mines and minerals, regarding the coal situation in Canada, spent a few days in Toronto before returning to the West.

City Engineer McFaul, of Hamilton, Ont., in accordance with instructions from the board of control, has prepared a report on the method of installing a chlorinating plant at the pumping station. Duplicate apparatus would have to be installed, and the plant would cost in the vicinity of $8,500.

Peterborough Utilities Commission has accepted the tender of the Canadian General Electric Co., of that city, for switching equipment for the new electrical distribution station there. The amount of the contract accepted is $30,745. Only one other Canadian firm tendered for this equipment, and that was the Westinghouse Co., whose tender totalled $36,460.

John Inglis Co., Toronto, are at present working on an order for fifty heaters for the Worthington Pump Co., and expect to have the order completed in another two weeks' time.

Sealed tenders will be received until 12 o'clock noon, June 8th, 1923, by E. L. Ruddy, chairman of building committee, 317 Spadina Avenue, Toronto, for boiler house, concrete pipe conduits, chimney, boilers, piping, auxiliary equipment, radiation and domestic hot water equipment for the Toronto Free Hospital for Consumptives, Weston, Ont. Plans and specifications may be seen at the office of the consulting engineer, Melvern F. Thomas, 229 College Street, Toronto.

The Westinghouse Electric & Manufacturing Company have been given the contract to electrify 213 miles of its track by the Virginian Railway. The order includes construction of electric locomotives, power house, transformer station and apparatus, and the total expenditure will be $15,000,000.

Kirkland Lake, Ont., is expending approximately $150,000 in installing waterworks.

The Quebec Streams Commission and the Quebec Development Company, Limited, have filed plans at Ottawa relative to the water power project in the Lake St. John and Chicoutimi district. The cost of this work will be over $20,000,000.

The Public Service Corporation and the Q. R. L. H. & P. Co., of Quebec, P. Q., have amalgamated and will be known in future as the "Quebec Power Company, Limited."

The Bawden Machine Co., 163 Sterling Rd., Toronto, are installing a complete waterworks pumping station of the township of York at the village of Oriole. The equipment includes Sterling and Kermath Engines as an auxiliary to the electrical power.

W. S. Haggas, for some years with H. W. Petrie, Limited, Toronto, has been appointed Canadian representative of the Keighley Gas & Oil Engine Co., Keighley, England. Mr. Haggas has opened an office in the Petrie Bldg., 131 Front St., W. The Keighley Company produce engines ranging from 5 to 600 h. p. adapted to industrial, municipal waterworks or power plant requirements.

The John T. Hepburn Co., Toronto, are installing in the new Morgan Bldg., Montreal, pumps for the purpose of supplying high pressure steam to electrical generating plants. Two of these pumps are 11 x 14 x 20 in. to be used as vitalizers, which are designed to serve 70,000 square feet of direct radiation. Two other pumps are of the horizontal ram type—12½ x 9 x 12 in. for boiler feed purposes. Another installation which the Hepburn people are making is that of a 4-stage centrifugal pump with a capacity of 150 Imperial gallons per minute against a total head of 600 feet. This equipment will be installed in Lynn-Canyon as an auxiliary waterworks plant for the district of North Vancouver, B. C.

To keep in touch with the operation of the plant to determine if it is working at the highest efficiency, it is necessary that a correct log be kept of all departments. This log of itself has no value unless it is carefully analyzed from day to day to determine whether the plant did maintain the highest efficiency on each particular day under the conditions at which it was necessary to operate.

Cylinder oil containing fatty acids should be avoided, as it is apt to injure the metal. The acid absorbed by the piston and valve-rod packing sometimes attacks the rods, when the engine is out of service, to a serious extent.

Rosin oil is cheap and its specific gravity high, therefore it is sometimes used to adulterate lubricating oil. When it has been considerably refined, it can be added in large quantities without much chance of detection except by a chemist; but since it has no lubricating qualities, the action of the mixture will be unsatisfactory.

Progress in New Power Equipment

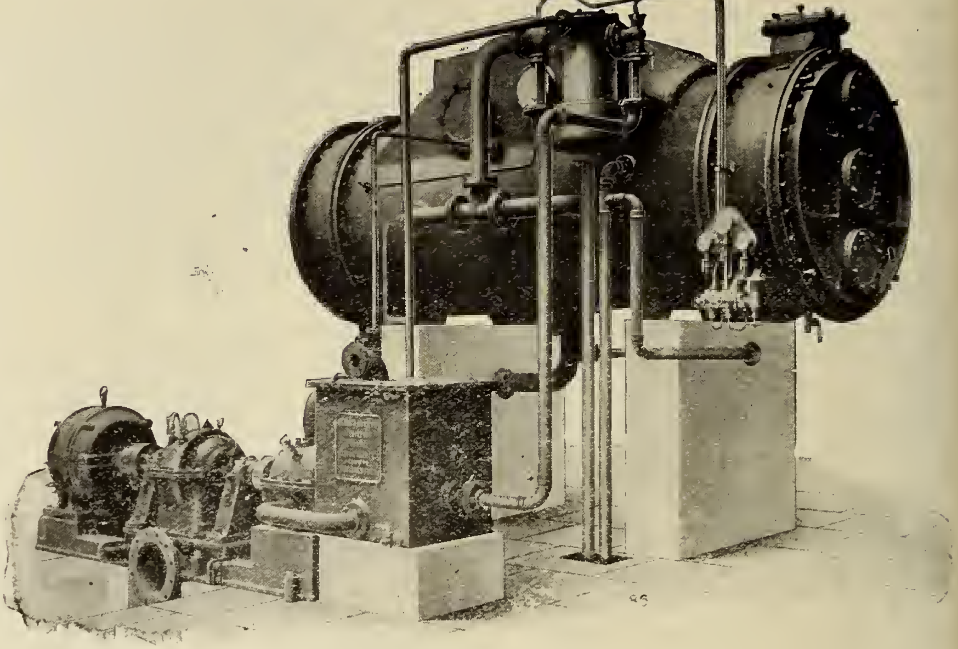


Figure One.

CONDENSING PLANT TYPES

There are two main types of condensing plants, surface and jet. The surface is possibly the more popular, but in many instances the hard nature of the condensing water supply precludes its use owing to the inevitable scale formation on the inside of the tubes. It is then necessary that direct contact should take place between the steam and the condensing water in a jet condenser.

Since the advent of the steam turbine great strides have been made in condensing plant design, especially in that of the surface condenser.

Laboratory experiments in universities, and trials on a larger scale on manufacturers' test plates have enabled the problem of heat transmission from the exhaust steam to the condensing water to be more fully investigated.

The general principles of surface condenser designs are now fairly well established, but the main value of the experimental data obtained is that it has formed a basis upon which can be made a proper comparison and valuation of results given under ordinary running conditions.

Results Aid Designer

From these latter results the designer has been able to acquire knowledge of the essential correction factor for formulae founded upon laboratory and test house trials.

The surface condensing plant illustrated by Figure 1, represents an up-to-date design, and has been evolved from considerable past experience. This experience applies not only to the manufacture of the plant but also to questions arising in connection with its installation.

This is a matter of equal importance for in every instance a thorough investigation of individual conditions and requirements must be made if all-round success is to be attained.

The condenser has a cast iron body and water ends, with brass tube and tube plates, and internal baffles, ensuring the passage of the steam over the whole condensing surface and eliminating any "dead" spaces. There is, however, but little obstruction to the free flow of steam inlet and the air pump outlet.

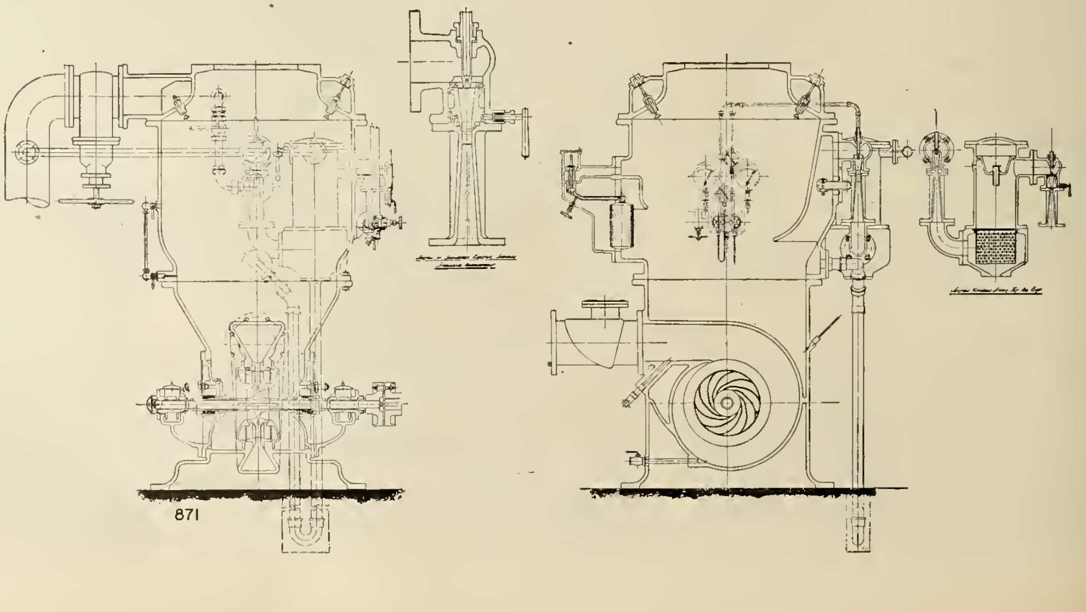
The velocity of water flow through the tubes is between 4 to 6 feet per second, depending upon various factors, and is sufficient to keep the tubes free from any matter carried in suspension with the water, and further tends to reduce scale formation.

The problem of air extraction from a vacuum chamber has been attacked in various ways but the simplest and most direct of them all is that of steam jet extraction. Further, it is one that gives good efficiency, for the steam passed through the air extractor can be afterwards wholly or in part utilized for heating the boiler feed, thus maintaining the thermal balance.

The surface plant illustrated is equipped with an air extractor of this type, being of the two-stage with intermediate condensation design. It is of the utmost simplicity in construction and very reliable and economical in operation.

The difficulty of stabilization of the

Figure Three—Sectional Drawing of Typical Multi-Jet Condensing Plant.



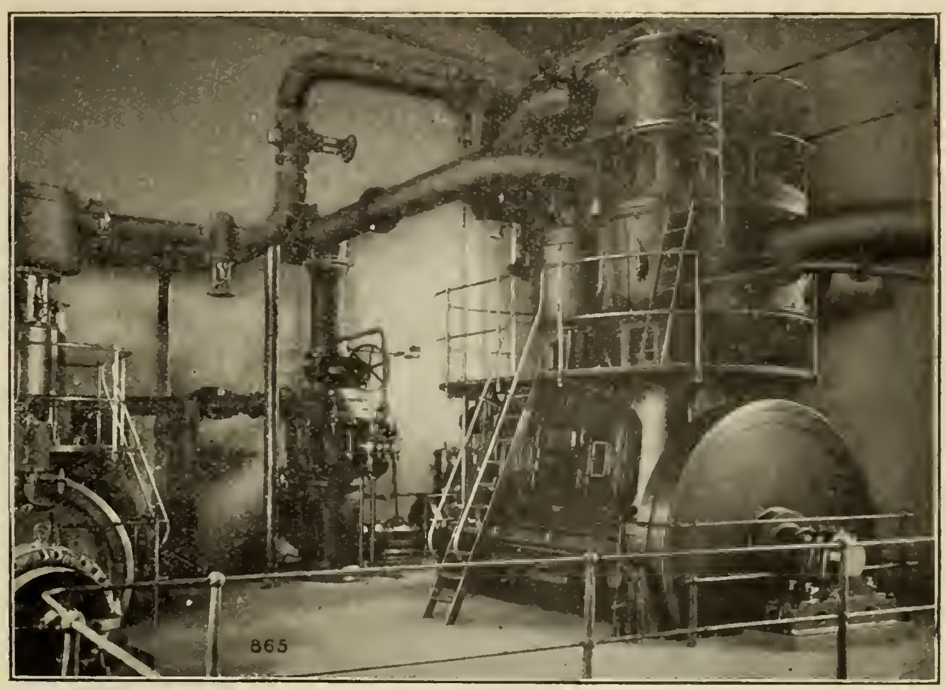


Figure Four.

jet over a large range of vacuum readings has been overcome in a quite satisfactory manner by returning again through the final ejector throat a portion of the discharged vapors. Thus stabilization is attained without the use of excess air.

The circulating water pump and condensate pump are of the centrifugal type, the latter pump delivering into a tank, receiving also the steam discharged from the final air ejector, thus conserving its heat value. In the same body as the condensate pump is a second disc which delivers the condensate from the tank to the boiler hot well.

Driven by One Motor

The pumps are arranged for driving by one motor and the whole forms a compact and easily handled plant, equally applicable to turbine or engine duty.

The jet condenser is the oldest form of all condensing plants, but it is only within recent years that much effort has been expended on improving its efficiency and design. The earlier plants employed reciprocating pumps to remove the contents of the condenser, dealing with both the air and water, and as the latter is of considerable volume the pumps were cumbersome and costly.

The newer method adopted is to extract the water and uncondensable vapors separately, the water being dealt with by a centrifugal pump, which can remove the large water quantity involved with a pump of very much smaller dimensions than those of a corresponding reciprocating pump, and moreover, with very much less cost for upkeep and renewal.

Removes Air Efficiently

The removal of the air from the jet condenser is effected on modern plants most efficiently by a steam ejector air pump of exactly the same design as that already described for use on a surface condenser. Thus standardization of air pump is obtained for either type of plant, with all the inherent advantages of quick and cheap production.

Figure 2 illustrates a multi-jet condensing plant and Figure 3 is a sectional drawing of a slightly larger size.

The exhaust steam inlet is at the top of the condenser through an unobstructed passage into the condensing chamber, and is there met on the whole of its circumference by the condensing water, leaving special spraying nozzles which effect an intimate mixture between the steam and the water.

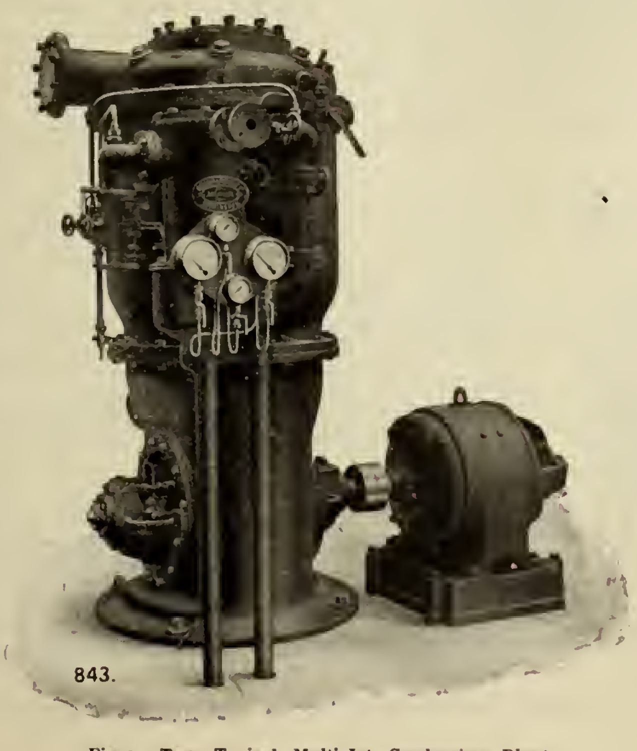


Figure Two—Typical Multi-Jet Condensing Plant.

The heated water falls to the bottom of the condenser to be dealt with by the centrifugal extraction pump, and the non-condensable vapors flow into a passage through a spray of cold water to the first stage of the air extractor.

It will be noted that the water extraction pump forms the base of the condenser, thus saving floor space, also by the directions of the connection between pump impeller and water chamber overcoming many of the difficulties experienced on the suction side of a centrifugal pump drawing from a high vacuum.

The whole of the internal parts of the pump are accessible through the side cover, and the shaft bearings are exterior to the pump, thus allowing of oil ring lubrication and the maintenance of the bearing in a close state of adjustment.

Impeller Design Special

The design of the impeller is special to meet the unusual conditions on the suction side, which demand special consideration and accuracy of manufacture. The material of the impeller is hard gunmetal; the shaft is of high-grade steel fitted with hard gunmetal sleeves where it passes through the water-sealed stuffing boxes.

In addition to the other usual accessories the condenser is fitted with a vacuum breaker, which comes into action should the water level rise too much above the normal, and a non-return valve is provided for the water discharge branch, thus rendering the plant quite safe in operation.

As in the case of the surface plant previously described this multi-jet plant is suitable for turbine or engine duty and Belliss & Morcom, of Birmingham, England, the manufacturers, report that samples of both types are in full commission and giving every satisfaction to the users.

Fig. 4 shows a multi-jet condensing jet plant receiving the exhaust steam from a 5,000 cu. ft. steam-driven compressor. Notwithstanding the comparatively small size of the condenser, it has given perfect satisfaction in operation and maintains a good vacuum. Incidentally, it may be mentioned that at the time the photograph was taken the plant was in full operation.

DIFFERENTIAL RELAY

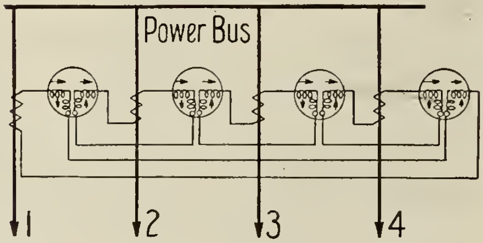
A current relay that requires no more apparatus or connections than ordinarily needed for the simple overload (short circuit) protection of transmission lines has been developed by the Westinghouse Electric and Manufacturing Company, for giving balanced protection to transmission lines. Where two or more transmission lines are in parallel between generating stations or sub-stations means must be provided for disconnecting a defective line without interrupting the power service in the remaining lines. Various methods of accomplishing this are in common use, but practically all of them involve the use of special apparatus.

This relay works on the induction principle and operates on current alone, so that no source of potential is required. This is a very great advantage, particularly on high voltage lines where the cost of potential transformers is considerable. Also there are no phase relations to be considered in connecting up this relay.

Simple Construction

The relay has two overload elements acting upon a common disc through a common magnetic circuit. Each element is connected separately to its own current transformer in corresponding phases of the two balanced lines. The two elements are electrically opposed, and under conditions of balanced line loads the fluxes in the magnetic circuit of the relay are equal and opposite, giving a resultant zero torque on the relay disc.

Under these conditions the disc which carries the moving contact is held in a mid-position by the control springs. These springs are initially restrained in the zero position, which prevents the disc from making any movement until a predetermined current unbalance exists between the two lines. Under the proper condition of current unbalance the disc can rotate 80 degrees in either direction from zero and make contact on either side. Thus the moving contact acts as a single pole, double-throw switch in the trip circuits of the circuit breakers of the two unbalanced lines, and will trip out the circuit breaker on the line carrying the heavier load. This action is the same regardless of the relative directions of the currents in the two lines.



Method of Application.

Differential Current

The differential current which is required to trip the relay is practically the same for all load values of line current in the lower loaded line. If, however, one line of the balanced pair is open, the current in the relay necessary to cause it to trip out the remaining line is approximately twice the differential current setting. This automatic doubling of the current setting with one line open is due to the fact that half of the operating coil of the relay is then no longer active, as it receives no current from the dead current transformer in the open line.

This is a very desirable feature, as it gives automatic protection to the service if one line is accidentally opened. Thus if each line were carrying 100 per cent. load, with the relay set to operate at a differential current of 150 per cent. of the load of one line, and an accidental switching operation occurred to open one end of one of the lines, the remaining line would carry the double load.

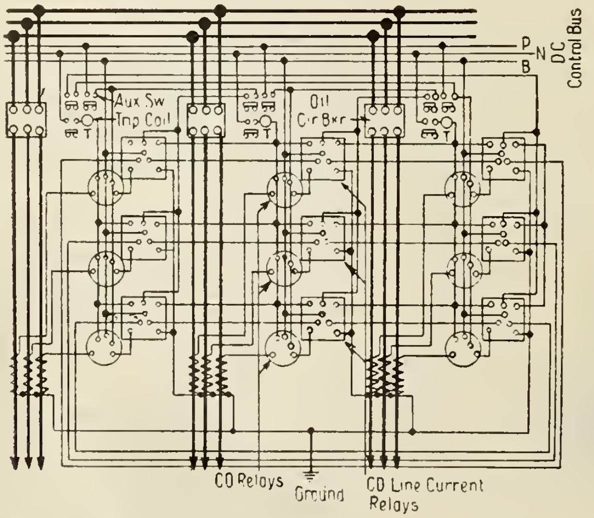
The relay on the opposite end would not, however, close contacts due to the unbalanced load current for, although, the one line would then be carrying 200 per cent. load, the relay setting would have been automatically increased to 300 per cent. leaving an ample margin of safety. When the accidentally opened switch was closed, the balanced protection would be again restored. This feature also makes it unnecessary to render the trip circuit of the differential relay non-automatic while the parallel lines are being connected to the busses at both ends; for it can be seen that after both ends of No. 1 line, and one end of No. 2 line have been closed, the same condition will exist as described above when one end of one line is accidentally opened.

Automatically Converted

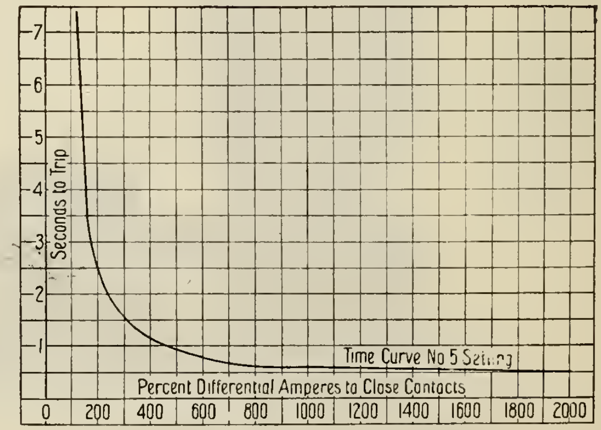
It will be noted that when one of the lines is opened the differential relay is then automatically converted into an overload relay, with a tripping current setting of twice the differential setting, and with the disc tending to rotate in such a direction as to trip out the loaded line. This means that the remaining line may then be considered as provided with overload protection without the use of additional overload relays, if so desired.

It should be remembered, however, that the current balance relay is set for a short time operation, which is not usually desirable for overload protection.

The condition of through short-circuits, i.e., short-circuits on other sections of the system, should also be considered, as this condition usually requires selective settings of the overload relays in series on the system. For this reason it is customary to use overload relays in series with the current balance relays to give selective overload protection to the remaining line after one



Connections for Protection of Three Lines.



Load-Time Curve Showing Adjustable Minimum.

Babcock & Wilcox Chain Grate Stoker

For Natural Draft

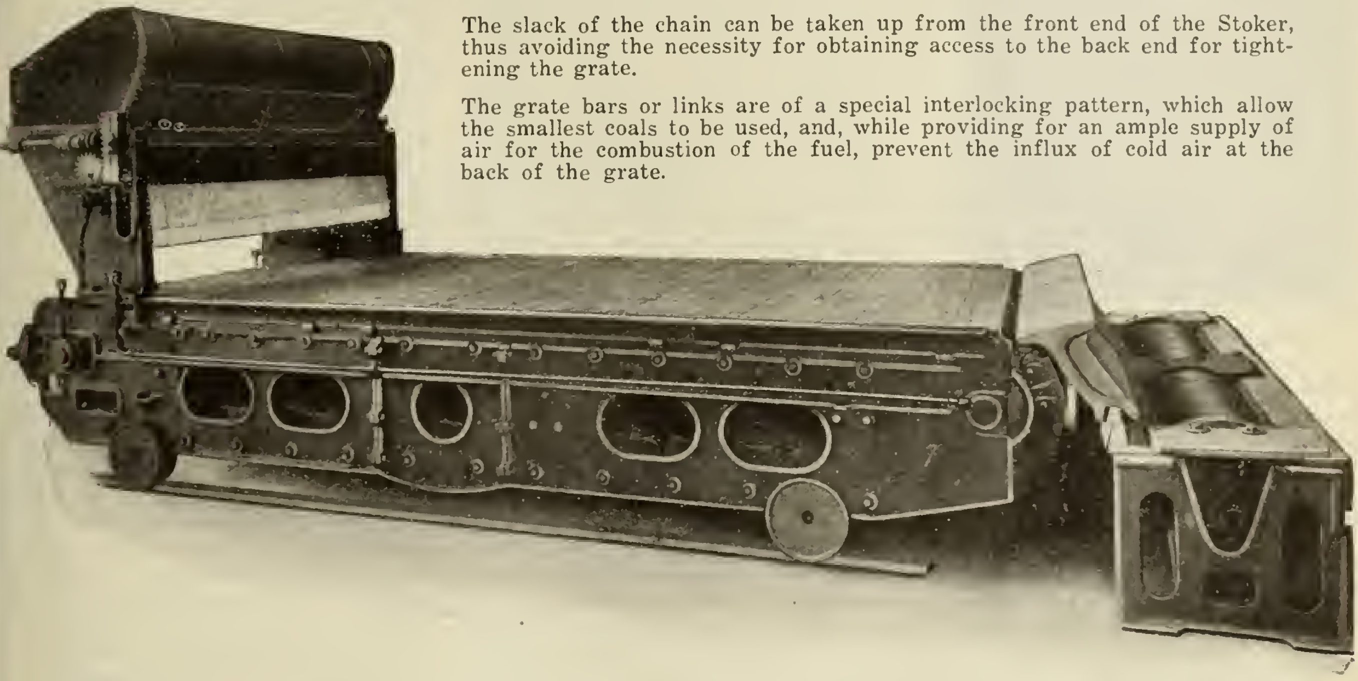
The grate consists of an endless chain of short interlocking cast-iron grate bars, linked together, running on angle irons and rollers and driven by a revolving shaft and sprocket wheels at the front end of the Stoker. The necessary power to drive the revolving drum is transmitted through a link chain and sprocket wheels from a shaft arranged either overhead or underground.

The starting or stopping of the Stoker, or the variation of speed, is effected through the B. & W. patent gear box, which can be driven at varying speeds. This box forms an oil bath in which the gear runs, and also contains an efficient clutch for putting the driving gear out of action should any unusual strain arise from an obstruction on the grate.

Any small repair, such as replacing a link, can be carried out with the Stoker in place under the boiler; but in case of need the whole Stoker can be brought out clear of the boiler, the frames being provided with wheels running on rails placed at the sides of the ashpit.

The slack of the chain can be taken up from the front end of the Stoker, thus avoiding the necessity for obtaining access to the back end for tightening the grate.

The grate bars or links are of a special interlocking pattern, which allow the smallest coals to be used, and, while providing for an ample supply of air for the combustion of the fuel, prevent the influx of cold air at the back of the grate.



The coal is fed over the whole width of the grate, and the depth of the fire is regulated by the adjustment of the vertically lifting fire door.

THE FEED OF THE COAL IS SLOW and the gas evolved from the fresh fuel as it drops on to the grate readily perfects its combustion by passing over the incandescent fuel further on.

The depth of the fire being regulated by a vertically lifting fire door, the Stoker CAN BE ADJUSTED IN A MOMENT to suit the class of fuel to be consumed and varying demands for steam, both by the depth of the fire and the speed of the grate.

The Stoker is easily manipulated and so simple that any fireman can understand it. It is the only form of stoker in which the undue admission of air at the back of the grate is prevented and with it THE HIGHEST EFFICIENCY is obtained.

The Stoker ultimately proves itself the embodiment of economy because it is efficient and saves coal over any other method of firing and the cost of upkeep is low compared with any other type.

The first cost of some other makes may be less, but consideration must be given to whether they have the necessary metal in them to stand up under the work they are intended to do. By reducing the weight of metal the price can be lowered but only at the sacrifice of the durability, consequently the cost of repairs will be great. Due consideration should also be given to whether by any other method of firing the price of the Stoker can be recovered in the amount of coal saved in a given period.

Full information given on request.

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE: BANK OF HAMILTON BUILDING

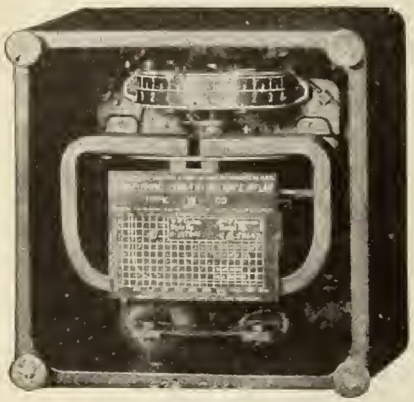
of the balanced lines has been disconnected.

Differential Settings

Differential current settings of 3, 4, 5, and 7 amperes, are provided. The relay has an inverse time curve, with a definite minimum time of operation, adjustable from instantaneous to 0.5 second.

The current balance relay can be used at the transmitting ends of any number of parallel feeders. It can be used at the receiving ends of any number of parallel lines in a system having a source of power at both ends, or at the receiving ends of three or more parallel lines in a radial system.

In brief, it can be applied at any point in a system where, in case of trouble on one parallel line, this line will receive more current than the other line of the pair. An ideal application of current balance relays is for the protection of parallel tie lines between generating stations.



Relay With Cover

Lines Not Identical

It is sometimes the case that parallel lines are not identical in characteristics, such as being different sizes of wire, or of different lengths of line. In this case the current balance relays can be used for protection by creating equal currents in the two elements of the relay by the use of balancing auto transformers to step-up the current of the low line. The loads of the two lines must, however, be proportional at all times.

The current balance relay can also be used for the ground protection of parallel transmission lines. The neutral currents of the two lines are then balanced against each other and in case of a ground on one line the predominance of current will be in the neutral of the grounded line. The ground relays are identical with the line relays except that they operate on lower differential current values.

An engine runs forward or over when, standing at the cylinder and looking toward the flywheel, the wheel revolves in a direction away from you.

MANY UNIQUE FEATURES IN THIS NEW AIR COMPRESSOR

A new line of steam driven air or gas compressors ranging in size from 67 to 1083 cu. ft. piston displacement per minute has recently been placed on the market by the Canadian Ingersoll-Rand Company Limited, 260 St. James St., Montreal, Canada.

These machines, known as the Class "FR-1" are the steam driven companions of this company's Class "ER-1" belt-driven compressors and like the latter are of the single stage, straight line centre crank dust and dirt proof type with automatic lubrication of both running parts and compressing end.

They embody every refinement of modern compressor design including a number of features which make them as nearly automatic in action as any machine of this type can be expected to be. This is an important consideration in any compressor but is even more essential in the case of small and medium sized units which are often operated in isolated locations where but little attention can be given them. Large machines on the other hand are generally located in a central power house under the supervision of an expert engineer. For this reason the Class "FR-1" compressors are suitable for use in small mines, quarries, on contract jobs, in foundries, machine shops, industrial plants, etc., as well as for use as auxiliaries in large air power plants.

In general the Class "FR-1" compressor consists of a plate valved compressing cylinder direct-connected to steam engine with balanced piston valve and automatic cut-off control, a design which makes it possible to operate with high pressure and super-heated steam as well as the moderate pressures more common in the past. This feature alone ensures a steam economy at all pressures not heretofore attainable.

The main frame is of the enclosed type, the bottom part forming a reservoir for the combined splash and flood lubrication system. It is fitted with removable side and crank end covers, which are not bolted on, but are retained by lips on the frame casting. Removal of these covers permits inspection or adjustment of all running parts. The cross-head guides are of the bored type and the design of the frame provides for an oil stuffing box near the cylinder end of the frame, which prevents any chance of crank case oil entering the compressing cylinder end of the main frame and in the trunk piece interposed between the steam and air cylinders provides for adjustment of all stuffing boxes when the machine is running.

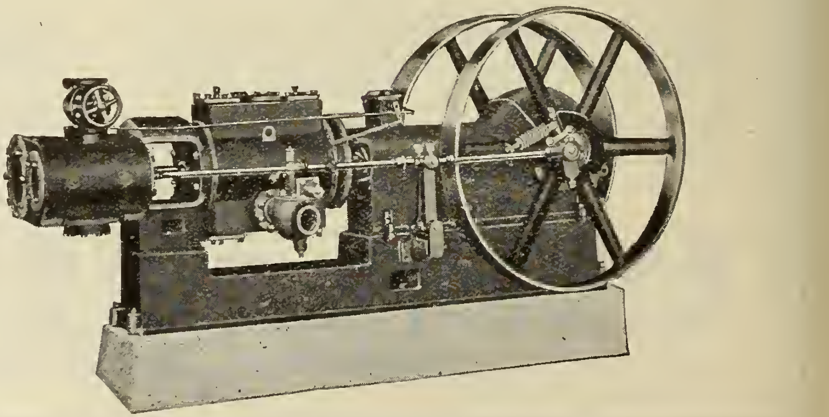
The main frame and trunk piece are mounted on a substantial cast iron subbase which lends rigidity to the entire structure, makes the machine a complete self-contained, accurately aligned unit and also forms a support for the single rocker arm which guides the valve rod. There are no guide blocks or other sliding surfaces in the piston valve gear.

The main bearings are of very heavy construction and are provided with removable die-cast shells or liners of genuine babbitt metal which can be removed and renewed in a few seconds at small cost. Due to the area of the bearings and the complete circulation of oil through them at all times, however, the shells last for very long periods without appreciable wear.

The crank-shaft and connecting rods are solid one-piece drop forgings accurately machined and heat-treated. The connecting rod is of the solid end type with renewable and adjustable boxes in both cross head and crank shaft ends. The cross-head is of the cylindrical type, of box construction with adjustable bored and turned shoes. Pistons are of the box type with broad faces and are securely fastened to a turned and ground steel rod.

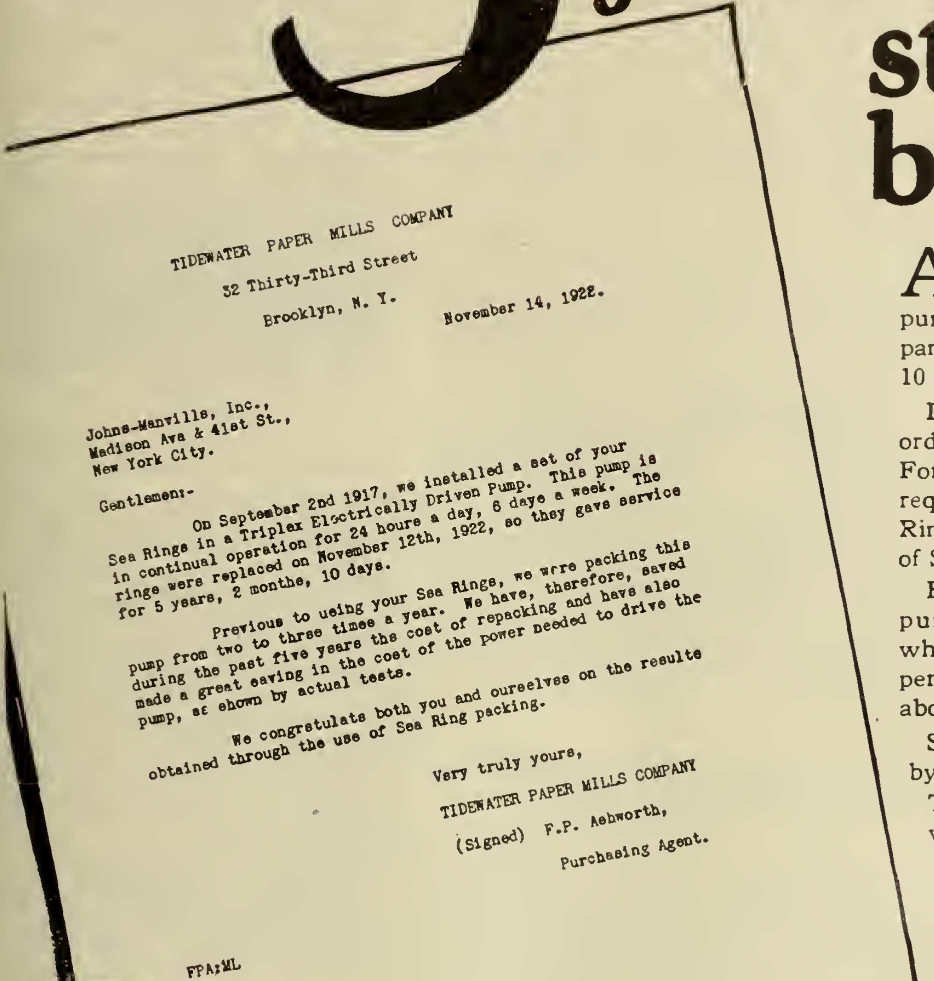
Oil is distributed to all of the running parts by throwers on the crank webs which lift or throw the oil against baffles from which it runs to all wearing surfaces. Lubrication of steam and compressing cylinders is provided for by a double compartment adjustable sight feed mechanically operated lubricator.

The piston valve is provided with two piston rings at each end and operates in a renewable bushing. With this type of valve there is no rapid wearing or cutting and the valve chest stuffing box is only subjected to exhaust pressure as steam is admitted to the centre of the valve and exhausted from the ends.



Compressor with wide range automatic cut-off governors.

Again! 5 years in the stuffing box!



TIDEWATER PAPER MILLS COMPANY
32 Thirty-Third Street
Brooklyn, N. Y.
November 14, 1922.

Johns-Manville, Inc.,
Madison Ave & 41st St.,
New York City.

Gentlemen:-

On September 2nd 1917, we installed a set of your Sea Rings in a Triplex Electrically Driven Pump. This pump is in continual operation for 24 hours a day, 6 days a week. The rings were replaced on November 12th, 1922, so they gave service for 5 years, 2 months, 10 days.

Previous to using your Sea Rings, we were packing this pump from two to three times a year. We have, therefore, saved during the past five years the cost of repacking and have also made a great saving in the cost of the power needed to drive the pump, as shown by actual tests.

We congratulate both you and ourselves on the results obtained through the use of Sea Ring packing.

Very truly yours,
TIDEWATER PAPER MILLS COMPANY
(Signed) F.P. Ashworth,
Purchasing Agent.

FPA:ML

A SET of Sea Rings installed on an electrically driven triplex pump at the Tidewater Paper Company's Plant lasted 5 years, 2 months, 10 days.

It cost $20 to pack the pump with ordinary packing lasting 5 months. For 5 years 12 packings would be required, total cost $240. The Sea Rings cost about $115—a net saving of $125.

By actual *wattmeter* test, the pump ran with 23.3% less power when packed with Sea Rings—at 1c per K. W. H. the Sea Rings saved about $850 worth of power.

Saving in packing and power cost by Sea Rings totals $975.

The amount saved by Sea Rings varies according to conditions. But one thing is certain—Sea Rings average a far greater economy than any other rod and plunger packing.

CANADIAN JOHNS-MANVILLE CO., Limited

Toronto Montreal Winnipeg
Vancouver Ottawa

JOHNS-MANVILLE
Power Plant Materials

The Sea Ring is a scientifically constructed rod and plunger packing. Cylinder pressure trapped in the U-shaped section forces the packing against the rod or plunger just in proportion to the tendency to leakage. This automatic action cuts friction, saves power and increases the packing life.

Through
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

Regulation of Class "FR-1" Compressors is regularly provided for by an Ingersoll-Rand "Wide Range" Automatic Cut-off Flywheel Governor and either "A-39" Inlet or the new Ingersoll-Rand "Free Air Unloader."

Announcements

200 H. P. Goldie and McCulloch Co. water tube boiler and a Combustion Engineering Co. type E single retort underfeed stoker, are being installed at the plant of the Northern Aluminum Co., Toronto.

The John Hepburn Co., Toronto, recently shipped to East Vancouver, B. C., a four stage 150 gal. per min., 600 ft. head, centrifugal pump for the Water Works Dept.

Canadian Non-Exhaust Pneumatic Machine Co., Ltd., has recently been incorporated with a capital of $750,000, to manufacture machinery, boilers, compressors, pumps, etc. The head office will be at Kingston, Ontario.

The St. John Hydro Commission has recommended to the city council the acceptance of a tender by the Stephen Construction Co., of that city, for the civic hydro distribution system. The figure is $63,745.

T. M. Grindley Company is now the name of the organization handling the sale of the products of the Conveyors Corporation of America in the Province of British Columbia. The address of the Grindley Company is 1158 Homer Street, Vancouver, B. C.

The Grindley Company was the western office of Gormans Limited, Edmonton, and operated under that name up to May 1, but after that date, T. M. Grindley took over the business, organized his own company and enlarged his selling staff.

Mr. Grindley has associated with him in the new firm J. H. Sinclair, a sales engineer of experience who has been in the west for some years and latterly has been representing the Aurora Pump Company in Ontario as well as being sales manager for the London Concrete Machinery Co., of London, Ont.

The Northern Canada Power Company have let contracts to proceed with the development of a first unit of 20,000 hydro-electric horsepower at Des. Quinze. The firm of Morrow & Beatty has been awarded the contract to build the plant, and Sutcliffe & Neelands, together with Gordon Summers have been engaged to survey the transmission line.

The Winnipeg Hydro-Electric system has decided to install a steam stand-by plant, using two 5,000 K.W. condensing and one 1,000 K. W. non-condensing steam turbines. The steam is to be furnished by three 1,100 h.p. Erie city type vertical water tube boilers, which are being built and supplied by the John Inglis Co., Limited, Toronto.

For The New Ford Plant at Ford, Ont., the Combustion Engineering Corporation are making good progress in the installation of a fuel pulverizing plant which will be equipped with three 1,000-horsepower units. Three McAleenan boilers are being installed.

In December, 1922, James B. Duke, of New York, and Sir William Price, president of Price Brothers & Company, Ltd., of Quebec, incorporated the Quebec Development Company for the development of 1,200,000 h. p. to be generated by the construction of a great dam at the head of the Saguenay River in Quebec.

British Trade generally keeps improving, despite disputes brewing in the industrial, shipping, and railway world. Iron and steel prices reached a peak in April. The week ending April 14 saw record coal shipments. Production reached 5,776,600 tons. Fifteen vessels, aggregating 51,531 tons, were launched by Clyde builders during the month.

Price Brothers will erect two new mills in which part of this power will be used, and existing mills will be converted to the use of electric power. The contract for the electrical machinery to be used for generating this power was awarded the Canadian Westinghouse Company, Hamilton, Ont. This order includes eight hydro-electric generators rated at 30,000 kv-a each at 80 per cent. power factor, generating 13,200 volts, 3-phase, 60-cycle at 112½ r.p.m. These generators are of the vertical shaft type and are equipped with Kingsbury thrust bearings. A direct connected exciter with a capacity of 225 kw. at 250 volts will be supplied with each generator.

PRODUCTION AND POSSIBILITIES OF LIGNITE CHAR

(Continued from page 29)

The combustion zone can be maintained by burning some of the distilled gases within the moving mass of lignite, and such direct heating is more efficient than where heat must be transmitted through refractory walls. The hot gases of combustion also pass through the mass, driving off the moisture and departing fairly cool. It is something like an open-top lime kiln. The process has proved simple and efficient. Of the gas driven off, much of it is used in the combustion zone, and in addition, less than 5 per cent. of the weight of the original lignite is burned. That is to say, the fixed-carbon loss in the process of drying and distilling is lower than is usually found for drying alone where separate driers are used.

Passing the combustion zone the lignite enters a lower section protected from the air, where it cools and is then removed. The char obtained by such a process may, of course, be briquetted.

In February about 100 tons of Saskatchewan lignite was tried, to discover whether it presented any special problems.

About two and a half tons of raw lignite reduce to one ton of char, and the heating value is about 12,000 B. t. u. per lb. The moisture is very low, and the char can be stored without danger of fire or degradation in size. Where the freight charge is heavy it would be an advantage to ship char instead of raw lignite.

STEAM TURBINE COSTS

(Continued from page 27)

Automatically, therefore, more high pressure steam is available for prime movers. At the same time, the additional steam into the condenser system helps to raise the feed water temperature, thereby helping to decrease the amount of "bleeder" steam necessary, and, of course, saving high pressure steam.

It might be said that the "bleeder" valve floats on the line and acts as an automatic heat balance regulator. Hence the same heat balance effect is obtained as in the combination motor-turbine drive. The first cost of the unit is lower than that of the combination unit, while the automatic feature alone pays a big return in the time saved to the operating engineer.

Turbine Ideal Drive

It seems reasonable that auxiliaries in the boiler room should, for the most part, be steam driven. The average power plant is made up of two component parts; first, the boiler room, which delivers energy to the generator; and second, the generator, which turns that energy into electricity and feeds it to lines. Therefore, is it not logical that the boiler room should depend on its own steam for operation so that it will always be ready to furnish steam for generating purposes?

The moment the generator shuts down for any reason, the boiler room immediately becomes incapacitated. If it is operating at the time, on an electrically driven boiler feed pump or induced fan, these immediately become disabled and the operating engineer must be able to fall back upon the steam drive.

If we settle in our own minds the fact that the steam drive is reliable in the boiler room, then we can pass on to the question of the type of machine which should utilize the steam.

Trade Catalogs

F. G. Sterne & Sons, of Brantford, are the publishers of a series of booklets which should be of great interest to all who are interested in the operation of boilers. The most comprehensive of these books is entitled "Boiler Scale, Its Prevention and Removal," and deals with the elimination of this boiler room nuisance by the use of silicate of soda. The passage of water through a boiler is dealt with most thoroughly, attention being paid to all of the factors which enter the field. Attractively put together, this book should prove of value to all stationary engineers.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES ◉ $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE, STEAM ENGINE rules and formulas. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ________________

Occupation ________________

Employed by ________________

Residence ________________

Reference ________________

BELTING BARGAIN

ABSOLUTE BELTING BARGAINS—BELTING every description; rubber hose, thresher supplies, tank pumps, pump leather feeds, canvas, McGill auto powers, special reduced prices; for quality and price, you can't beat us. N. Smith, 134 Adelaide west, corner of York, Toronto. When answering this advertisement, please mention this paper. P.F.H.

POSITIONS WANTED

FACTORY SUPERINTENDENT OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

REFRIGERATING AND MECHANICAL ENgineer with 10 years' operating record, also with experience in heating and lighting work, desires employment in Toronto. Apply Box 108, Power House.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St,. Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order. Apply Box, 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

TAYLOR SAFES FOR SALE—RARE OPPORtunity to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

WELDING

ELECTRIC AND ACETYLENE WELDING—of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

REPAIRS

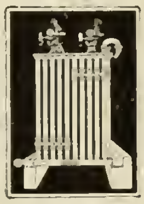
A. D. FISHER MANUFACTURING CO., 77 Front St. East, are prepared to build special machinery, dies, tools and all kinds of repairs; prompt service.

M. BARRY WATSON
B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer
Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W



Cut Fuel Bills

Save 10% to 20% of your fuel--the Sturtevant Economizer soon pays for itself.

Ask for Folder 609

B. F. Sturtevant Co. of Canada, Ltd.
Montreal Galt Toronto

See
Buyers' Guide
Pages
50, 52, 54

When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*

Annual Convention

of the

CANADIAN ASSOCIATION
of
STATIONARY ENGINEERS

OF THE DOMINION OF CANADA, INC.,

will be held in conjunction with

Annual Exhibition of Power Plant Equipment

June 25, 26, 27, 28

in the

Central Technical School

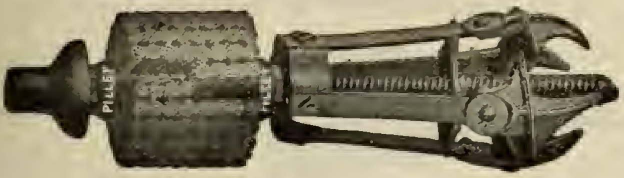
Toronto, Ontario

Remember it ! *Boost it !* *Come to it !*

For further particulars write

George J. Soucy, Chairman, 48 Moore Avenue
TORONTO

HINTS TO BUYERS



The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St. New York

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

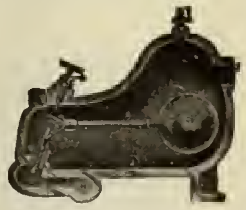
Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue
THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.



BOICO BOILER COMPOUND
routs the most stubborn cases of boiler formations, quickly, thoroughly and economically. Hurts nothing but scale.

ANTI-CLINKER SHELL BAR GRATE
Ample air space gives perfect combustion ensuring maximum heat, without waste, from the last bit of fuel.

ONE-PIECE JOINTLESS FURNACE LINING
"Plibrico" gives your furnace greater resistance. Lasts longer and installed quicker than brick.

TIP-IT PATENT WELDING PROCESS
Tools with shanks of carbon and high-speed steel tips save time and money.

SHELL-BAR BOICO
Supply, Limited
1-15 Saunders Ave., Toronto

Sales Agents: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T.J. CUNERTY** *Company*
9 Richmond St. E. Toronto

Hays Apparatus
STANDARD GUIDES To EFFICIENT COMBUSTION
The Jos. W. Hays Corporation
MICHIGAN CITY, INDIANA

SEND INFORMATION ABOUT
☐ AUTOMATIC CO₂ & DRAFT RECORDERS
☐ HAYS DRAFT GAGES
☐ HAYS IMPROVED GAS ANALYZERS
☐ HAYS AUTOMATIC GAS COLLECTORS
☐ "BESTIX"-COATING FOR SETTINGS
☐ "SPIZZERINKTUM"-BOILER METAL TREATMENT

NAME
POSITION
COMPANY
ADDRESS

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING

Oil Burning Systems Installed

Full line of Power Plant Equipment and Supplies.

LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL.

NORTHERN CRANES

NORTHERN CRANE WORKS, LTD.
Walkerville, Ont.

ELK FIRE BRICK

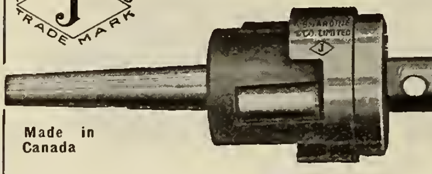
Coupled with

OUR SPECIAL SERVICE MEANS ECONOMY

Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.



REGISTERED J TRADE MARK

Jardine's Self-feeding Tube Expanders

All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co., Ltd.
Hespeler, Ont.

EDWARD

Write for catalogue describing the EDWARD line.

Most vital part positively protected against cutting action by the EDWARD Protected Seat and Disc.

THE EDWARD VALVE & MFG. CO
General Office and Works: East Chicago, Indiana.

CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal; Valve Engineering Co., Toronto.

VALVES

LADD WATER TUBE BOILER

LADD
WATER TUBE BOILER
COMBINES PERMANENT ECONOMY OF OPERATION WITH UNUSUAL ADAPTABILITY TO ANY INSTALLATION REQUIREMENTS.
DESCRIPTIVE CATALOGUE ON REQUEST.

GEORGE T. LADD COMPANY
First National Bank Bldg PITTSBURGH, PA.
CHICAGO OFFICE 528 McCORMICK BLDG CHICAGO, ILL.

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

"SAFETY" PLASTIC METALLIC PACKING

This packing is made of an alloy of the FINEST ANTI-FRICTION METALS which, combined with the BEST LUBRICATING MATERIALS which always remain in the packing, make it practically Self-Lubricating and Frictionless. It is

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL

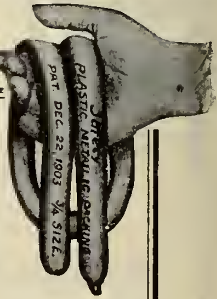
In fact there are many Engines, Pumps, Compressors, Expansion Joints, Valves, etc., on which this packing has been in use for over 12 years with the very best satisfaction.

Let us send you further particulars also about our "Safety" Superheat Sheet Packing.

STEEL MILL PACKING CO. - WINDSOR, ONT.
AGENTS WANTED

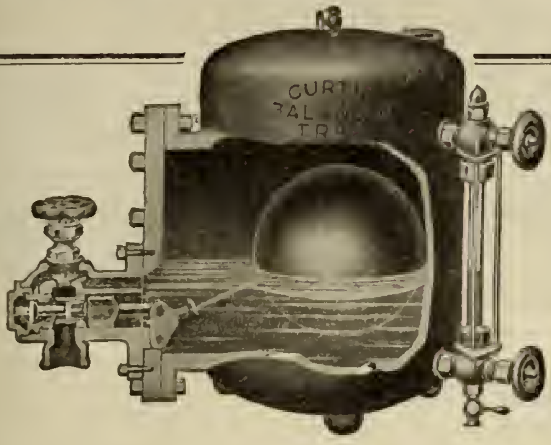
Established 1899

Packing in bulk.



Packing in Cotton Tubes.

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

Send for descriptive circular of this trap.

Sole Distributors for Canada:
DARLING BROS., 120 Prince Street, Montreal, P. Q.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.

De Laval OilPurifiers

centrifuge sludge and water out of turbine or Diesel lubricating oil, keeping the system clean and maintaining the efficiency of the oil all of the time it is in service.

As much as five pounds of dirt has been taken from a lubricating system in thirty-six hours. Compared with other methods of removing impurities from oil, the centrifugal machine has the advantage of applying a force many hundred times greater than that of gravity.

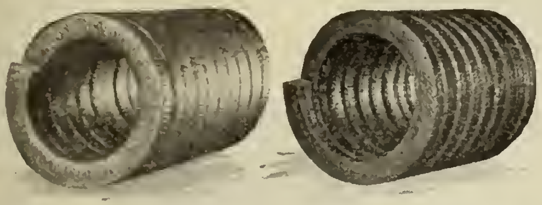
Bulletin No. 105 shows and tells how DeLaval Purifiers may be connected to purify lubricating oil with the continuous by-pass method or in batches. Write for your copy to-day.

The De Laval Co., Ltd.
Peterborough, Ont.
Montreal Edmonton
Winnipeg Vancouver

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING



AMMONIA PACKING

The combination of styles 100 (left) and 400 (right) shown above to make style 104 special shown below, is the ideal packing for ammonia compressors of speeds up to 400 ft. per minute. It produces a perfect non-abrasive metallic face with wipers that prevent the ammonia film on the rod from reaching the air.

Investigate

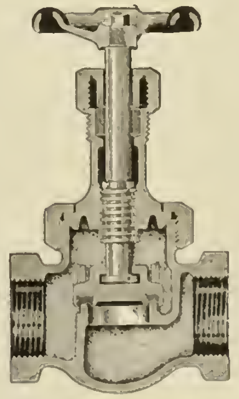
With two coils on hand the engineer can cut rings as needed—a genuine economy Life of a set is often five years or more Sets also made up to order. Tell us box measurements. Ask for our text book "Metallic Packing" to get the right angle on the value of "John Crane" Packings.

"MADE IN CANADA"

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA

BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, B. C.

PRATT & CADY VALVES



It is real economy to install Pratt & Cady Bronze Union Bonnet Renewable Disc globe and angle valves. It is so easy to replace parts subject to wear that you are sure to take advantage of this feature.

P. & C. Folder No. 2 describes this valve in detail. May we send you a copy?

Reading Steel Casting Co., Inc.
Pratt & Cady Division
General Sales Office: Bridgeport, Conn.

CANADIAN REPRESENTATIVES:—CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co. Ltd. Hamilton
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

ASBESTOS SPECIALTIES
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Undar-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed. Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia. Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkervilla, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridga Supply Co., Montreal.
H. Mueller Mfg Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que
Dominion Belting Co., Hamilton, Ont
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal. Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limitad.

BELT LACING
Bristol Co., Tha, Waterbury, Conn.
D. K. McLaren Limited, Montreal. Qua

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal. Que.

BELTING, LINK
D. K. McLaren, Limited. Montreal. Que
Waterous Engina Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morsa Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Qua.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montraal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago. Ill.
W. R. Sexton Boiler Satting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manvilla Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cola Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridga Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Roma.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Tha Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crana's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa

BUSHINGS
Can. Link-Balt Co., Toronto, Ont

BUSHINGS BRONZE
Kerr Engina Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauga and Valve Co Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Muallar Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldia & McCuloch Co., Galt.
Karr Engine Co., Walkerville, Ont.
Muellar Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mualler Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fira Brick Co. Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill
Shell Bar Boico Supply, Ltd., Toronto

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal
Canadian Johns-Manville Co. Ltd., Toronto
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

CONVEYORS
Babcock & Wilcox Ltd., Montraal.
Can. Mead-Morrison, Monreal.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Maad-Morrison Co., Ltd., Montreal.

COAL HANDLING. MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto. Ont.
Can. Mead-Morrison Co., Ltd., Montraal.
Northern Crane Works, Walkervilla, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Qua.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Qua.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manvilla Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crana Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machina Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

This furnace has not been relined in four years!

AFTER so much trouble with ordinary brick linings at the Otis Bldg., Chicago, that, as the chief says, "we did not know whether we were keeping up steam on coal or brick," they relined with

PLIBRICO
JOINTLESS
FURNACE LINING

This was four years ago. The linings under the four Edge Moor Boilers, have never been replaced. The chief says, "they promise a lot more service."

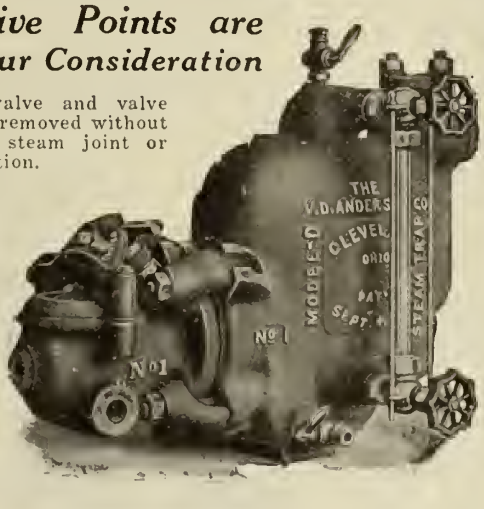
Plibrico is a plastic lining applied with mallet and trowel. When baked, it forms a jointless lining—airtight, gastight, resistant to temperature of 3100 deg. F.

Ask for the 50 page booklet. See 'phone books for warehouses in 52 principal cities. *Plibrico is delivered only in steel containers of distinctive appearance as shown below.*

JOINTLESS FIRE BRICK Co
1142 CLAY ST., CHICAGO, ILL.

ANDERSON MODEL "D" STEAM TRAP

These Five Points are Worth Your Consideration



1. Both the valve and valve seat can be removed without breaking a steam joint or pipe connection.
2. The valve is always sealed with at least three inches of water, making the escape of live steam impossible. The strainer and sediment chamber prevent sediment or scale getting into the valve.
3. A glass water gauge fitted to the trap makes it possible to ascertain at a glance whether the trap is working properly.
4. Made for high or low pressure or exhaust steam. Will lift water against back pressure 5 lbs. less than pressure of trap.
5. Built of best possible materials for the purpose. Every part interchangeable.

THE V.D. ANDERSON CO.
1935 West 96th St. Cleveland, Ohio

Can a Barrel be Emptied through the Bunghole as quickly as it can be filled through the Open Head?

Seems like a foolish question. Yet this is the principle on which most steam traps are designed—with an opening of only ¼ inch in the discharge valve while the pipe connection has a 1½ inch hole. And then you wonder why you require such a large, expensive trap to handle your condensation.

It's different with the American Ideal. Here the valve discharge orifice is much larger than in ordinary traps.

As a result, the American has a larger discharge capacity at the different pressures than any other trap having the same size inlet. Consequently you can use a smaller trap of the American Ideal **continuous flow type** than of other makes.

AMERICAN
IDEAL STEAM TRAP

is the only trap with a powerful enough leverage to operate a valve with such a large orifice.

Because of this powerful leverage, we can use a heavy float, of **thicker, stronger,** seamless copper, which will withstand a pressure of 600 pounds to the square inch. This heavier float eliminates the danger of the float collapsing and enables us to guarantee it for the life of the trap.

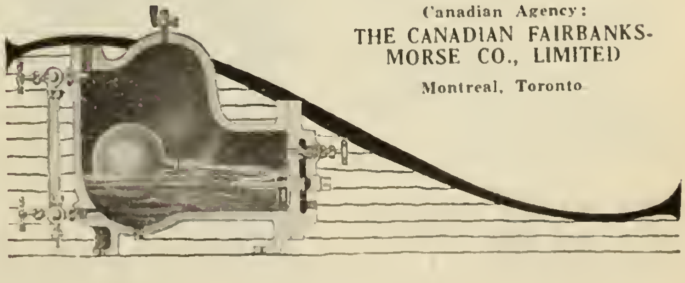
These features, and others like the reversible and renewable Monel metal valve stem, renewable phosphor bronze seat, water sealed valve, etc., make the American Ideal the most efficient and durable as well as the cheapest trap on the market.

Write for interesting booklet R-33.

The Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO. DIVISION

BROOKLYN, N.Y.

Canadian Agency:
THE CANADIAN FAIRBANKS-MORSE CO., LIMITED
Montreal, Toronto



DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hageratown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Wateroua Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada. Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal

FEED WATER PURIFIERS
Stephens Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Schaeffer & Budenburg Mfg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati. Ohio
Reading Steel Casting Co., Hartford, Conn.

FLANGES
Dart Union Co., Ltd., Toronto, Out.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio
Reading Steel Casting Co., Hartford, Conn.

FLOOR AND CEILING PLATES
Crane'a Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS. STEAM. WATER)
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co. St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd. Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS. RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto
Can Steam Boiler Equip Co., Toronto
Durabla Mfg. Co., New York, N. Y
Frick Co. Waynesboro, Franklin Co., Pa
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co, Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jaa. Morrison Braas Mfg. Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland,
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div-Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Moutreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Masa.
Waterous Engine Works Co., Brantford

HEATERS METERING
Yarnall-Waring Co., Philadelphia. Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto. Ont.
Northern Crane Works, Walkerville, Ont

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co, Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johna-Manville Co., Ltd., Toronto

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil. Ltd., Torono.

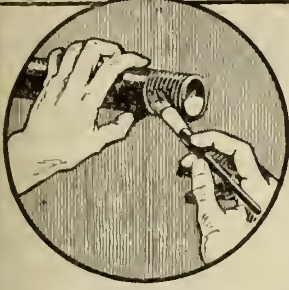
OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Jas. Morrison Brass Mfg. Co., Torouto,

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

Make tight screw-thread joints with
SMOOTH-ON "No. 3"



JUST BRUSH IT ON THREADS

Make Your Screw-thread Joints with SMOOTH-ON "NO. 3"

As one engineer said, "I make all my screw-thread joints with SMOOTH-ON 'No. 3' and every joint made that way is one less thing to worry about!"

And that's a fact! SMOOTH-ON "No. 3" will make screw thread joints permanently and everlastingly tight. Vibration, heat, cold and violent temperature changes have no effect on SMOOTH-ON "No. 3."

Our Instruction Book No. 19 should be in the hands of every Engineer. It contains valuable facts on power plant installation, maintenance and repairs that are drawn from the actual experience of 77 Engineers. Send for it—it's FREE—a post card will do.

SMOOTH-ON Cement "No. 3" comes in paste form, ready to use and is sold by Supply Houses in 1-lb., 5-lb., and 10-lb. tins.
☛ *SAMPLE FREE.*

THE CANADIAN ASBESTOS CO.
Dept. 52-F, Montreal, Que.

If your Supply House cannot supply you WRITE US.

SONDERGLASS

"The Unbreakable Boiler Gauge Glass"

Two Glass Tubes in One

The different metals used allow for expansion and changes of temperature to which the glass is subjected, and add greatly to its pressure-resisting qualities, as each of these metals has different degrees of expansion. The inside of the tube expands in proportion to the temperature of the steam or hot water and the outside according to the temperature of the air.

There are no others "Just as Good"

LYTLE ENGINEERING CO. LIMITED
404-406 St. James Street, Montreal
VALVE ENGINEERING COMPANY
174 King Street West, Toronto

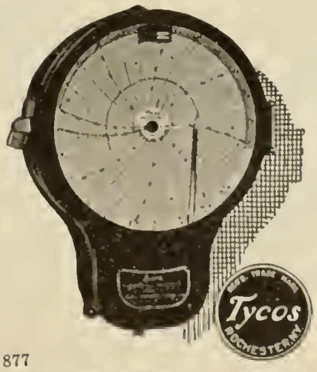
IT JUST
PACKS and PACKS and PACKS
PACKS and nd PACKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS CKS
PACKS and PACKS and PACKS

AMBEST FLEXIBLE METALLIC PACKING
Every Size Needed in Same Can.

Beveridge Supply Co., Ltd.
62–630 St. Paul St. West MONTREAL.
Stocked by Shell Bar Boico Supply Co., Ltd., Toronto, Ont.
Winnipeg Supply & Fuel Co., Ltd., Winnipeg, Man.

Tycos and **Steam Pressure**

On long steam lines the problem of pressure is an important one. *Tycos* Recording Pressure Gauges are placed at each end of the line. Any drop or rise in pressure is found simply by comparing the two charts. The charts show the time of fluctuations enabling the operator to more easily seek out the cause. Pressure leaks are detected by the recorder at the far end of the steam line.



Have you a copy of our Power Plant Catalog? Write for a copy to-day.

Taylor Instrument Companies
110-112 Church St.,
Tycos Bldg., Toronto

There is a *Tycos* or *Taylor* Temperature Instrument for every purpose.

Indicating, Recording and Controlling

877

PACKING, AMMONIA, STEAM AND WATER

Beveridge Suppy Co., Montrea.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Jenkins Bros., Limited, Montreal, Que.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto

PACKING, OIL

Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill
Flexible Metallic Packing Co., Windsor Ont.

PACKING, COMPRESSED ASBESTOS SHEETS

Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS

Shell Bar Boico Supply Ltd., Toronto, Ont

PIPE COILS

Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE AMMONIA AND ICE WATER

Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED

Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS

Crane's Limited, Montreal.

PIPING AND FITTINGS

Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS

Lunkenheimer Co Cincinnati, Ohio

PLUMBING SUPPLIES

Jas. Morrison Brass Mfg. Co., Toronto
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS

Can. Link-Belt Co., Toronto, Ont

POWER TRANSMISSION MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

POWER PUMPS (OIL, GASOLINE)

Pratt & Cady, Hartford, Conn

PRESSURE REGULATORS

C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa,
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES

C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont,
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC

Frick Co., Waynesboro, Franklin Co., Pa

PRESSURE AND REDUCING VALVES

C. A. Dunham Co., Ltd., Toronto.
H Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL

D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

PULLEYS, FRICTION CLUTCH

Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID

Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P Q
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCulloch Co., Galt.
John T Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford

PUMPS, DUPLEX

The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE

Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL

Albany Pump Co., Toronto, Ont,
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY

Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO

Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal,
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal,
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX

Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can Ingersoll-Rand Co., Ltd., Sherbrooke, P Q
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING

Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL

Smart Turner Machine Co., Hamilton, Ont

PYROMETERS

Jas. Morrison Brass Mfg. Co., Toronto
Taylor Instrument Co., Toronto, Ont.

RADIATORS

Crane's, Limited, Montreal.

RADIATOR TRAPS

C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS

Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES

C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS

Shell Bar Boico Supply Ltd., Toronto.

REBOILERS

Frick Co., Waynesboro, Franklin Co., Pa.
W R Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS

Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2

Sarco Company, Inc., New York.

REFRACTORY MATERIALS

Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg, Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE

Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER

Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE

Crane'a Limited, Montreal,
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS

The Superheater Co., Ltd., Montreal.

REGULATING VALVES

H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS

Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING

Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES

Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER

Beveridge Supply Co., Montreal,

SAFETY STEPS (Irving Life Step)

Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY

Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS

Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM

V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS

W. R Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE

C A. Dunham, Co.,
Laurie & Lamb, Montreal,

SMOKE BOXES

Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

SOOT CLEANERS

Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET

Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS

Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS

Goldie & McCulloch Co., Galt.
Can Fairbanks-Morse Co., Montreal
Waterous Engine Works Co., Brantford

STACKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q

STEAM TRAPS

Julian D'Este Co., Boston 14, Maas.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS

Smart-Turner Machine Co., Hamilton.

STEEL DRUMS

Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL

Can. Fairbanks-Morse Co., Ltd., Montreal

STRAINERS

Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK

Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES

Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS

Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF

Waterous Engine Works. Co., Brantford

TANKS, BRINE

Frick Co., Waynesboro, Franklin Co., Pa
Wateroua Engine Works Co., Brantford
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE

Conveyors Corp. of America, Chicago, Ill

TANKS, FREEZING, STORAGE AND WATER COOLING

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE

Imperial Oil, Ltd., Toronto.

TANKS, OIL

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co. Division, Brooklyn, N.Y.
Taylor Iuatrument Co., Toronto, Canada

TRANSFORMERS

Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES

Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING

Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS

Babcock & Wilcox Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co., St Louis, Mo.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal

TUBES, BOILER

Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS

Engineering and Machine Works of Can Ltd., St Catharines, Ont.

TURBINES, STEAM

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES

Babcock & Wilcox, Ltd., Montreal,
Can. Fairbanks-Morse Co., Montreal.
Edward Valve & Mfg. Co., East Chicago, Ind.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brasa Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H Mueller Mfg. Co., Limited, Sarnia, Ont
Reading Steel Casting Co., Hartford, Conn.
Shell Bar Boico Supply, Ld., Toronto.
Valve Engineering Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Underfeed Stoker Co., Toronto, Ont.

WALKWAYS, (Irving Subway)

Irving Iron Works Co., Long Island City N. Y.

Bronze to Bronze

DART

At the Joints

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

Building a one-piece furnace lining without special forms.

BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

Makes practicable, solid, one-piece furnace linings, including front and back arches, side walls and baffles. It costs but little to install in any make or type of boiler. It saves fuel, annoying shut-downs, costly repairs, and increases the amount of power from the fuel used.
Complete details of the many uses, methods of installing, how to order, measurement blanks, etc., are contained in a booklet of information which we will gladly send you. Tell us the individual to whom it should be addressed.

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6, Rome, N.Y.
Canadian Distributors
INTERNATIONAL CHEMICAL CO.
26-6 Adelaide St., Toronto, Ontario, Canada.

Emergencies Prove Its Superiority

It may not be often that the oil film fails in any of your bearings, but the possibility is always present. It is emergencies such as this that test the value of your bearing metals. Magnolia Anti-Friction Metal protects your shafts and bearings from damage in such temporary contingencies. With the lowest frictional coefficient of any known bearing metal proven by U.S. and foreign government tests it runs cool with less lubricant and is a safeguard against hot boxes and melting out where lubrication is neglected or may fail for any reason.

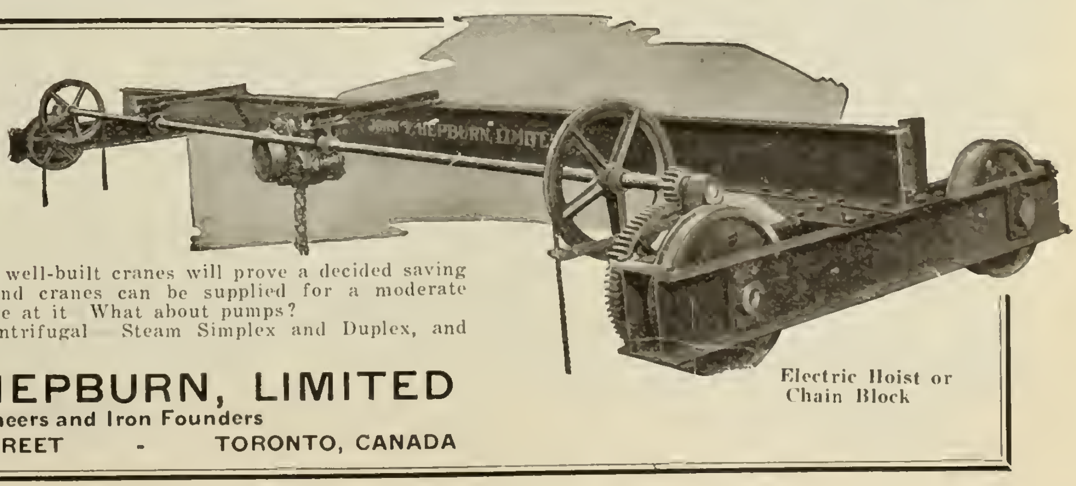
Try out a sample Magnolia-lined bearing and test its many advantages for yourself.

Magnolia Metal Company
113 Bank St., New York

CHICAGO Fisher Bldg. SAN FRANCISCO Pacific Bldg. MONTREAL 37 Shannon St.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK

HEPBURN CRANES



Electric Hoist or Chain Block

These easily manipulated, well-built cranes will prove a decided saving in the Power House. Hand cranes can be supplied for a moderate outlay. And while you are at it What about pumps?
We make all kinds — Centrifugal Steam Simplex and Duplex, and Power Pumps.

JOHN T. HEPBURN, LIMITED
Engineers and Iron Founders
18-60 VAN HORNE STREET - TORONTO, CANADA

Established 1907 **POWER HOUSE** Member A.B.C.

B. G. NEWTON, Manager

S. S. MOORE, Advertising Manager

CANADA—**Toronto** (head office): 153 University Ave., Tel. Ad. 5740. **Montreal:** A. E. Guidal, 128 Bleury St., Tel. Plateau 946. **Winnipeg:** 810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—**New York:** J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. **Chicago:** A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. **Boston:** C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—**London:** The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.

JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

American Steam Pump Co...... 6
Anderson Co., V. D............ 51
Armstrong Cork and Insulation Co., Ltd. 12
Audel Co., Theo 45

Babcock & Wilcox............ 41
Betson Plastic Fire Brick Co... 55
Beveridge Supply Co., Ltd...... 53
Bristol Co., The............... 16
Buyers' Directory 50, 52, 54

Can. Fairbanks-Morse Co. 5
Canadian Ingersoll-Rand Co... 13
Can. Johns-Manville Co........ 43
Classified Adv. Section........ 45
Cole Co., Grant E.............. 56
Conveyors Corp. of America Front Cover
Counerty, T. J................. 47
Crane Packing Co. 49
Can. Sirocco Co............... 14

DeLaval Steam Turbine Co.... 6
DeLaval Co., Ltd., The........ 49
Dart Union Co., Ltd., The..... 55
D'Este Co., Julian 49
Diamond Specialty Ltd......... 8
Durabla Mfg. Co............... 5

Elk Fire Brick Co............. 48
Engineering & Machine Works of Canada 16
Edward Valve Mfg. Co......... 48

Fisher Governor Co........... 18

Foxboro Co. ....Inside Front Cover
Flexible Metallic Packing Co... 49
Frick Company 11

Garlock Packing Co............ 3
Garth Co., The 47
Goldie & McCulloch Co........ 20
Greene, Tweed & Co.........Inside Back Cover
Gutta Percha & Rubber, Ltd... 4

Hints to Buyers............... 47
Hepburn, John T. Co.......... 55
Hays Co., Jos. W............. 47

Jardine, A. B.................. 48
Jenkins Bros. 15
Jointless Firebrick Co. 51

Kerr Engine Co. 12

Ladd, Geo. T.................. 48
Laurie Engine Co. 48
Laurie & Lamb 8
Linde Can. Refrig. Co......... 10
Lunkenheimer Co............. 2
Lytle Engineering Co., Ltd..... 53

Mueller Mfg. Co.............. 17
McLaren, D. K. Co........... 9
McGowan Co., John H......... 18
Magnolia Metal Co............ 55
Moncrieff Ltd., John.......... 56
Morrison Brass Mfg. Co., Jas., Outside Back Cover

Northern Crane Works......... 48

Pilley Packing & Flue Brush Mfg. 47
Pratt & Cady Co.............. 49

Railway & Power Engineering Corp., Ltd................ 19
Reading Steel Casting Co...... 49
Refrigeration Dept. 10
Refinite Co. of Canada........ 47

Schaeffer & Budenberg Mfg. Company 51
Smooth-On Mfg. Co. 53
Superheater Co. 48
Sturtevant & Co., Ltd., B. F... 45
Steel Mill Packing Co......... 48
Shell Bar Boico Co............ 47
Sterne & Sons, G. F.......... 18

Taylor Instrument Co......... 53

Underfeed Stoker Co. of Canada, The 7

Vilter Mfg. Co................ 10
Valve Engineering Co. 53

Wall, W. J.................. 56
Waterous Engine Works Co.... 1
Watson, M. Barry 45
Watson & McDaniel Co........ 48

Yarnall-Waring Co. 19
York Mfg. Co. 11

"MONO" TRADE MARK REG. U.S. PAT. OFF. BOILER BAFFLES ARE MONOLITHIC

AND "HUG THE TUBES" AT ANY ANGLE

AND ARE NOT DAMAGED WHEN TUBES ARE WITHDRAWN, REPLACED OR BY THE USE OF A TURBINE CLEANER.
OUR ENGINEERS ARE AT YOUR SERVICE TO HELP YOU SOLVE YOUR COMBUSTION PROBLEMS. THE CUT ON THE RIGHT IS AN EXAMPLE OF WHAT WE CAN DO FOR YOU.

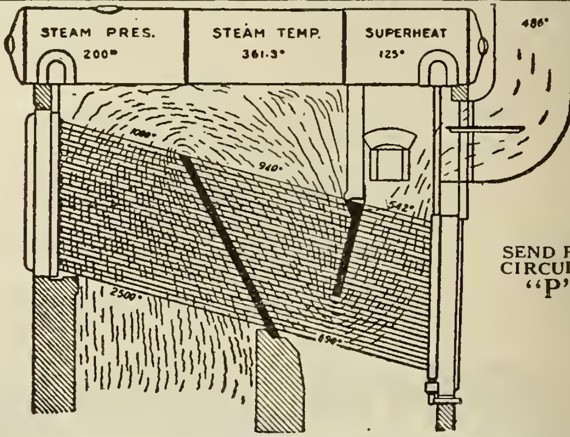
KING REFRACTORIES CO.

Sole Canadian Representatives:

GRANT E. COLE CO.

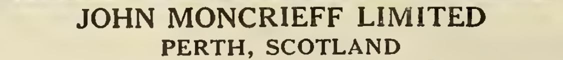
21-23 River St., Toronto, Canada

Represented in Vancouver, Winnipeg, Montreal, Halifax.



SEND FOR CIRCULAR "P"

MONCRIEFF'S "UNIFIC" WATER GAUGE **GLASSES**



Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is **economical.** British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: **W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA**

Braided for Rods

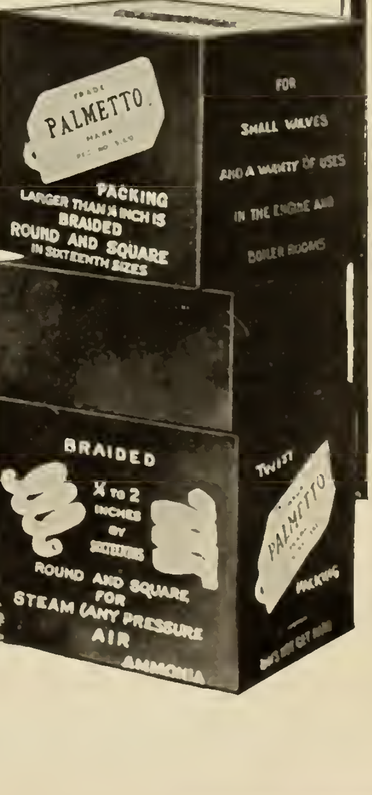
If You Do Not Know That

"PALMETTO"

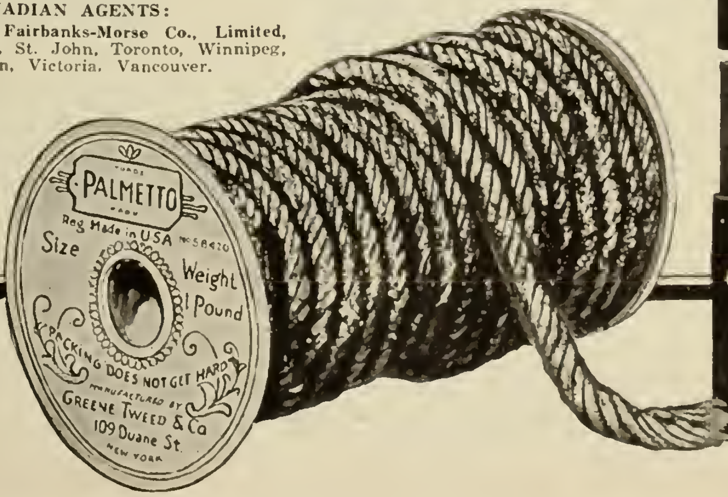
gives much longer service under steam and compressed air pressures than other packings, then let us send you free working samples to test out under your own conditions.

Greene, Tweed & Co.,
Sole Manufacturers
109 Duane St., New York

CANADIAN AGENTS:
The Canadian Fairbanks-Morse Co., Limited,
Montreal, Ottawa, St. John, Toronto, Winnipeg,
Calgary, Saskatoon, Victoria, Vancouver.

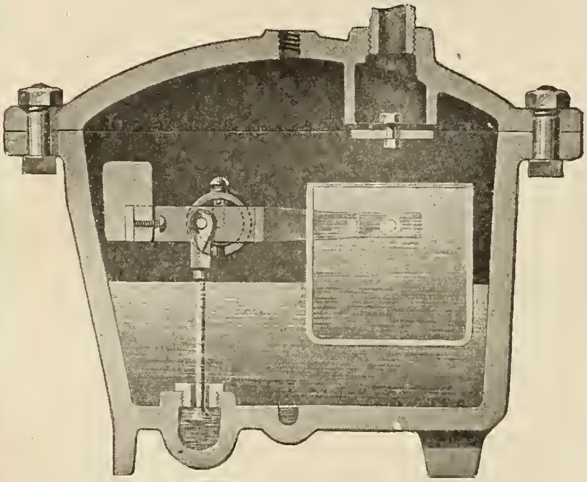


Twist for Valves



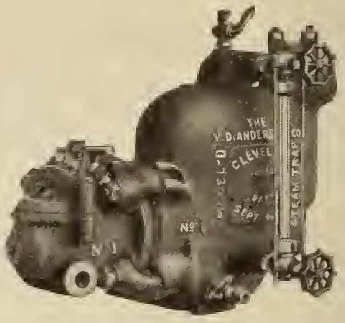
MORRISON
STEAM TRAPS

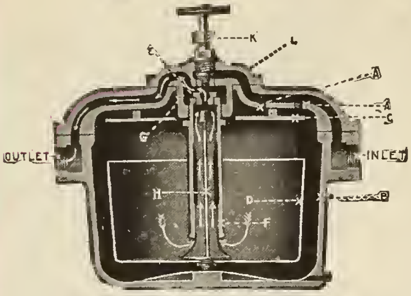
Keep Your Pipe Lines Free From Condensation



Universal Steam Trap—Works on any pressure from ½ lb. to 150 lbs. per square inch. Does away with the necessity for ordering Traps to suit certain pressures.

Anderson Model "D" Steam Trap—Made for high or low pressure of exhaust steam. Lifts water against back pressure 5 lbs. less than pressure of trap. The valve is always sealed with at least three inches of water, making the escape of live steam impossible.

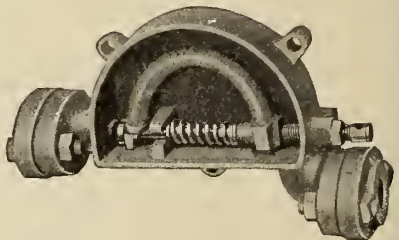




SECTIONAL VIEW.

Outside View

"Nason" Steam Traps receive and automatically discharge the condensation from heating surfaces of every description, without loss of pressure or waste of steam. Made to suit various pressures from 1 lb. to 150 lbs. All parts interchangeable.



Haines Steam Trap — Starts wide open. Is compact, needs no attention and can be installed in inaccessible places. Will not freeze.

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Co., Limited
93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Fostering Economy in the Development of Power for All Industries

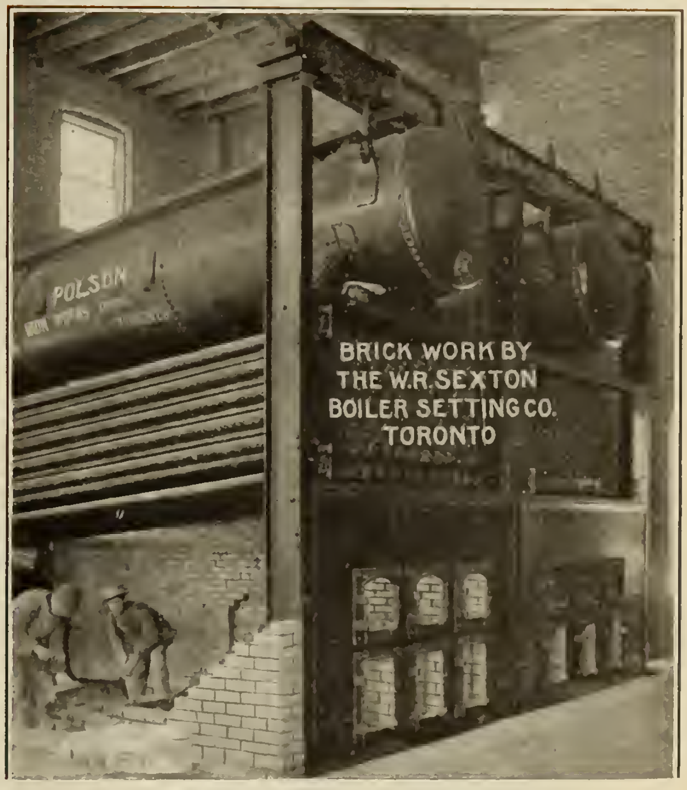
Vol. XVI—No. 12. Published Semi-Monthly by The MacLean Publishing Company, Limited, Toronto, Ont. June 20, 1923

Welcome, C.A.S.E. Delegates

Let
"Safety-First" Sexton
Handle Your
FIREBRICK WORK

You can't be too particular about your Firebrick work. There's no two ways about a job of that kind—it's got to be done RIGHT.

That's why some of the most important plants in Toronto make a point of having all their Firebrick work done by SEXTON. They appreciate the work of a specialist in Firebrick work of all kinds; they know that SEXTON has built up a reputation for doing his work thoroughly, whether it is building-in boilers or just general repairs; they know that SEXTON Boiler Settings last longer and are 100% EFFICIENT and SAFE.



Only the best High Tension Fire Cement is used by SEXTON in his Firebrick work.

"BURN ALL" NONPAREIL GRATES

A Child Can Operate It

save you money right from the start. At a conservative estimate they are saving 10% on fuel bills for many leading Canadian plants. Even with low-grade fuel, NONPAREIL Shaking and Dumping GRATES ensure maximum heat value. The 65% air space and 95% underdraft—a feature of NONPAREILS under perfect working conditions—gets the last bit of heat from the last bit of fuel.

Let us tell you about our 30-day trial—it will interest you.

AGENTS: W. Green, Church St., Smiths Falls, Ont. Gates Engineering Co., Montreal, Que. Mr. A. McTaggart, Leamington, Ont.

THE W. R. SEXTON BOILER SETTING CO.

Established 1900 114 Grenadier Road, Toronto Phone Junc. 2765w

Renewals and Repairs for all kinds of Shaking and Dumping Grates for all sizes of Boilers.

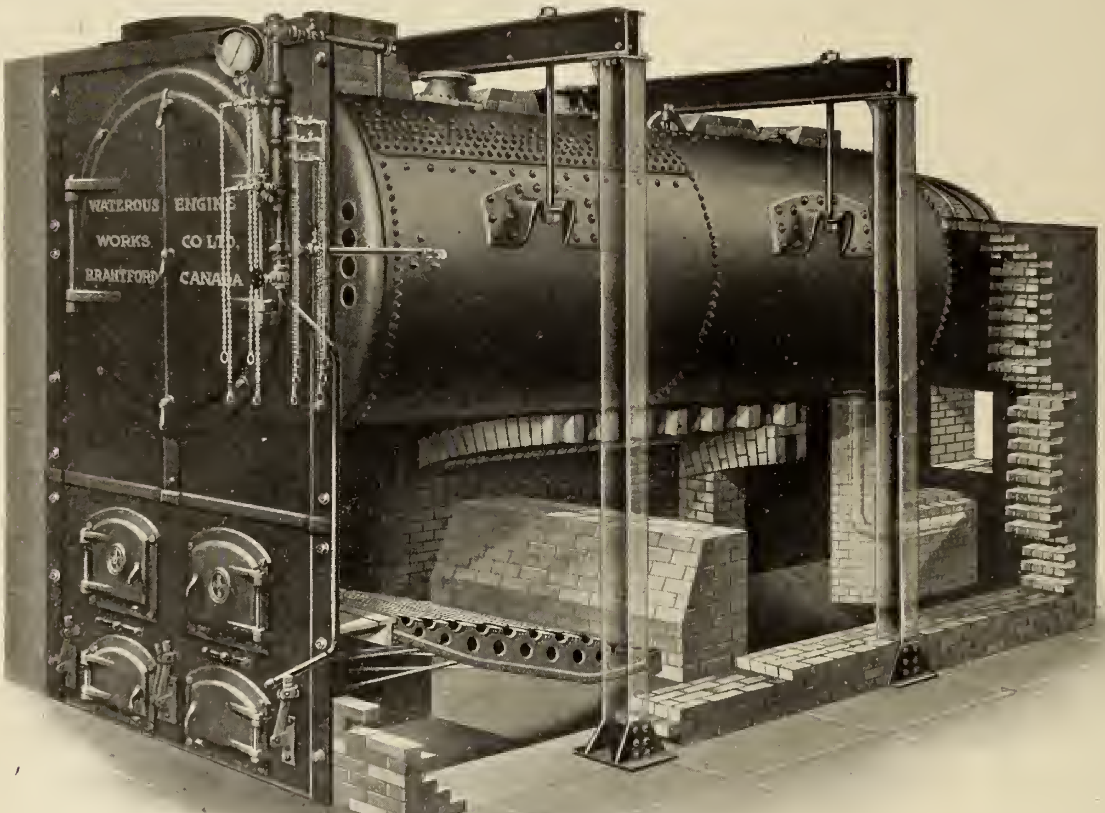
Our PINHOLE GRATE burns—ANYTHING. Special Bars for Brickyards.

Files Stokers

Hand Operated

With the Installation of Files Stokers Six Boilers Now Do the Work of Eight Boilers

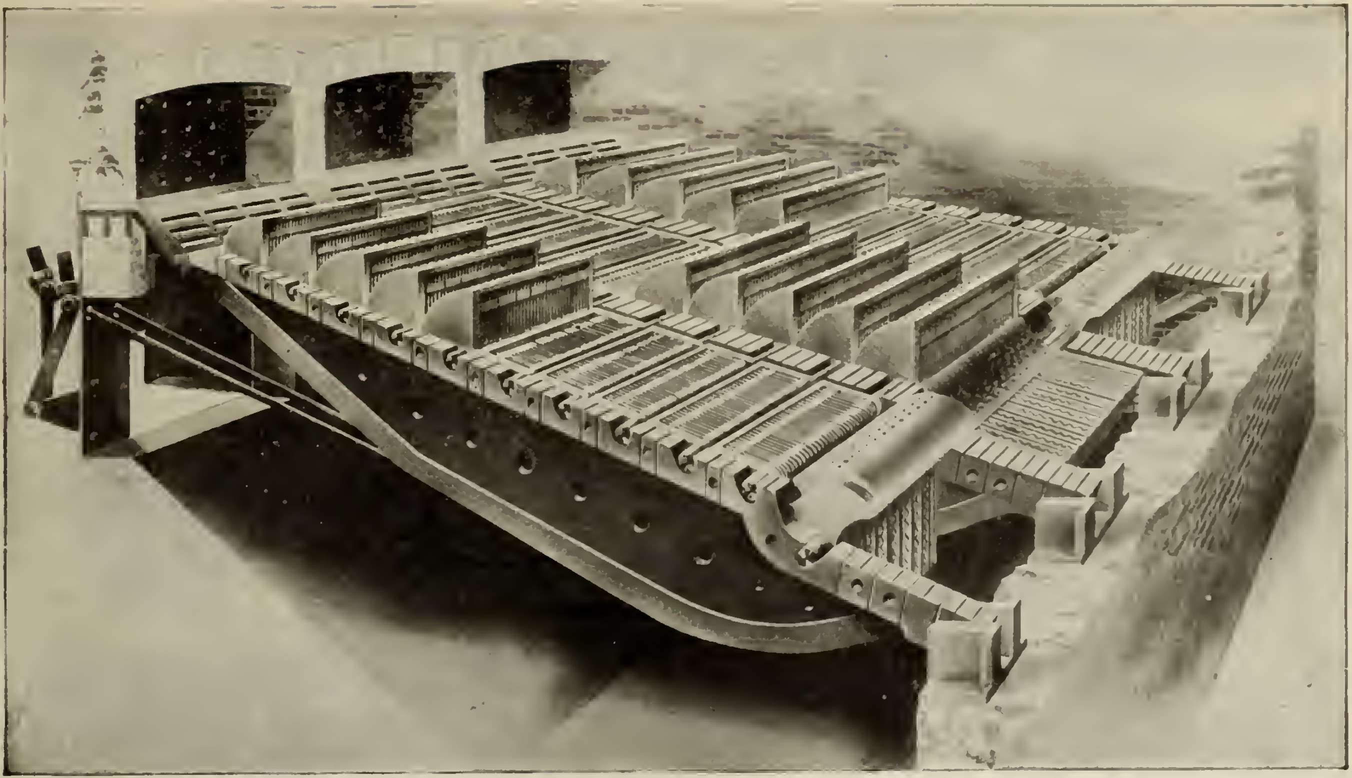
WE have on our files a letter from a manufacturing company reporting the discontinuance of two out of eight boilers after the installation of Files Stokers. Increased efficiency is the answer! Besides the time saved in operating six boilers instead of eight think of the amount of fuel saved. A Files Stoker installation to be sure soon pays for itself.



We invite you to see Files Stokers at the C. A. S. E. Exhibition

Waterous

BRANTFORD, ONTARIO, CANADA



Users Testify to the Saving Power of Files Stokers

ONE user of Files Stokers says a single installation (3,600 H.P.) saved enough coal to pay for the stoker investment in five months.

The average rating for this period was 223%.

Another user has written to say "While we have not made an actual test we would judge the saving in coal to be 10% to 15% as our load increased 25%. We are now able to obtain required steam without difficulty, which we could not do with down-draft furnaces."

Quoting from the letter of a third user the fuel-saving merits of Files Stokers is attested as follows: "Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel."

Files Stokers Achieve Results because:

1. They give correct distribution and proper proportion of air according to load carried.
2. The fuel bed is at all times kept clean and uniform.

You will be interested in the details of design of the Files Stoker. Write for complete information.

Waterous

BRANTFORD, ONTARIO, CANADA

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

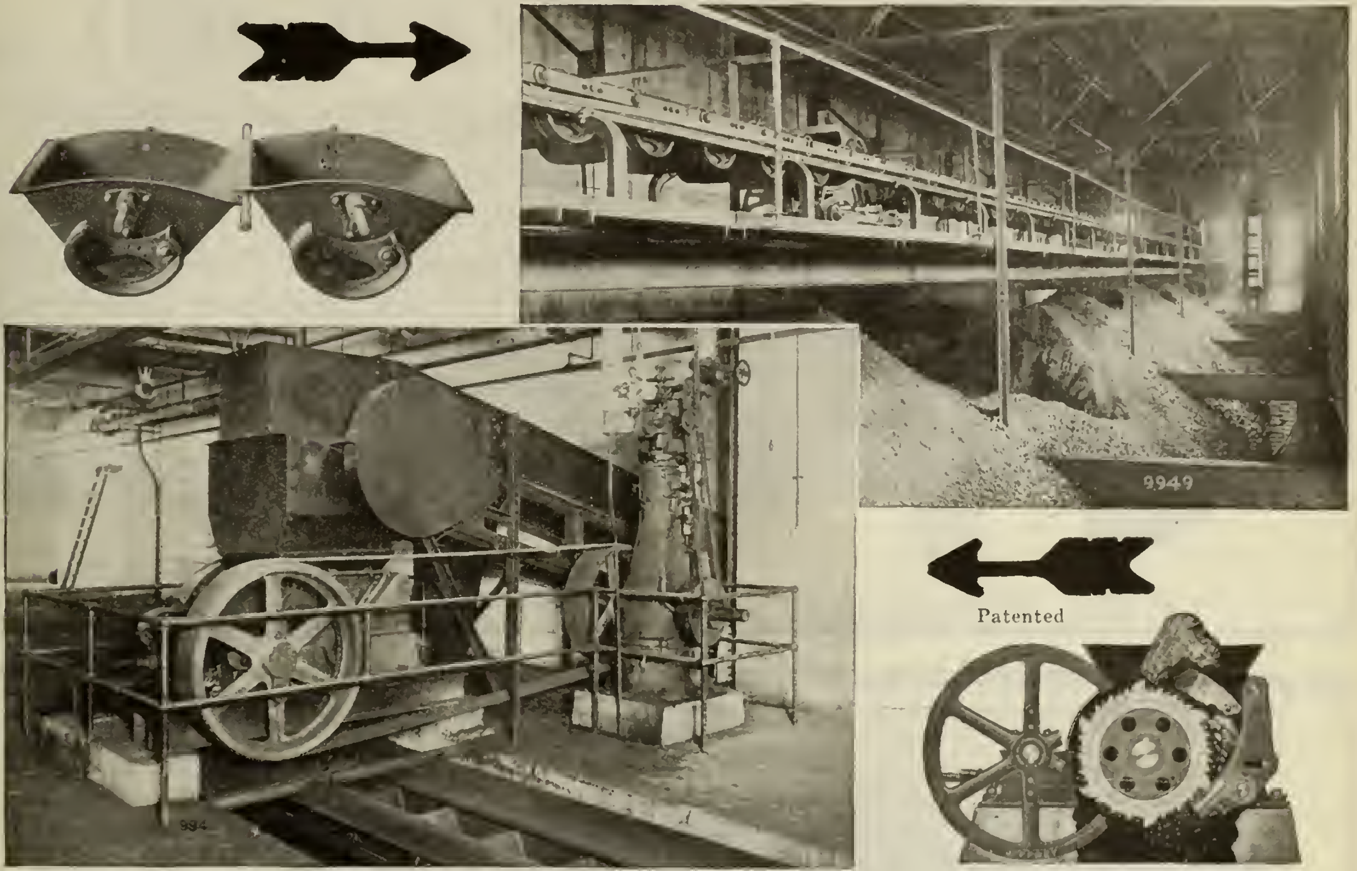
Eventually!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

A Combination That Insures
—Low Cost Handling of Both Coal and Ashes
—A Constant Supply of Properly Sized Coal

Upper Run of Jeffrey Carrier



In basement showing lower run of Jeffrey Carrier beneath Jeffrey Single Roll Crusher.

The Jeffrey Pivoted Bucket Carrier has a working principle which ordinarily combines in the one carrier the work of at least one elevator and two conveyors, in that it handles both coal and ashes. Its economical installation is usually for a capacity of 50 to 175 tons coal per hour.

The Jeffrey Single Roll Crusher enables the power plant to crush its own coal, at a moderate cost for stoker use, where lump or unsized coal only is available, and where stoker sizes cannot be secured from the mines.

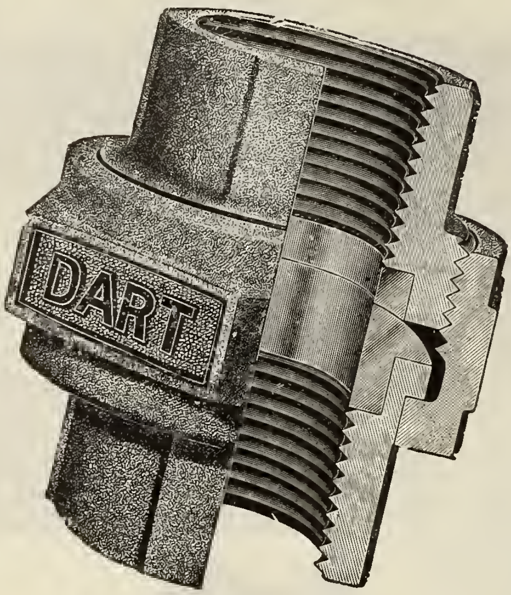
A wide range of capacity requirements is met by Jeffrey complete coal and ashes handling equipment, including: Track and Weigh Hoppers; Crushers; Bucket Elevators; Conveyors of the Bucket, Belt, Steel Apron, Pan, Scraper, Drag Chain, Spiral and other types; Skip Hoists; Portable Bucket Loaders and Belt Conveyors; Industrial Locomotives, etc.

Let Jeffrey Engineers diagnose your coal and ashes handling requirements.

The Jeffrey Mfg. Co., *Canadian Branch and Warerooms* **Power Bldg., MONTREAL**

JEFFREY
MATERIAL HANDLING MACHINERY

DART UNIONS



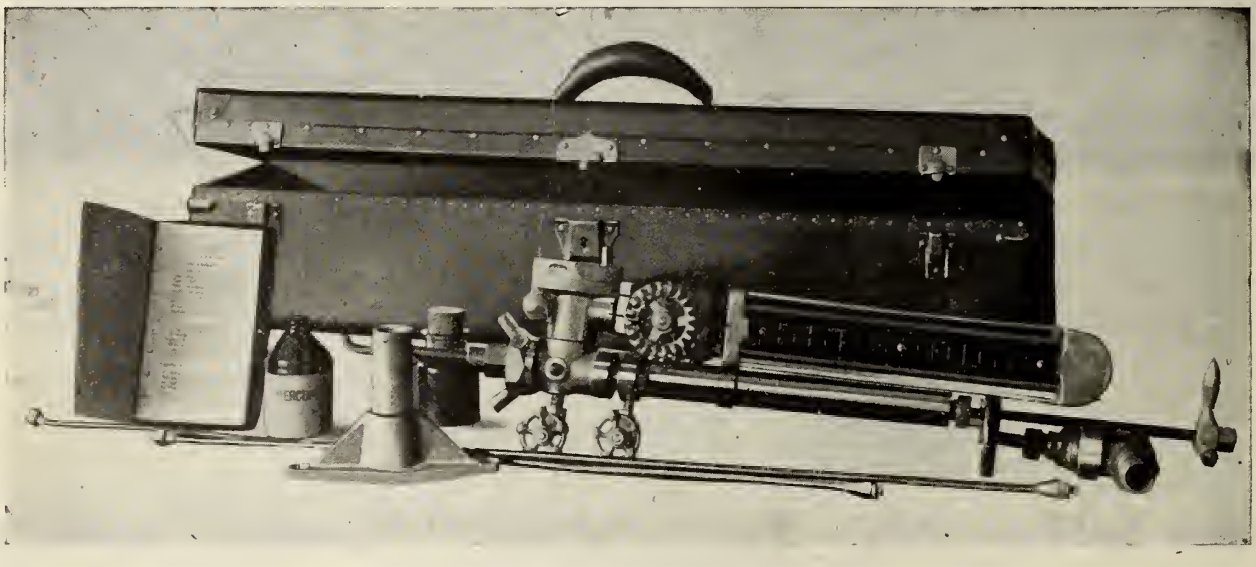
Stay Tight Permanently

No Upkeep Cost
No Replacement Cost
No Loss from Leaks

Because—THEY ARE BRONZE TO BRONZE AT THE JOINT

Your Jobber Sells Them

Manufactured by
DART UNION CO., LIMITED, TORONTO, ONT.



Cory-Royer Flow Indicator
Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

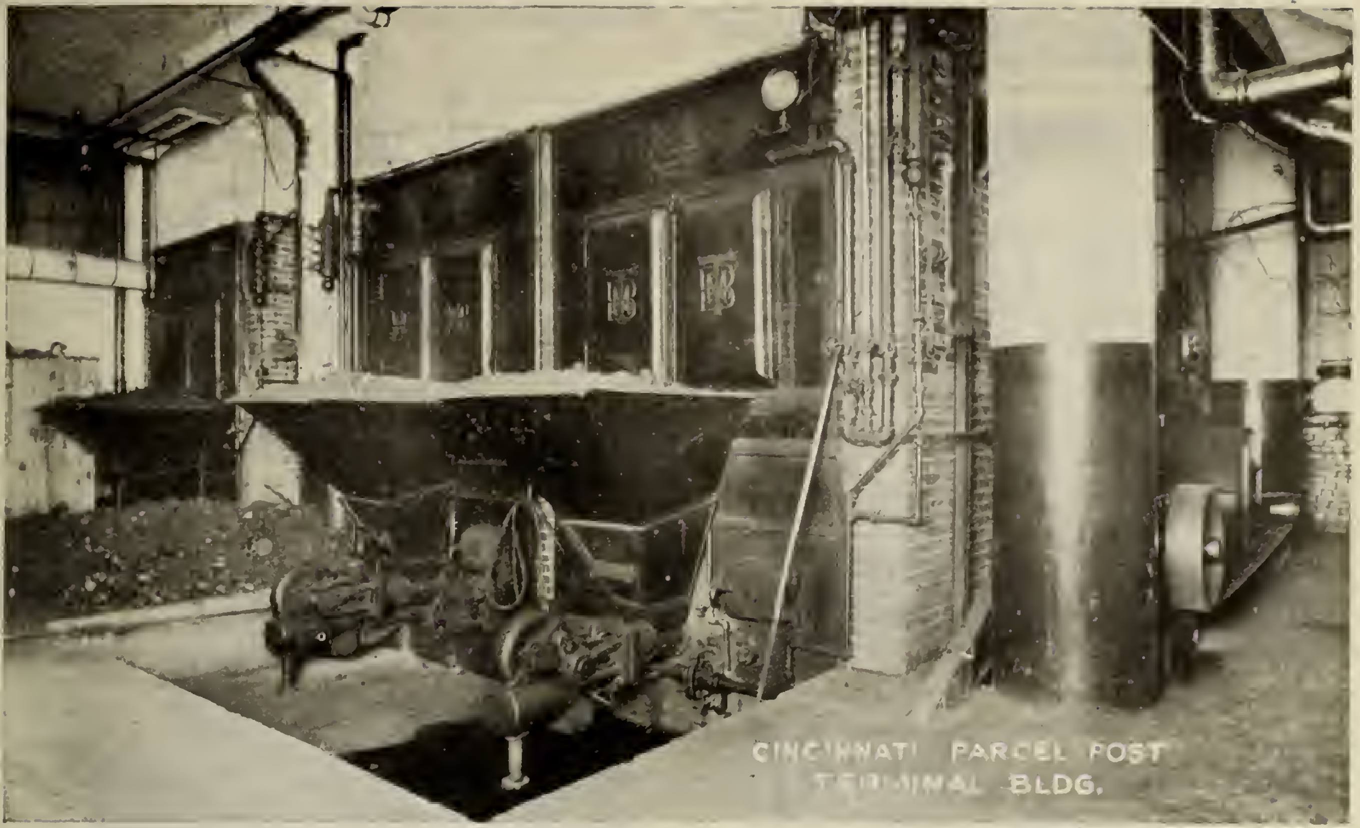
CHAS. CORY & SON INC.

183-7 VARICK STREET - - NEW YORK CITY

VANCOUVER
P. A. Goepel,
525 Pender St. W.

Est. CORY 1845

TORONTO
The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers



Detroit Underfeed Stokers are equally well adapted to small boilers

You can profitably install Detroit Single Retort Side Cleaning Stokers under very small boilers. Those shown above are installed in connection with three 165 horse power Horizontal Return Tubular Boilers.

Under even the smallest boilers Detroit Underfeed Stokers will show a saving of from 15 to 20 per cent over the ordinary method of hand firing. The installation can conveniently and economically be applied to existing boilers in both large and small plants. Practically no excavation is required.

Many typical installations of Detroit Underfeed Stokers have been made in both public and private buildings, including such well known plants as the

Dixie Terminal Building, Cincinnati, Ohio
National Home for Disabled Volunteer Soldiers, Johnson City, Tenn.
New Detroit Municipal Garage Building, Detroit, Michigan
South High School, Youngstown, Ohio
Buffalo Hospital of the Sisters of Charity, Buffalo, N. Y.
Central Junior High School, Saginaw, Mich.
Curtis Hotel, Minneapolis, Minn.
American Cotton Oil Co., Cincinnati, Ohio
H. C. Godman Company, Columbus, Ohio
Globe Wernicke Company, Cincinnati, Ohio
Fifth Avenue Building, New York City
Fairview Pumping Station, Detroit, Mich.
Evanston Pumping Station, Evanston, Ill.

Send for your copy of "Cutting the Cost of Producing Steam", the booklet which fully describes the Detroit Single Retort Side Cleaning Stoker. Ask for bulletin [illegible]

DETROIT STOKER COMPANY
Underfeed Forced Draft and Overfeed Natural Draft Stokers
238 GENERAL MOTORS BUILDING DETROIT, MICHIGAN

DETROIT UNDERFEED STOKERS

IRVING SUBWAY
TRADE MARK (PATENTED)
THE FIREPROOF VENTILATING FLOORING

IRVING SUBWAY TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

Irving Subway for floors—**Irving Safsteps** for stairs—with this combination the under-foot problem of any industrial plant is solved—permanently and economically. This combination gives you low-cost insurance against the foot-accidents that result from slippery floors and stairs. And their first cost is their one and only cost—upkeep and replacements need not enter into your calculations. Write for Catalog 3A50 describing these all-steel plant accessories.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Canadian Agents:
Montreal, P. Q., 304 Coristine Bldg.
Winnipeg, Man., 141 Bannatyne Ave.
Welland. Ont., Standard Steel Cons. Co.

Manufacturers of

IRVING SAFSTEP TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS

Saving 3 Tons Of Coal Daily with FISHER Steam Traps

A manufacturer may believe he has a device the world needs. The real test comes in actual service—strenuous, pitiless service—that soon puts apparatus out of the running unless it is built to withstand such conditions.

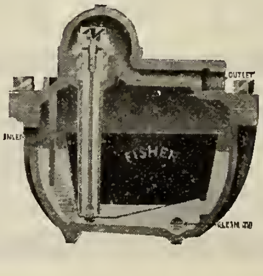
There is a multitude of steam traps on the market, but we do not believe any one of them will stand up in difficult service like the Fisher.

Read what this Fisher user says. The letter tells its own story:

> "We installed quite a number of these traps at your suggestion and replaced a number of traps of other makes and we find on checking up that after the changes have been made we have made a *saving* in our coal consumption of approximately *three tons in every twenty-four hours.*
>
> "We are, therefore, more than pleased with the performance of these traps and will take pleasure recommending them to our friends.
>
> J. GREENEBAUM TANNING CO.,
> (*Signed*) per H. E. Horne, Supt.,
> North Milwaukee, Wis."

A trap that earns a letter like that deserves investigation. Will you let us send you complete information? Simply ask for the "Fisher Trap Book."

The Fisher Governor Company
Fisher Avenue, Marshalltown, Iowa, U.S.A.



JENKINS
Bronze
Swing Check Valve

Equipped with Disc Holder and Composition Disc

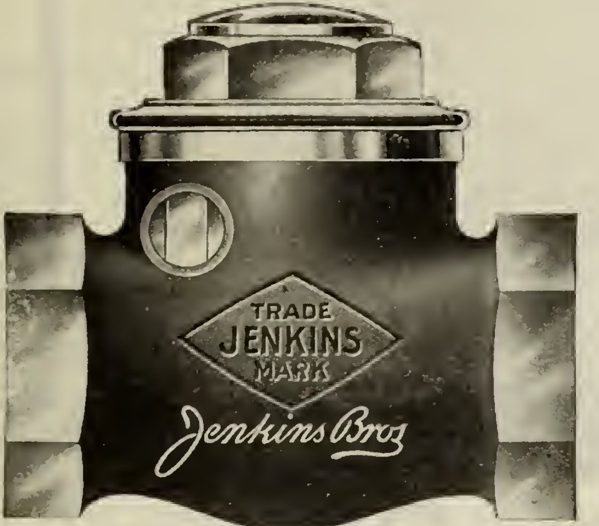


FIG. 475

Perfectly adapted for use in either horizontal or vertical position.

A strong, durable valve that will function satisfactorily. Angle of seat assures valve opening readily at low pressures while the shock of closing in the most severe service is absorbed in the line piping.

These Bronze Swing Check Valves have the Jenkins Renewable Disc feature. Disc lifts well out of passage. Hanger is heavy and has large bearing surface for carrying disc holder. Hanger pin is long and provides ample wearing surface.

Fig. 475, shown above, is the standard pattern made for 150 pounds working pressure. Flanged end valves, Fig. 476, can be supplied if desired.

This and the other Diamond-marked valves in the complete Jenkins line are fully described in Catalog No. 9—free on request.

JENKINS BROS. LIMITED

Head Office and Works: 103 St. Remi St., Montreal.
Sales Offices: Toronto, Vancouver.
European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, Eng.
Factories: Montreal, Bridgeport, Elizabeth.

Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

—a type for every plant

THE most important of all power plant problems is the correct burning of coal. In the larger central station, coal constitutes 40 per cent. of the total cost of operation. In the average boiler room itself 80 per cent. of the total expense is found in this one item.

There is a "Jones" Stoker for every requirement, regardless of the size of the plant or the boiler, the nature of the fuel or the range of the load—whether the plant is old or new. "Jones" Stokers are also extensively used in various industries for chemical, metallurgical and enameling furnaces, in fact, wherever efficiency, control of heat, and smokeless operation are desired.

All "Jones" Stokers are characterized by unmatched simplicity, sturdy construction, and therefore by lower maintenance costs. They consist of one or more simple self-contained retorts with no moving parts in the fire.

All embody the highest development of the underfeed principle of combustion — originated and perfected in the "Jones" Stoker. More economy in fuel burning is thus assured with ability to burn all Canadian coals smokelessly.

Every type of "Jones" Stoker is provided with automatic control of fuel and air, which insures efficiency at all rates of operation. Where stokers are applied to boilers an even steam pressure is automatically maintained. Where applied to industrial furnaces, both the quality and quantity of the heat is controlled.

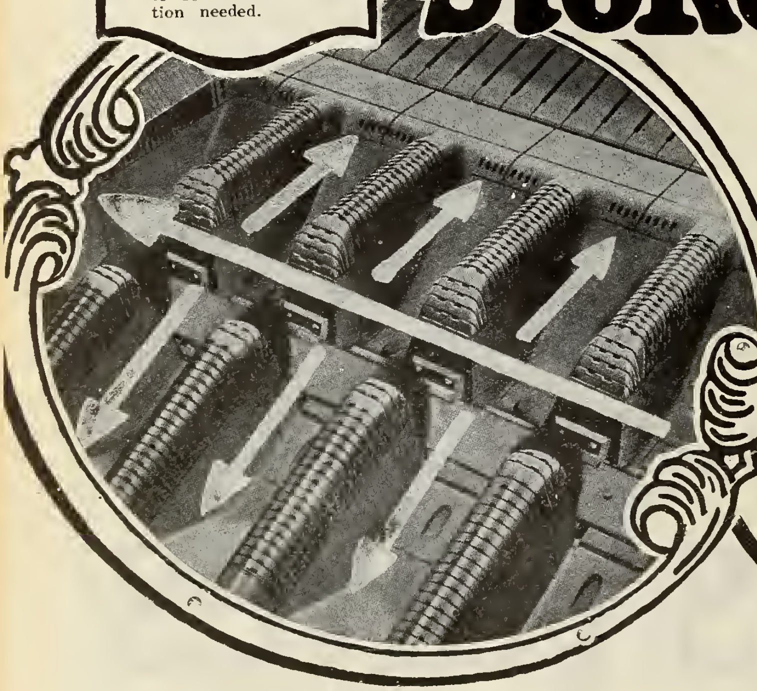
How can you know which type you need? Ask for bulletins covering any types you are interested in.

The Under-Feed Stoker Co. of Canada, Ltd., 146 King St. W., Toronto
Sales Agents for "Jones" Stokers, "Riley" Stokers and "Murphy" Automatic Furnaces

Jones Stokers

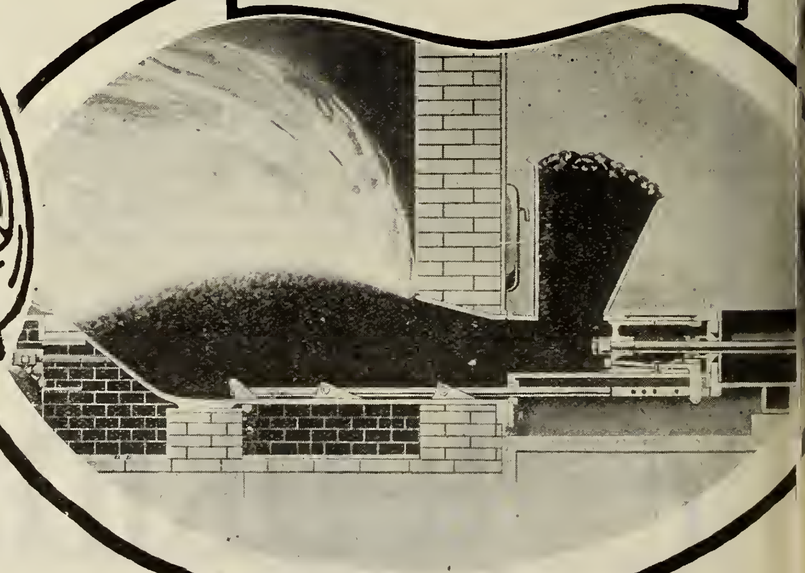
"Lateral Retort"

"Multiple retort" in everything but price. Makes available for every plant the high capacity of the multiple retort at low cost. Coal follows path of arrows. Only 6 to 18 inch excavation needed.



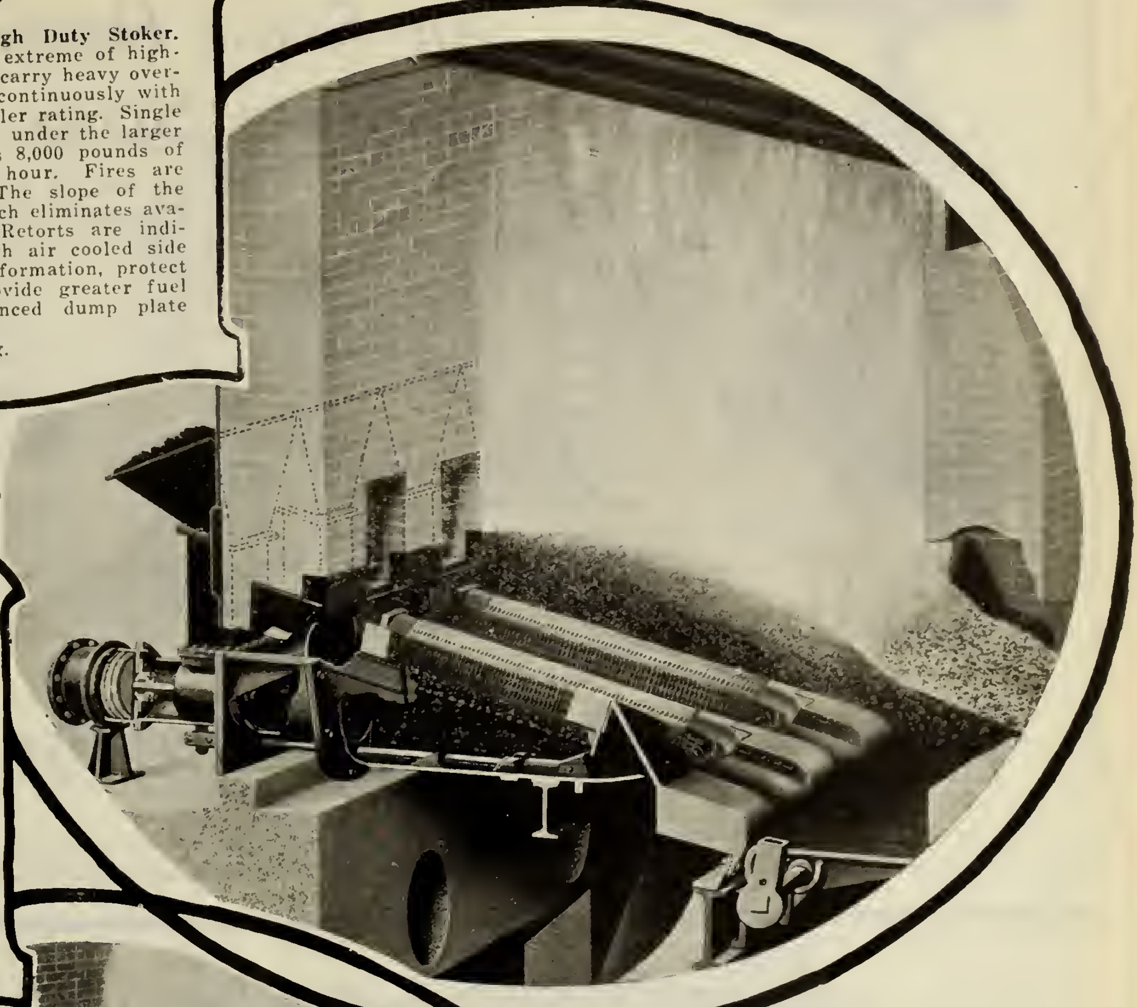
"Standard"

—a stoker that embodies the basic "Jones" features. Moderate in first cost. No special excavation required for ash pit. Simplest under-feed stoker. There are more "Jones' Standard" Stokers under Return Tubular Boilers than all other makes of stokers combined. The "Standard" Stoker is widely used for industrial heating furnaces. This stoker has a fuel burning capacity of 1,000 to 12,000 pounds of coal per hour. Single units serve boilers up to 200 H.P.



"A-C"

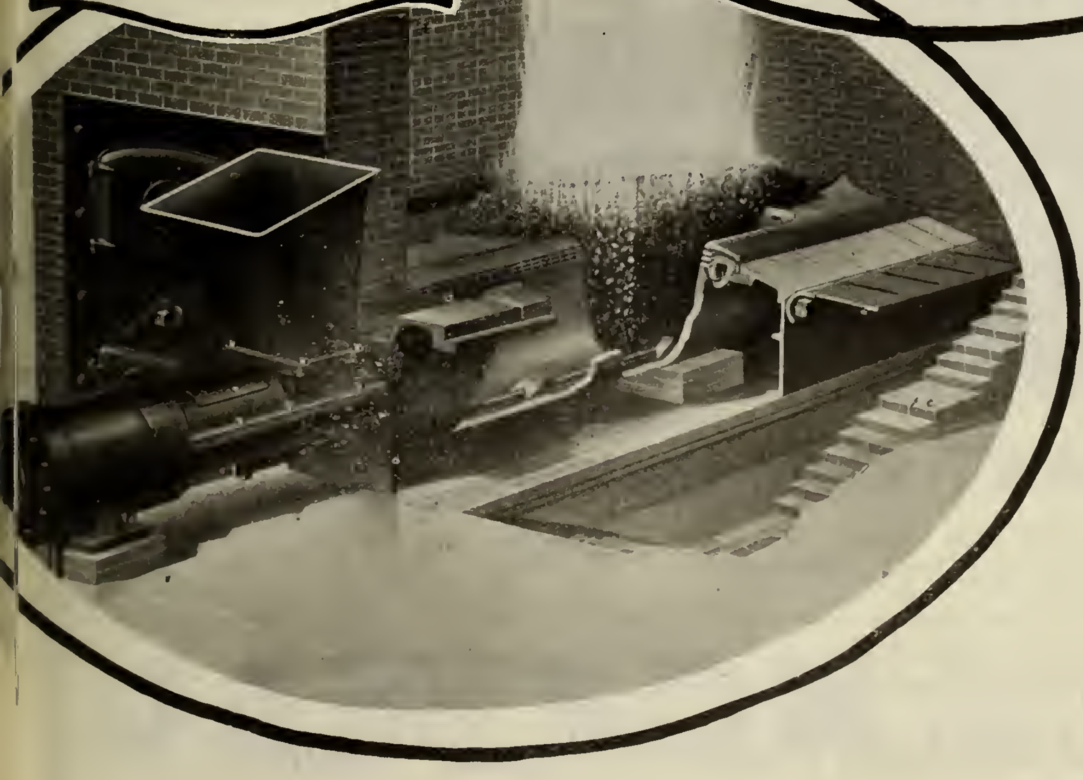
Automatic-Cleaning High Duty Stoker. A stoker for meeting the extreme of high-duty service—designed to carry heavy overloads of 200% and over continuously with peak loads of 300% of boiler rating. Single "A-C" Stoker installations under the larger boilers burn as much as 8,000 pounds of coal to each boiler per hour. Fires are cleaned automatically. The slope of the fuel bed is only 11°, which eliminates avalanching of live coal. Retorts are individually controlled. High air cooled side tuyeres prevent clinker formation, protect side walls and also provide greater fuel bed area; simple, balanced dump plate easily operated.
Write for "A-C" Catalog.



"Side-Dump"

Self-Cleaning Stoker meets the needs of a wide range of plants for a self-cleaning stoker that may be installed at moderate cost.

The side dump plates drop the ash into shallow ash pits, slightly below the floor line, permitting easy removal. Only slight excavation required. This stoker has a fuel burning capacity of from 1,500 to 1,800 pounds of coal per hour and serves boilers up to 300 H.P. in size. The basic "Jones" features make this stoker a fuel, labor and money saver. Ask for description.



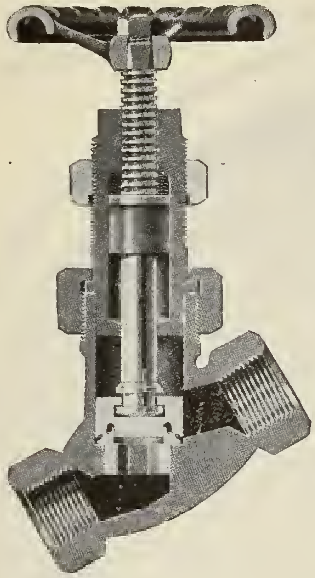
Alta & West, Sask.
Mr J. Twomey
Camrose, Alta.

British Columbia:
E. A. Earle, Limite
Vancouver, B.C.

Man. and East Sask.
W. W. Hicks & Co.
Winnipeg

Quebec
The Cleaton Co.,
(Canada) Ltd.
Montreal, Que.

RILEY JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY



Globe No. 680

Send for bulletin with complete description and price lists.

An Extra Heavy
Forged Steel Stop Valve

This Edward Valve was developed for the most severe service—high pressure oil still lines, and is especially suited to extremely high temperatures and pressures. (Up to 500 lbs. and 1,100 deg. F. intermittent temperature).

The body and bonnet are of forged steel. The body offers least resistance to flow and the minimum sectional area is equal to the pipe area. The bonnet is of the union type with outside stem and yoke. The union ring is also forged steel and the packing nut of monel metal.

The Edward Protected Seat and Disc, a distinctive feature of Edward Valves, may be reground or renewed.

These valves can be packed under pressure. Stem, seat and disc are of monel metal.

This forged steel valve is also made with the plug type seat and disc (Catalog Nos. Globe 682, Angle 683).

Angle No. 681

The Edward Valve & Manufacturing Company

General Office and Works: East Chicago, Ind.

Canadian Agents: Lytle Engineering Co., Limited, Montreal; Valve Engineering Company, Toronto.

Buy Boilers now—while they are still cheap

We are satisfied from the activity in our line of business that Boiler prices will not long remain at the present level.

Order your new Boilers now from us. Include the National Hand Fired stoker and have all the steam you want for the rest of your life—at very low cost and entire satisfaction in your Boiler room.

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices:
HALL MACHINERY CO., Sherbrooke, Que., and Birks Bldg., Montreal

A Service to the Nation

Man's mastery over nature is strikingly exemplified in our great modern system of marketing which feeds the greater part of the nation in constant defiance of time, distance and season.

The cold storage industry has made tremendous strides in refrigerating and insulating efficiency, by improved methods of controlling moisture, humidity and temperature and better means of ventilation and circulation.

The importance of properly insulated, perfectly fitting cold storage doors and windows is now generally recognized:

Architects, engineers, owners and superintendents have learned that "The Plant is only as Good as its Door."

There are many exclusive features in Jamison Doors,—greater structural strength, heavier hardware reinforcements, double seals of contact, ease of operation, longer life and fewer repairs,—as insured by "The Seal of Satisfaction."

Architects and Engineers

Aside from a complete stock of standard size doors ready for immediate shipment, Jamison built-in refrigerator fronts to specifications meet all sorts of special requirements.

A request addressed to "Desk 11" will bring our detailed, illustrated catalog, describing our entire sample line.

JAMISON Cold Storage Door Co.
HAGERSTOWN, MD., U. S. A.

When such eminent engineering firms as—

Alvord, Burdick & Howson, Chicago.
Black & Veatch, Kansas City.
Wm. M. Platt, Durham, N.C.
Nicholas S. Hill, New York City.
Chipman & Power, Toronto.
James, Proctor & Redfern, Toronto, Ont.
Gilbert & Stevens, Jacksonville, Fla.

And a great majority of the most prominent consulting engineers specify for Emergency service.

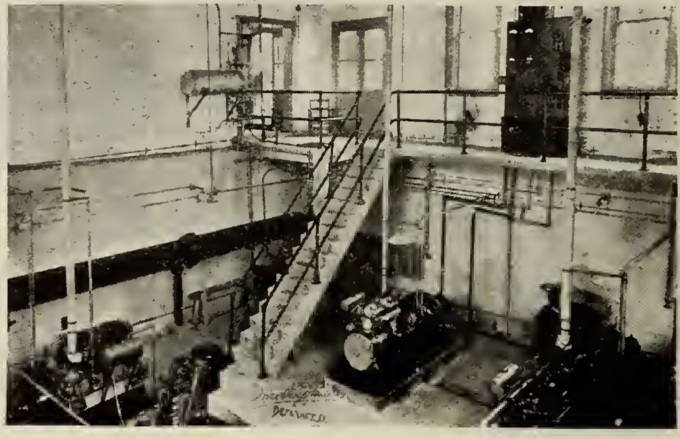
Sterling
THE ENGINE OF REFINEMENT

HIGH DUTY GASOLINE ENGINES

for centrifugal pumps and electric generator drives,

Because of—

1. Low first cost.
2. Cheap operating cost.
3. Saving in maintenance.
4. Dependable service.



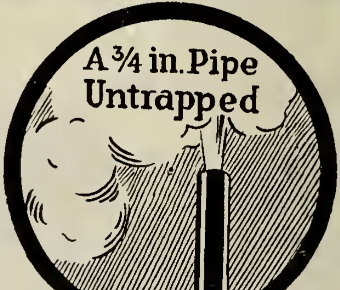
Three STERLING engines in the power station at Defiance, Ohio, two on DeLaval centrifugals for domestic water and fire protection, installed by Dravo-Doyle Co., one on a General Electric generator for lights.

Further particulars on request. 50 to 300 H.P. in single units, 600 to 1,500 R.P.M.—centrifugal pump and electric generator speeds.

Sterling Engine Co. (Dept. C4) **Buffalo, N.Y., U.S.A.**

1c a Day Saves $5.74 Daily

AN UNTRAPPED ¾-in. steam pipe in your plant would waste 820 lbs. of coal every 24 hours. At the present cost of coal that means a loss of $5.74 a day—$1,722 a year.



Perhaps there are several untrapped or poorly trapped lines in YOUR plant at this moment! If so, you can prevent enormous waste by installing the Steam Trap Sarco. The ¾-in. size costs only $9.45 list.

At that price the Sarco will cost about 1c a day even if you charge off 33 1-3% of its costs per year. And after three years it will go right on saving money for years, at no cost to you—for thousands of Sarcos have been in continuous service for more than ten years.

Isn't the Sarco a worth-while investment on that basis, especially when you may try it 30 days without charge and demonstrate that it will do as claimed?

You can purchase three Sarcos for the price of one bucket type trap, and the Sarco will do the same work.

In addition, the Sarco screws right into your pipe line and eliminates the cost of building a platform or digging a pit.

Write to-day for Booklet J-33 and follow the road to steam conservation

SARCO CO., Inc., 239 Broadway, New York City
Peacock Bros., Ltd., Montreal

Manufacturers of Steam Traps, Radiator Traps, Temperature Regulators, Indicating Thermometers, Strainers, etc.

STEAM TRAP **SARCO**

Wastes

Every 24 Hours

A-3006

Strength

A Chain is as strong as its weakest link—a steam system as strong as its weakest valve!

Make the valves the strongest parts in your system by using Mueller A-3006 Composition Disc Steam Valves. A valve that will withstand a test of 300 pounds steam pressure—80 pounds superheated pressure—will fill your requirements. Strengthen the weak spots to-day!

H. MUELLER MFG. CO.
LIMITED
Sarnia, Ont.

Water, Plumbing and Gas Brass Goods and Tools

American Factory at
Decatur, Illinois, U.S.A.

Branches:
New York and San Francisco

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

Make Canada Prosperous by Buying Canadian Products

LUNKENHEIMER Gate Valves

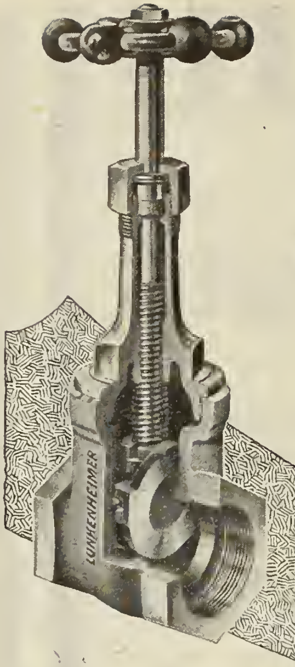


Fig. 427
Double Disc
Bronze. 150 lbs.
W.S.P.

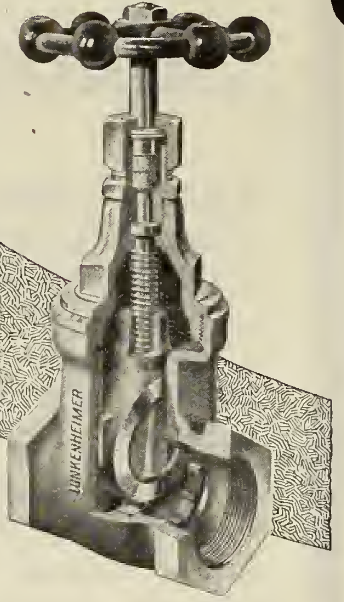


Fig. 768
Wedge Disc
Bronze. 200 lbs.
W.S.P.

The complete line of Lunkenheimer Gate Valves (part of which is here illustrated) enables the selection of designs particularly adapted for specific purposes and for all prevailing pressures and temperatures.

The designs, materials and workmanship are of the Lunkenheimer Standard and therefore satisfactory prolonged service and economy of maintenance are assured.

Catalog 58DC portrays the complete line. Write for a copy.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
EXPORT DEPT. 129–135 LAFAYETTE ST., NEW YORK

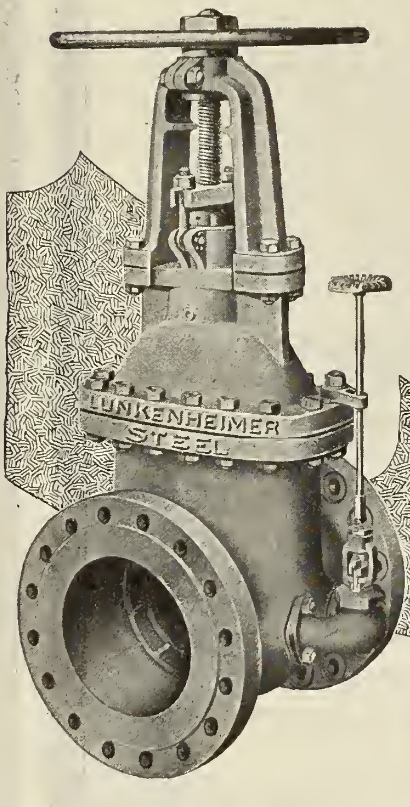


Fig. 1354
Wedge Disc
Steel. 350 lbs.
W.S.P.

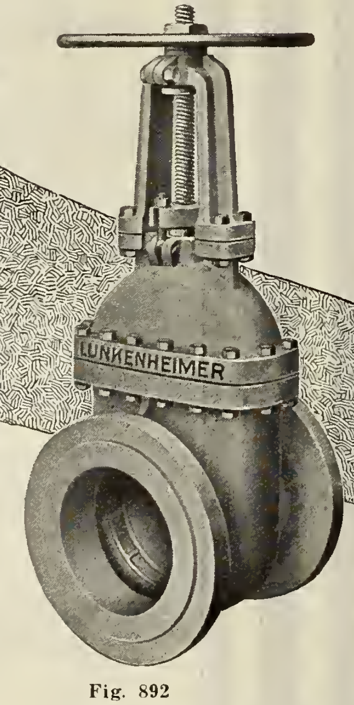


Fig. 892
Wedge Disc
Iron. 250 lbs.
W.S.P.

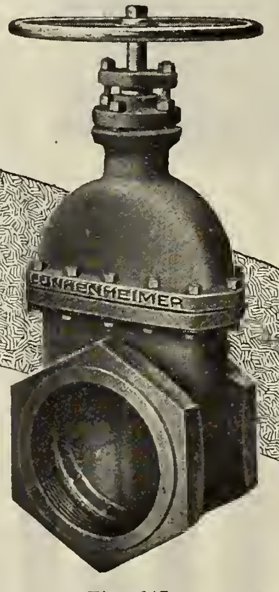


Fig. 647
Wedge Disc
Iron. 125 lbs.
W.S.P.

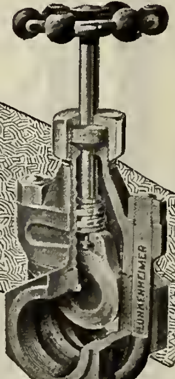


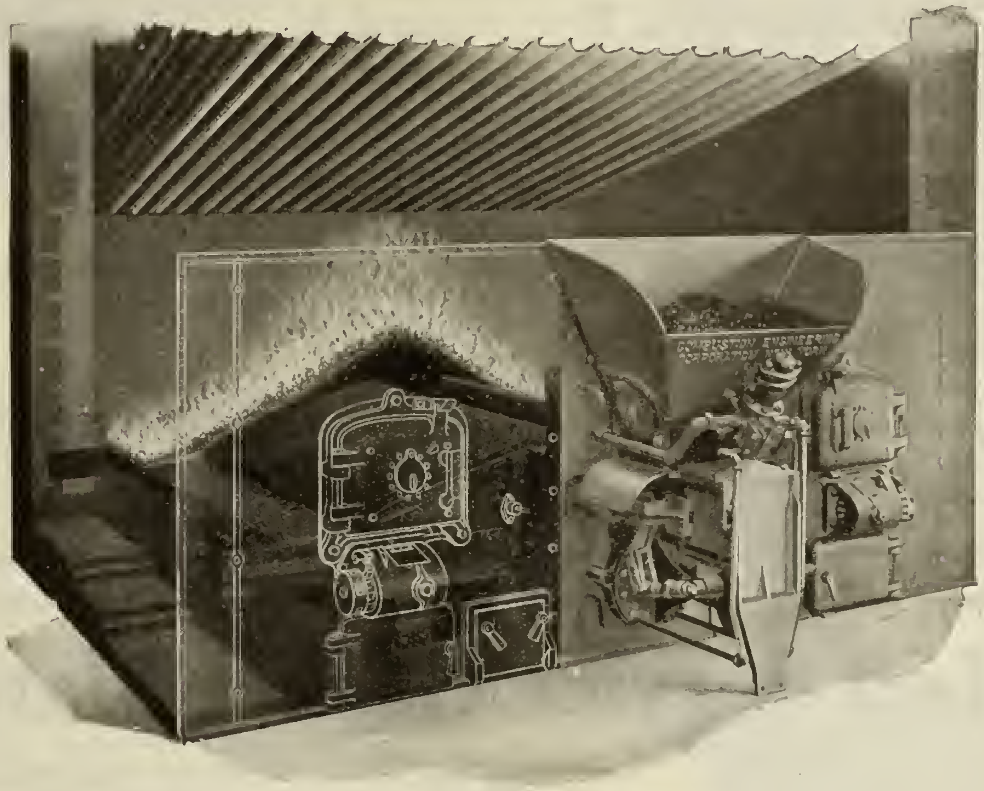
Fig. 600
"Clip." Iron.
100 lbs. W.S.P.

"America's Best since 1862"

600-31-43

SIMPLICITY

Type E Stokers



NO COMPLICATED PARTS TO GET OUT OF ORDER
95% of grate Surface is visible from Front Door
100% of the clinker line is in view
Operation is very simple

We also manufacture and supply

Coxe Stokers	*Type "K" Stokers*
Self-contained Stokers	*Lopulco Pulverized Fuel Systems*
Flat Furnace Arches	*Quinn Oil Burning Equipment*
Uehling Recording Instruments	*Custodis Radial Brick Chimneys*
Combusco Ash Conveyors	*Economisers and Air Heaters*

Everything in the boiler room except the boilers.

COMBUSTION ENGINEERING CORPORATION
LIMITED
MAIN OFFICE : TORONTO
VANCOUVER MONTREAL WINNIPEG

Make it easy for your firemen to maintain regular temperature

For upon this, the efficiency of the whole feed heating equipment depends.

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

RECORDING THERMOMETERS

are an incentive for your firemen to maintain a regular temperature because the charts show every temperature variation and exactly when it occurred. The men know that the chief knows just what is going on, and strive for a record of efficiency.

Bristol's Thermometers are installed on both the inlet and outlet sides of the feed water heater and of each economizer. They also record temperature of gases leaving economizer.

Bristol's Recording Instruments will help you to reduce power cost either in the large central station or small plant. Write for Bulletin 1202-A.

THE BRISTOL COMPANY
Waterbury Conn., U.S.A.

Canadian Distributors:

Eastern Territory — Powerlite Devices, Ltd., Toronto and Montreal.

Western Territory — Gorman's Ltd., Edmonton.

Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.

DURABLA
TRADE MARK REGISTERED

Strength; Goodness; Quality—these features distinguish durable Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

DURABLA is not affected by vibration or condensation. It will not burn out, blow out or pulp at the points. Let us send you a trial sample. Made in stock sizes 36 in. wide x 144 in. long, and 48 in. wide x 144 in. long, in thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Orders Filled Promptly.

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

Goldie & McCulloch

Dependable Power Plant Equipment

Vertical Simplex Double Acting Boiler Feed Pump

Built to Meet Modern Conditions

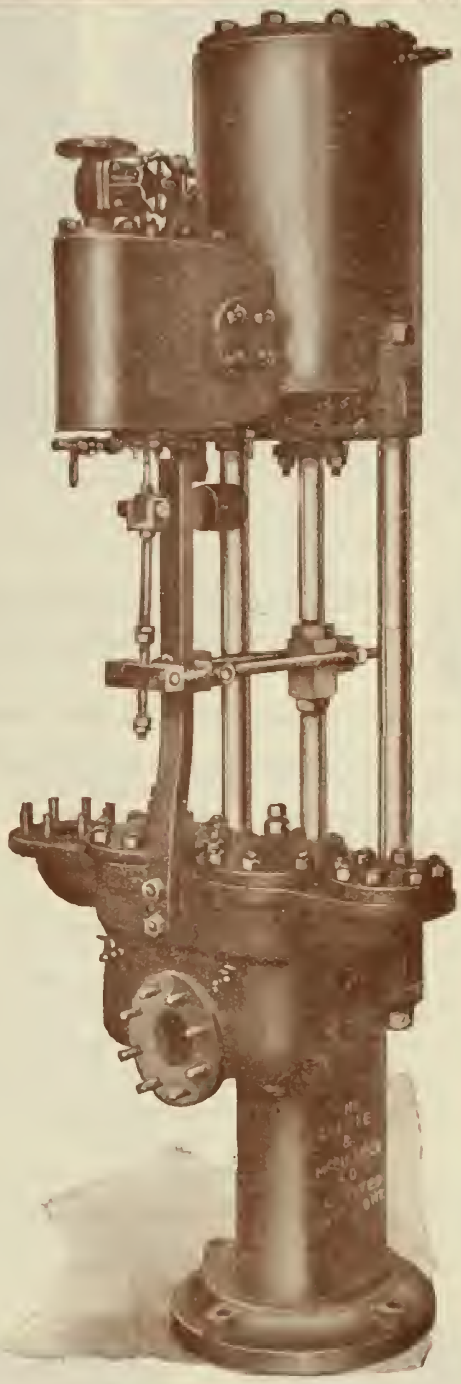
THEIR slow, steady speed gives a very high efficiency. Actual tests showing 95% in the water end as against 70% in a horizontal pump, with both pumps working under similar conditions.

In the Vertical Simplex Pumps the pilot or timing valve also acts as a cut-off valve, allowing steam to be used expansively and making possible the slowing down of movement at end of stroke.

Bilge and Ballast or Low Duty Pumps

These pumps are of the same general design as the Vertical Boiler Feed Pumps, but are primarily intended for discharging much larger volumes of water against low heads or pressures.

We have published a special folder treating these pumps. Have us send you a copy.



THE GOLDIE & McCULLOCH CO., LIMITED.

GALT, ONTARIO, CAN.

Branches and Agencies:

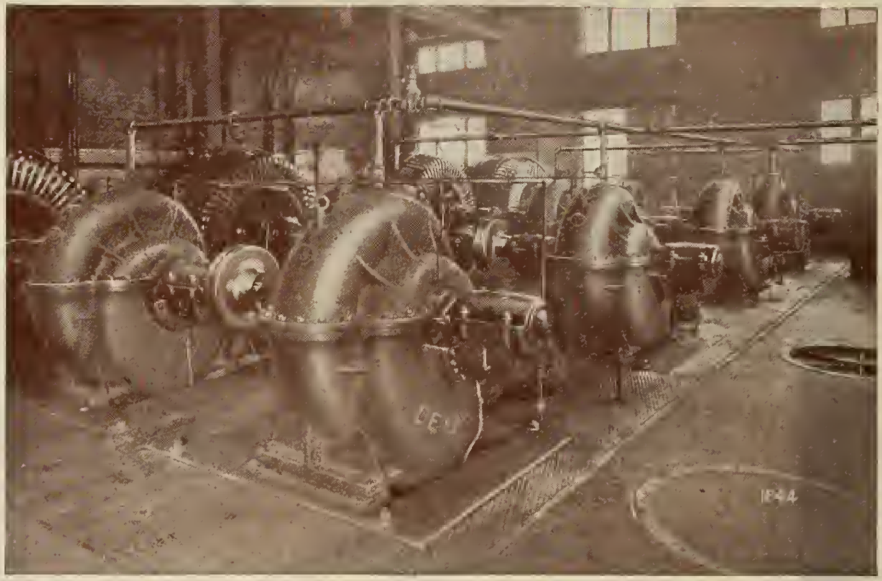
Toronto Office — 1101-2 Bank of Hamilton Bldg.

Western Branch—248 McDermot Ave., Winnipeg, Man.

Quebec Agents—Ross & Greig, 400 St. James St., Montreal, Que.

B. C. Agents—Robt. Hamilton & Co., Bank of Nova Scotia Bldg., Vancouver, B. C.

87.2% PUMP EFFICIENCY SHOWN BY DE LAVAL PUMPS AT TORONTO



SOME years ago the City of Toronto, Ontario, installed four motor-driven centrifugal pumps of European manufacture at the John Street main water works pumping station. It was subsequently decided to replace these pumps, and after receiving competitive bids, four De Laval pumps, guaranteed to develop 81% efficiency when delivering 20,000,000 Imperial gallons per day against 108 lbs. pressure, were purchased. One of these pumps when tested by Prof. Robert W. Angus established a new record for centrifugal pumps, showing AN EFFICIENCY OF 87.2% when delivering 22,240,000 Imperial gallons per day against a total head of 267.6%.

It behooves the prospective purchaser of a centrifugal pump to consider this matter of efficiency carefully, since in many instances he could not afford to use an inefficient pump even if it were given to him free of charge. You can easily figure this out for your own conditions, knowing the price you have to pay for electrical current per KW. hour, the amount of water to be handled, and the head pumped against.

Our engineers will be glad to consult with you on pumping problems. Ask for Leaflet B-100.

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

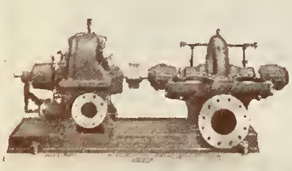
THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

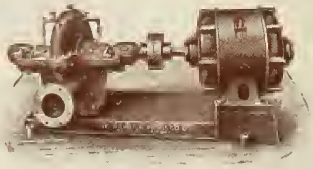
BAWDEN PUMPS & SPECIAL MACHINERY

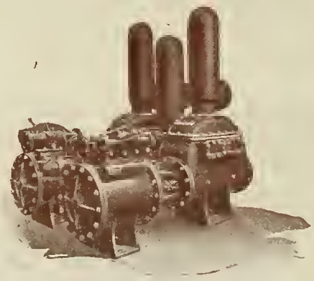
Made in Canada Products

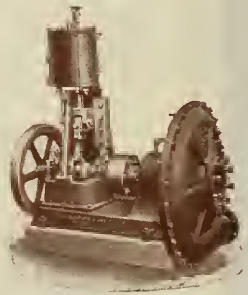
Steam Pumps for General, Boiler and Hydraulic Services.
Centrifugal Pumps for Fire, and Municipal Institutions and Services.
Pulp and Paper Mills, Mining, Irrigating and Hydraulic.
Gray Iron, Brass, Acid Bronze, Aluminum and Whitemetal Castings of all sizes.
Get our quotations on Alley MacLellan Air Compressors and High Speed Steam Engines

Catalog of these Pumps Promptly Mailed









BAWDEN MACHINE CO., LIMITED

Head Office: TORONTO, Canada

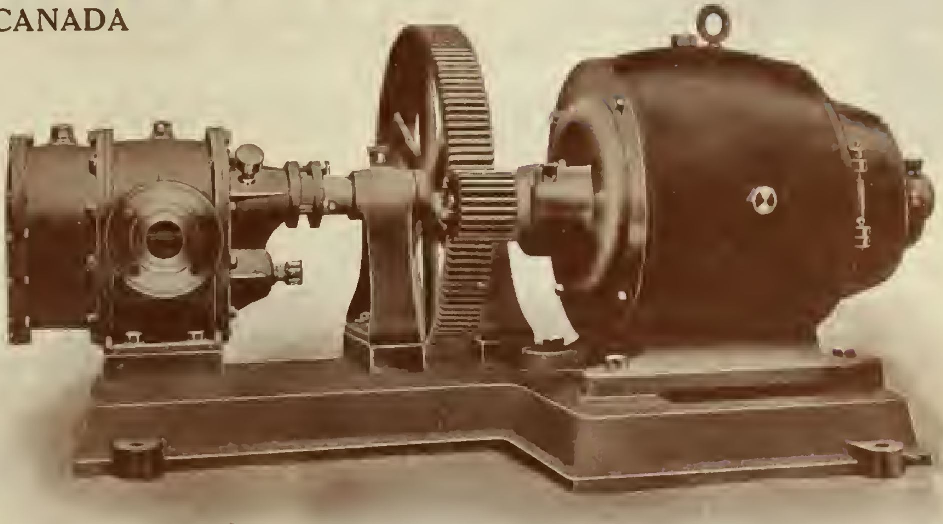
Agents: Montreal Winnipeg Calgary Vancouver

The "ALBANY" Water Sealed ROTARY PUMP

MADE IN CANADA

No Other Pump Like it

Patented in
All Countries



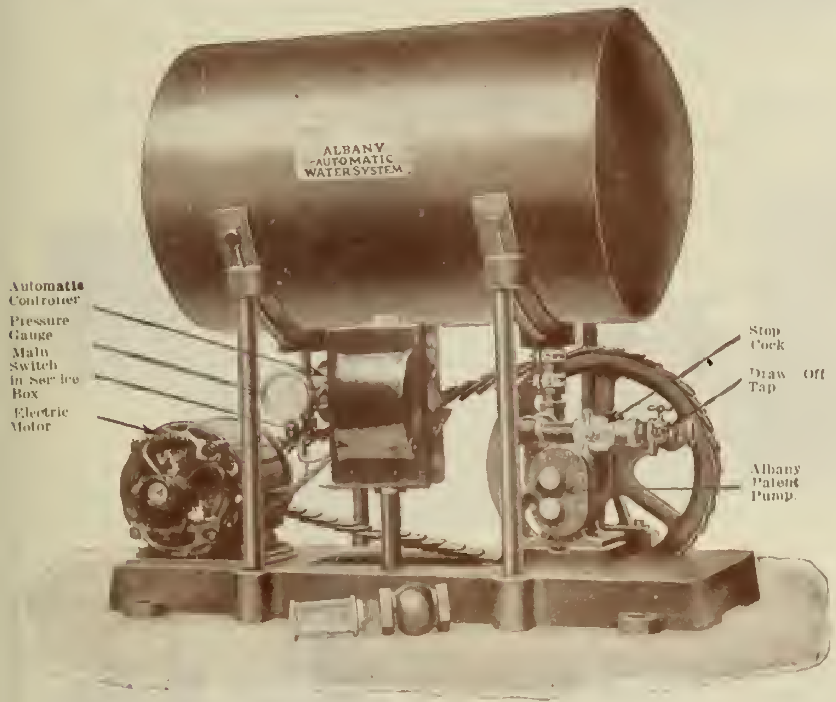
$175 with 60 Cycle Motor

$185 with 25 Cycle Motor

The "Albany" Patent Water-Sealed Rotary Pump is suitable for dealing with gas exhausters, oil, wine, vinegar, brine, acids, spirits, domestic water supplies, etc.; it is ideal for fuel-oil burning systems. No valves in these pumps—nothing to get out of order. Made in sizes from 100 to 60,000 gallons per hour. Either Belt or Motor driven.

Albany Automatic Water System

Practically Silent in operation



THE "ALBANY" AUTOMATIC WATER SYSTEM is without doubt the most compact system on the market. It occupies a floor space of only 2 ft. 9 in. x 1 ft. 6 in. Shipped complete as shown in the illustration.

ADVANTAGES: Low operating cost—small installation cost—no cumbersome and expensive storage tank—absolutely automatic and will furnish fresh water from the well. Suction lift up to 22 feet.

OPEN THE FAUCET AND THE PUMP STARTS. Close the faucet and the pump stops. The automatic switch starts and stops the pump as and when required.

The whole apparatus is built and lined up on a substantial cast iron base. Every part is direct connected. The pump is self-priming and is washerless.

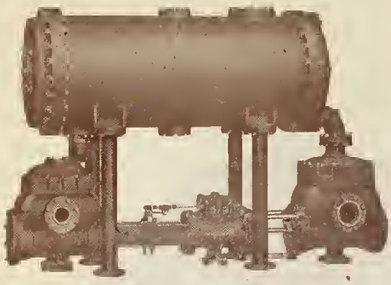
CAPACITY 300 GALLONS PER HOUR.

ALBANY PUMPS ARE NO EXPERIMENT. They have been in use in Canada since 1908. Many satisfied customers testify as to their durability and lack of repair expenses.

Have us explain the pump more fully

ALBANY PUMP COMPANY

159 Richmond Street W., Toronto, Ont.



The John H. McGowan Co.

Builders of Pumping Machinery

Cincinnati, Ohio, U.S.A.

Fig 425

Simple
Duplex
Steam
Power

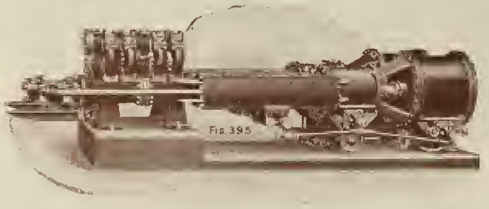


Fig. 395

Condensing
Non-Condensing

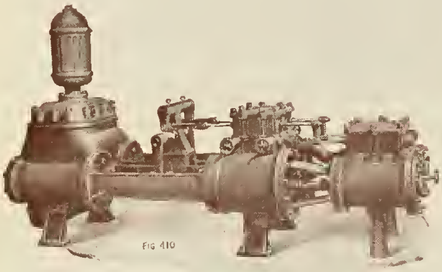


Fig 410

Mills Railways
Mines Power Plant
For All Industrial Plants

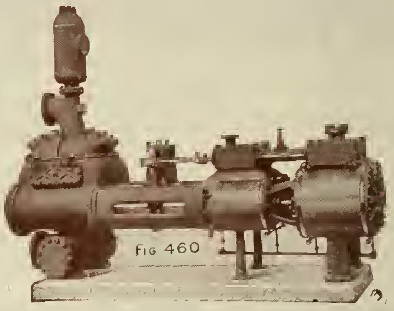
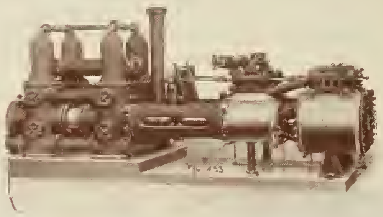


Fig 460



Pressure Patterns
Packed Piston

Compound
Triple Expansion

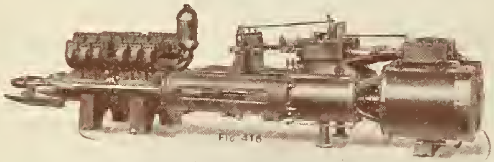
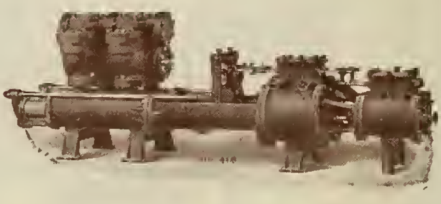
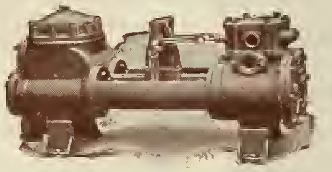


Fig 416

Outside
Center Packed
Plunger
Slide Valve





For
All Conditions
of Service

Semi-Corliss
Piston Valve

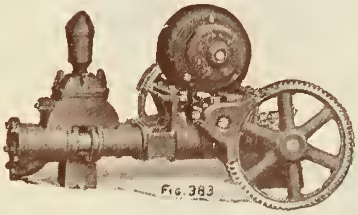


Fig. 383

McGowan has been in existence 70 years—not just existing — rather developing — so that our designs, patterns and shop methods are up to the minute. Our customers reap the benefit of all this as satisfied users.

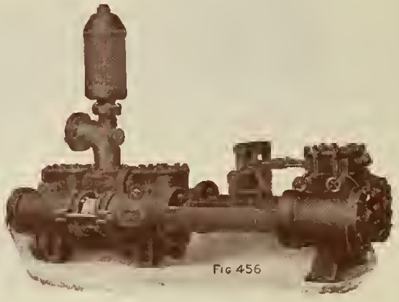
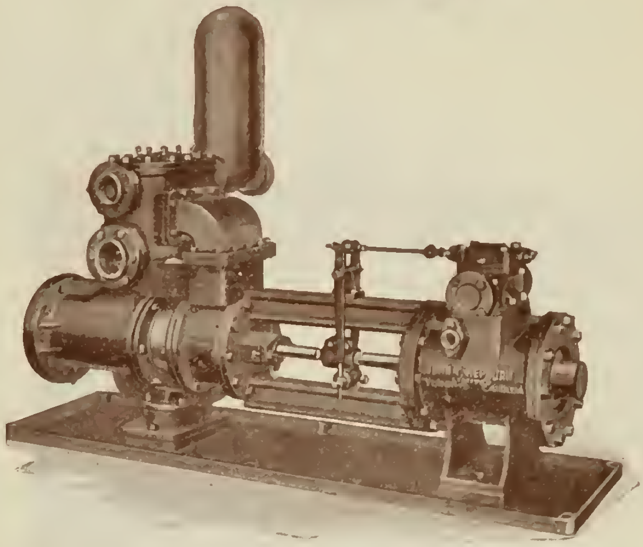


Fig 456

Hepburn Pumps

Installed
in the
New Morgan
Building
Montreal

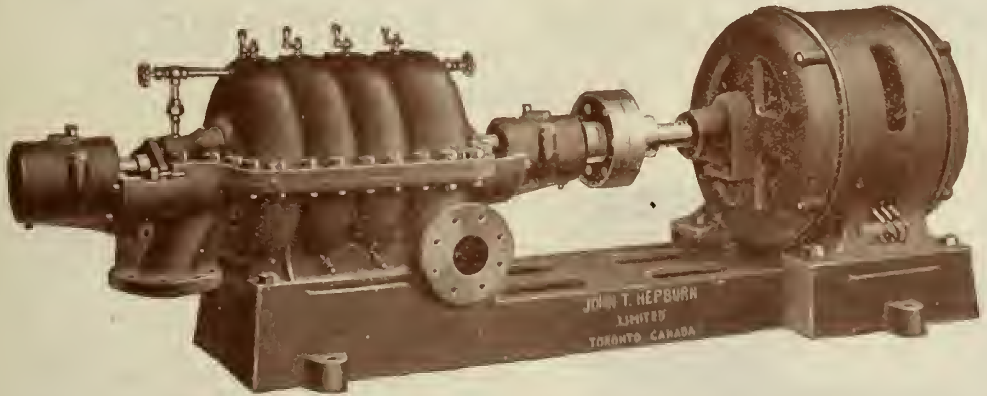


Four Hepburn pumps are used in the Morgan extension, two for boiler feeding and two as vitalizers in the heating system.

The two Boiler Feed Pumps, 12½" x 9" x 12", return the condensation to the boilers in a system of 70,000 sq. ft. of direct radiation. They are of the horizontal ram type, as illustrated above, with mechanically operated valve.

Two Hepburn Standard Vacuum Pumps, 11" x 14" x 20" are also employed in maintaining a vacuum in the heating system of the new building.

Hepburn Pumps for Waterworks Service



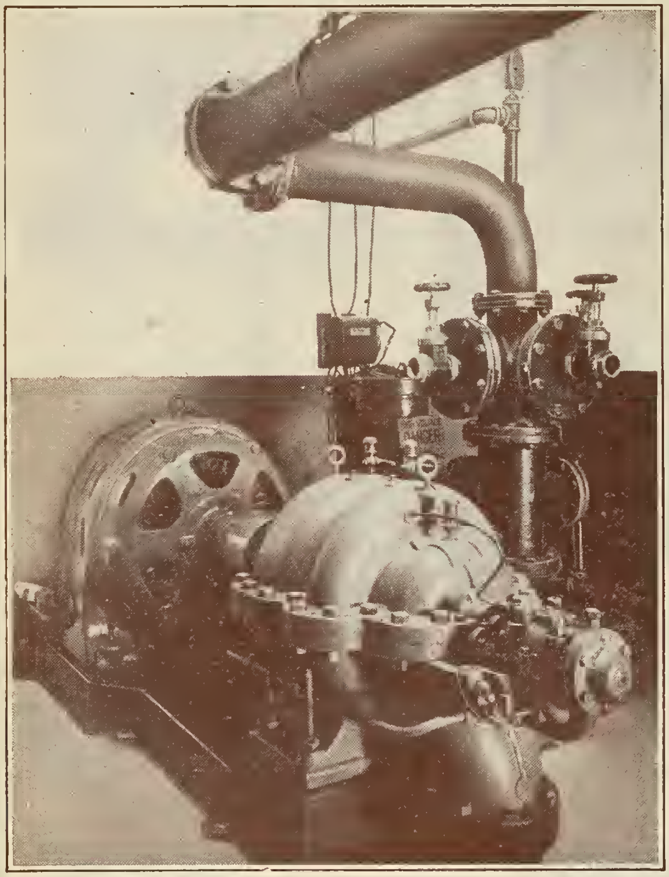
As a storage safeguard in connection with the water system, the district of North Vancouver has installed a 3-inch 4-stage Hepburn Pump in Lynn Canyon, to operate against a head of 600 feet.

Dependable performance is the reason behind these and many other installations of Hepburn Pumps.

Let us furnish you with complete information in regard to these pumps.

JOHN T. HEPBURN LIMITED

Engineers and Iron Founders
18-60 Van Horne Street
TORONTO



A Pump for Every Purpose

Pumps for Municipal Water Supply, High Pressure Irrigation, Marine Service, Hydraulic Elevator Service, water supply for mills, office buildings and apartment houses, etc.

These renowned pumps have a long record of continuous satisfactory service. They are of extra rugged construction, and all bearings are renewable bronze, while they may be opened quickly for inspection without disturbing pipe connections.

We supply practically every type of pump, be it Air, Boiler Feed, Centrifugal, Fire, Marine, Gasoline, Heavy Oil, Irrigation, Rotary, Hydraulic or Typhoon, etc., and our engineers will gladly recommend the proper type for your conditions, without charge or obligation. Write our nearest office for Pump data.

101

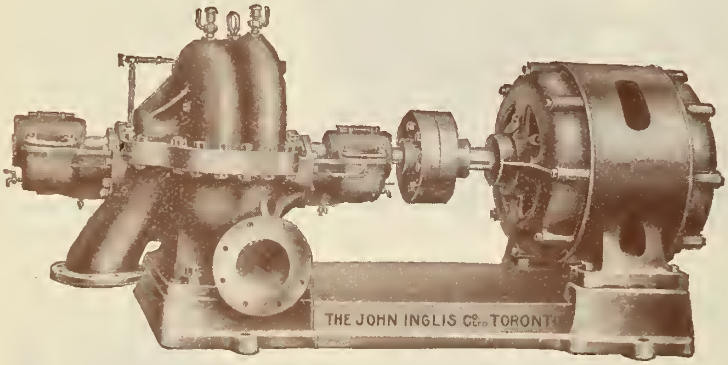
The Canadian Fairbanks-Morse Co., Limited

Montreal, Toronto, St. John, Winnipeg, Quebec, Ottawa, Windsor, Vancouver, Calgary, Regina, Victoria.

INGLIS PUMPS

STRENGTH - SAFETY - EFFICIENCY

High-Grade Workmanship



INGLIS centrifugal pump construction is according to the best accepted principles of present day pump design. Proper design assures freedom from a repetition of repair costs, which sometimes in the course of a few months costs more than the cost of the installation. It is sound business economy to instal only centrifugal pumps which are designed with features of strength, safety and highest efficiency.

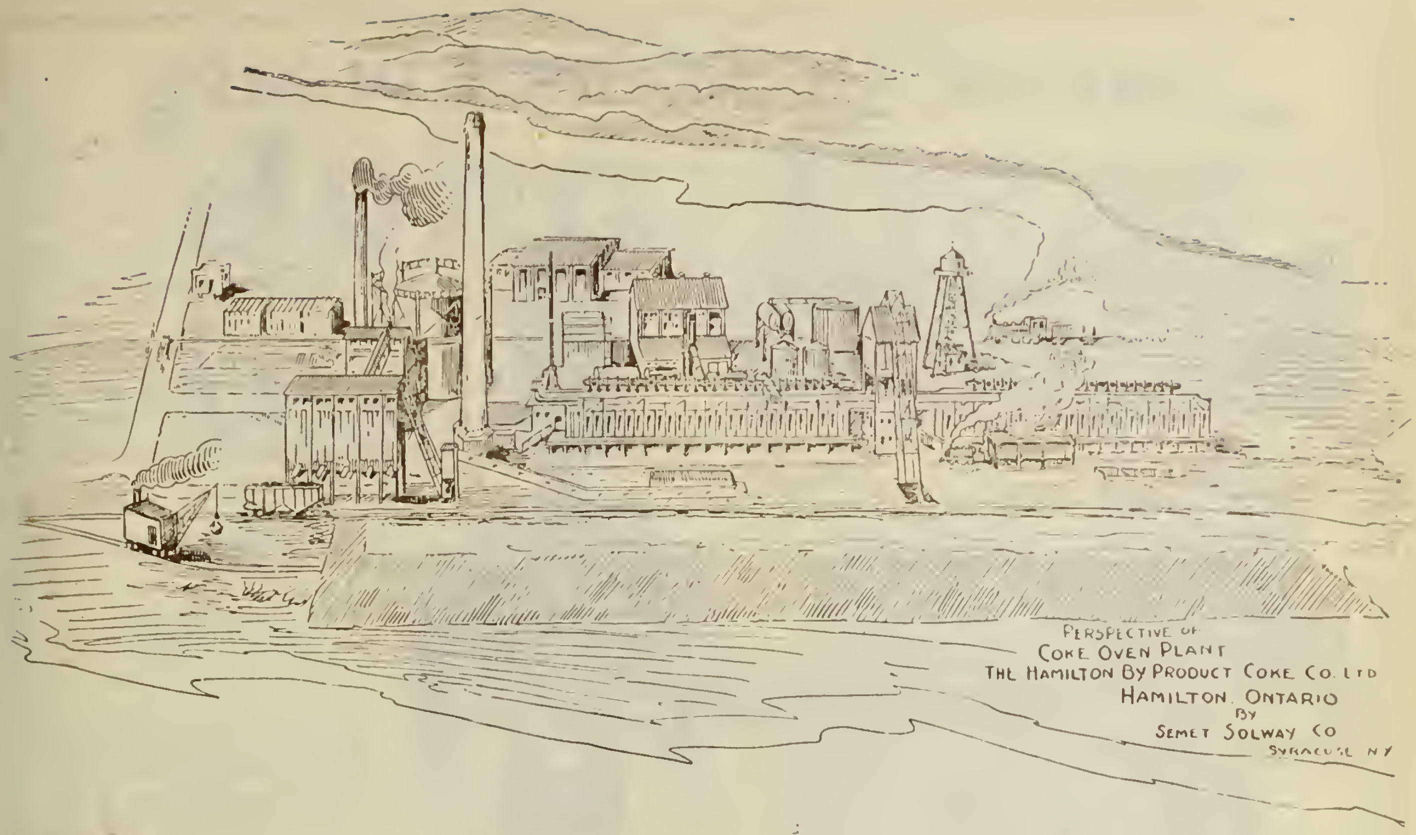
Inglis Two-Stage Centrifugal Pump

First-class Inglis workmanship is reflected in the Two-Stage Centrifugal Pump illustrated here. This standard type of pump is in wide use in city and town water pumping stations. It is preferred because of its unfailing service.

The John Inglis Company, Limited

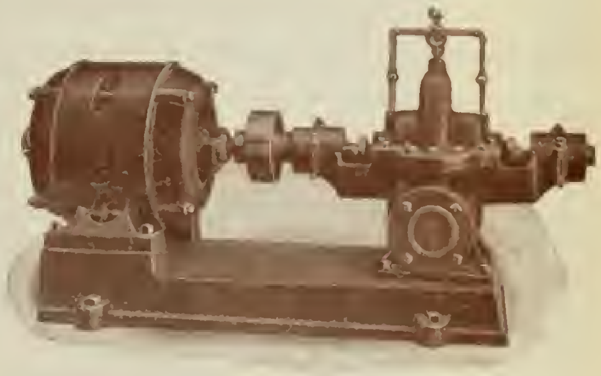
Engineers and Boilermakers

14 STRACHAN AVE. - - TORONTO, ONTARIO



Where Uninterrupted Service Counts—

THE Semet-Solvay Company, who are installing this plant at Hamilton, have chosen Smart-Turner Pumps for their work. Careful engineering investigation and practice have shown that they can be relied upon to deliver power continuously with the least attention.



A horizontally Split-Shell Centrifugal
W 243

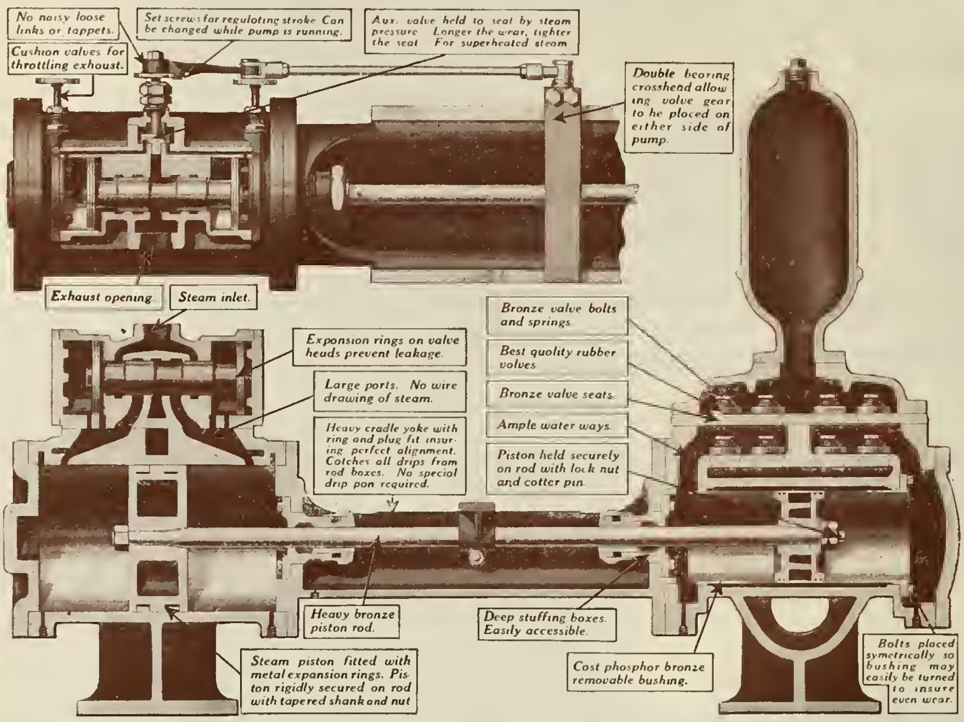
Consistently good construction makes Smart-Turner pumps dependable Servants

The Smart-Turner Machine Company, Limited

Hamilton, Canada

Representatives in Toronto, Montreal, Winnipeg and St. John

AMERICAN--MARSH PUMPS


No noisy loose links or tappets.
Set screws for regulating stroke Can be changed while pump is running.
Aux. valve held to seat by steam pressure Longer the wear, tighter the seat For superheated steam
Cushion valves for throttling exhaust.
Double bearing crosshead allowing valve gear to be placed on either side of pump.
Exhaust opening
Steam inlet.
Expansion rings on valve heads prevent leakage.
Large ports. No wire drawing of steam.
Heavy cradle yoke with ring and plug fit insuring perfect alignment. Catches all drips from rod boxes. No special drip pan required.
Bronze valve bolts and springs
Best quality rubber valves
Bronze valve seats
Ample water ways
Piston held securely on rod with lock nut and cotter pin
Heavy bronze piston rod.
Deep stuffing boxes. Easily accessible.
Steam piston fitted with metal expansion rings. Piston rigidly secured on rod with tapered shank and nut
Cast phosphor bronze removable bushing.
Bolts placed symetrically so bushing may easily be turned to insure even wear.

THE illustration tells its own story. Why the American-Marsh are the most reliable, trouble-proof and efficient pumps on the market.

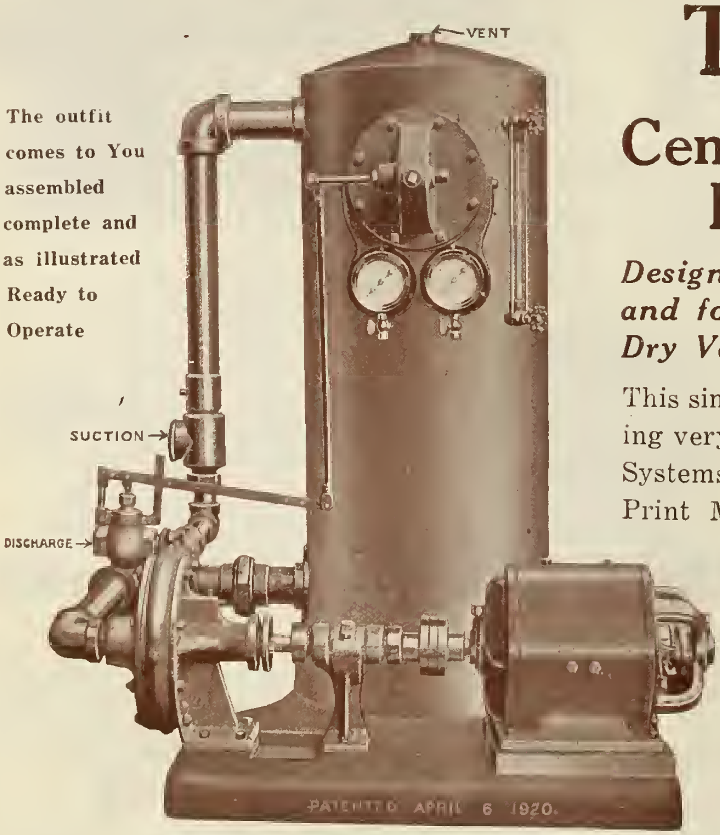
Less than one-half the wearing parts found in the duplex type while a saving of 25% in steam consumption is guaranteed.

Over 160,000 in successful operation.

Ask for catalog.

Canadian Agents: A. R. Williams Machinery Co., Ltd., Toronto and Winnipeg; Williams & Wilson, Ltd., Montreal. Bissett Pinder & Co., Edmonton. Stephens & Boyle, Vancouver. London Engine Supplies Co., London.

American Steam Pump Co., Battle Creek, Mich.



The outfit comes to You assembled complete and as illustrated Ready to Operate

The YOUNG

Centrifugal Vacuum and Boiler Feed Outfit

Designed for Vacuum Heating Systems and for All Conditions Where a Wet or Dry Vacuum is Desired—Highly Efficient

This simple, inexpensive and noiseless outfit is giving very satisfactory results with Vacuum Heating Systems, Dry Kilns, Paper Driers, Feed Driers, Print Mills, Cooking Apparatus, Vacuum Pans, etc., for the purpose of effecting a saving by returning the condensate for boiler feed.

Manufactured in Canada by

Young Pump Co. of Canada
96 Mary Street
HAMILTON, ONT.

A COMPLETE SERVICE IN

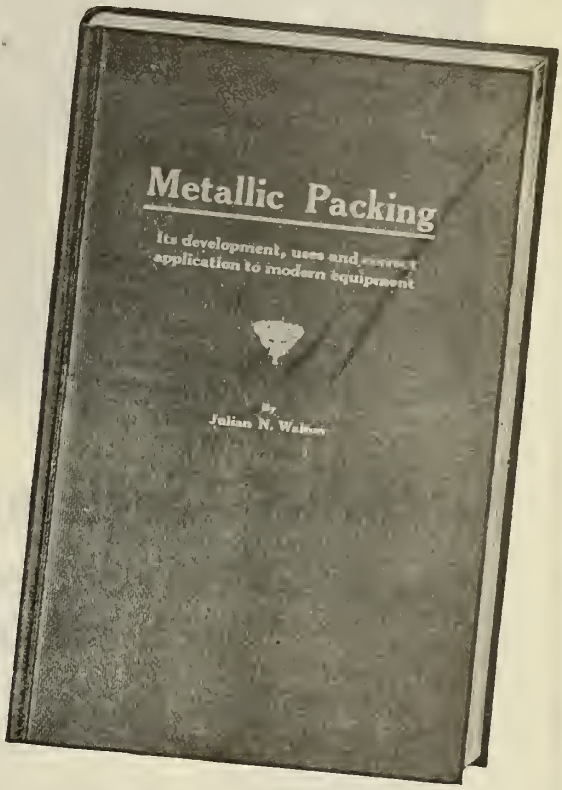
"John Crane"

FLEXIBLE METALLIC PACKING

"Metallic Packing"

1923 Edition

Revised edition covers the entire subject of metallic packing from the standpoint of the engineer, with valuable data, charts and convincing facts. Illustrated in detail. Its purpose is to show the superior value of John Crane Metallic Packing and to do this no question has been left unanswered.


Metallic Packing
Its development, uses and correct application to modern equipment
By
Julian N.

Ask for Your Copy at Our Booth

Exhibit in charge of "Beldam's Asbestos" Toronto Jobber

We especially invite every engineer to obtain his complimentary copy at the convention. If you are not going to attend, write for a copy.

Flexible Metallic Packing Co.,

Windsor, Ontario, Canada

TORONTO	MONTREAL	HALIFAX	VANCOUVER	St. JOHN, N.B.,
Beldam's Asbestos	Beldam's Asbestos	Stairs, Son & Morrow	H. E. Carman	Atlantic Ship Chandlery

In United States—Crane Packing Company, Chicago.

"John Crane" Special Ammonia Packing

The channels act as wipers, preventing the ammonia film from escaping to the outer air. The babbitt face is non-abrasive and keeps rods in excellent condition. Change to John Crane Style 104 Special. It will well repay you.

Style 100—Babbitt foil, impregnated with purest graphite. Compressible. Flexible.

+

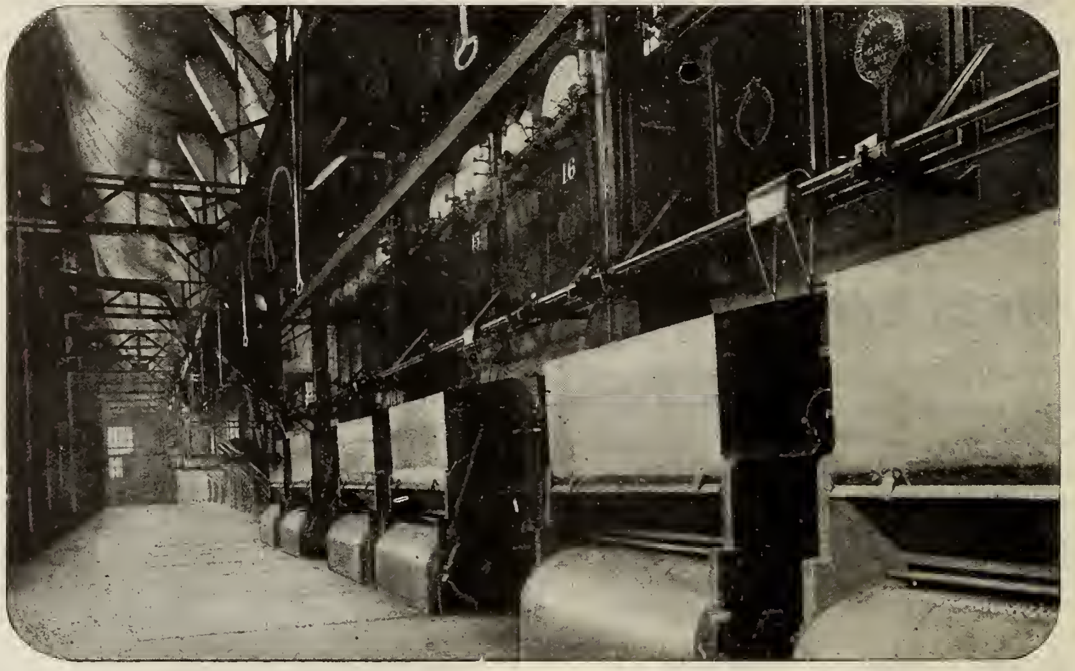
Style 400--Resilient duck channel. Metallic face

=

Style 104 Special Alternate rings of styles 100 and 400, providing metallic low friction wearing face. Channels wipe rods free of ammonia film. In sets as shown or cut from spirals as you need it.

Goldie & McCulloch

Dependable Power Plant Equipment



G. & McC. Sectional Water Tube Boilers

Every Part Subjected to Steam Pressure is Made of Forged Steel

This important feature of the design and construction of G. & McC. Sectional Water Tube Boilers give them a great advantage over all types of ordinary boilers. Other features of these boilers include large steam and water drums and connecting nipples of increased size, thus providing greater combustion area and increased steaming capacity.

Complete Information Promptly Supplied.

THE GOLDIE & McCULLOCH CO.,
LIMITED.

Head Office and Works: GALT, ONTARIO, CAN.

TORONTO OFFICE: Suite 1101-2 Bank of Hamilton Bldg.
WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

QUEBEC AGENTS: Ross & Greig, 400 St. James St., Montreal, Que.
BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B. C.

POWER HOUSE

ESTABLISHED 1907 *Toronto, June 20th, 1923* A SEMI-MONTHLY NEWSPAPER

Power Plant Efficiency Dependent on Engineer

By MELVERN F. THOMAS*

Although Good Boilers, Auxiliary Equipment, Draught and Fuel Are Essential to Secure Economical Results, in the Last Analysis the Man in Charge is the Decisive Factor

THE actual service and efficiency of a steam plant is dependent upon the engineer in charge and the men under his direction.

This statement is probably true in most branches of industry, but the purpose of this article is to discuss the relation of the engineer and his assistants to the service rendered by their plant.

If the design and construction of the plant is correct for the service required, it is the duty of the engineer to maintain the apparatus in good condition, operating only the parts necessary to supply the demand.

If the construction of the plant is not suitable to the service required, it is the duty of the engineer and his assistants to put forth their best efforts in operating the equipment to the best advantage without allowing their zeal to condone unsafe conditions that would endanger the lives of themselves and others.

Depends on Engineer

The owner of the average steam plant is dependent upon the engineer for recommendations as to the equipment required from time to time for improving the efficiency of the plant and replacing obsolete or worn out apparatus. To know what is required, and what can be installed as the best paying investment, an engineer must be constantly studying the requirements of his particular plant. He must know what other engineers in similar plants are doing and how and why they are doing it. He should keep up with the "times" by reading technical newspapers and by contributing articles on the operation of steam plants and steam plant equipment.

The engineer is more valuable to his employer if, when a certain piece of equipment is required for efficiency he can advise as to its suitability for his plant, not merely state that the new device seems to be O. K. in another part of the world where conditions may be entirely different, and where coal may cost only half what he pays for it.

Produce and Use

There are two branches of service in the modern steam plant,—one being to produce steam and the other to use it. To secure the highest efficiency, naturally, the problem is to produce the greatest amount of steam at the smallest cost for fuel, labor and overhead and to use the least possible amount of steam to supply the demands of the service.

On the eve of the C. A. S. E. convention in Toronto, Melvern F. Thomas is pre-eminently fitted to decide the dependency of efficiency in the power plant on the operating engineer. Himself one of the foremost consulting engineers in the Dominion, his experience and power of analysis has put within his grasp the solution of hundreds of the biggest power plant problems in Canada, such as the C. P. R. building, Toronto; the Massey-Harris plant at Brantford; the Queen's University plant at Kingston; and the Parliament Buildings at Ottawa. As past president of the Ontario section A. S. H. and V. E., his comment on the value and importance of the engineer in effecting combustion efficiency is worthy of the most serious attention of all Canadian executives.

To secure high efficiency in the production of steam requires good boilers, furnaces, draught and auxiliary equipment, suitable fuel, and operating men who will work together as a team.

To save coal it is vital to watch "the 7 keeps."

KEEP boilers clean outside and inside so that they will absorb the heat generated in the furnaces.

KEEP brick settings and baffle walls tight to keep out cold air and to prevent the hot gases from short circuiting and wasting heat up the chimney.

Watch Air Holes

KEEP the furnaces and grates or stokers in good repair and watch for air holes in coal bed and the waste of coal through the ash pit.

KEEP dampers adjusted to give the amount of draught required by the load. Too much draught means too much air passing through boilers and too much heat carried up the chimney. Draught reduced too low will impair the capacity of the boilers and cause furnace walls and arches to burn out.

KEEP high load on boilers by "cutting out" units when not required. Overloads on clean boilers, properly set, will not reduce efficiency or injure equipment, while underloading usually results in low efficiency.

KEEP sufficient help to properly operate and maintain the plant.

To Cut Overhead

KEEP down overhead expenses by not installing superfluous apparatus, but avoid the other extreme of insufficient capacity which results in heavy costs of cleaning and repairs made during holidays and nights.

It is the engineer's duty to operate the steam generating plant as a department of the manufacturing plant and supply the raw material, "steam," at the lowest possible cost, thus doing his part to conserve Canada's limited supply of imported coal.

The distribution and use of steam may also be under the supervision of the engineer, or if this is not practical in a particular case, he should be in close touch with those who control the use of steam and should be prepared to give to the "office" a statement of the quantity supplied to each department of the plant.

---

*Consulting Engineer, Toronto, Ont.

Do not let any department consider the steam supply as "free air" which can be "turned on" and forgotten.

The steam generated in the boilers is generally used in one or more of the general services of power, industrial service and heating.

While the steam used for power is of first importance in large stations; it is not considered within the scope of this limited discussion.

Losses Continuous

The industrial steam includes all services throughout the factory, where it is used in the process work either as high or low pressure. This service is usually "on" whenever the factory is running and the losses are continuous.

The piping to distribute steam for industrial purposes is often altered and temporary branches installed to supply new or re-located apparatus. This piping may never have met the covering man, and it will surprise industrial executives to know how much heat can be wasted by bare pipes.

For example, how much heat is wasted (and coal required to produce it) in one year of 300 days of 10 hrs. from 100 feet of 2-in. uncovered pipe, under steam at 50 lbs. gauge pressure, located in a building where the temperature averages 68 deg.?

The surface of this pipe is 60 sq. ft., and the difference in temperature between the pipe and the air is 230 deg. The heat loss will be a little more than 1 boiler horsepower, which during the year will waste 6 tons of coal.

From 4 to 5 tons of this coal could be saved by proper covering.

The engineer should watch all alterations to steam piping in the system and make sure that any unused pipes are cut off and that those under steam are covered. Bare pipes in the industrial steam distribution system not only waste coal but the condensation interferes with the flow of the steam, reduces the capacity of the piping and frequently causes leaks at joints.

Steam Traps Vital

The water from steam condensed in the piping and in steam-using equipment must be removed, and steam traps installed to prevent steam from escaping with the water. The engineer should have all steam traps inspected frequently and defective ones repaired at once.

There is no apparatus in use in a steam plant that is so often found defective as the steam trap, which leads the writer to conclude that many engineers do not fully appreciate the heat loss and trouble with return piping due to defective steam traps.

Condensate from the piping and process work should be returned to the boilers, wherever it is practical to do so, since it still contains from 10 to 15% of the heat of the steam from which it was condensed and is free from boiler scaling ingredients.

Our climate requires buildings to be heated 6 to 7 months of the year, low-pressure steam with direct radiation being largely used for this purpose.

With such systems the greatest difficulties are:

Removal of air from the piping and radiation.

Removal of water from the piping and radiation.

Control of the steam to give the amount of heat required without waste.

Reclaiming the hot water from condensed steam.

Obtain Best Results

The air and water must be removed from the system before steam can fill the radiators and give the full value of the heating surface. Either air or water collecting in the mains or branch pipes will interfere with the circulation of the steam and reduce the capacity of the boilers by necessitating an increase in pressure.

In a properly constructed heating system only a few ounces of steam pressure above that of the atmosphere is required to secure complete circulation through all the radiators.

If the engineer can heat all parts of the building evenly in a short time after "turning on" the steam he can then cut off the steam or greatly reduce the pressure on mild days.

Factory heating plants are designed to heat the buildings in the coldest weather; in the vicinity of Toronto there should be capacity to warm the building to 68 degs., with the outside temperature 15 degs., below zero, but the average through the winter months requires less than half this capacity.

The following tabulations give the average temperatures and percentages of the maximum load for the six winter months.

	Average Temperature	Degrees Rise to 68°	Per cent. of maximum load (15° to 68°)
Nov.	37°	31°	37
Dec.	28	40	48
Jan.	22	46	55
Feb.	21	47	57
March	29	39	47
April	42	26	31

The average heating load may be obtained from the last column, and during the season, it is only 46 per cent. of the maximum heat required to warm the building to 68° when the outside temperature is 15° below zero.

Big Steam Saving

If the engineer can arrange to cut off the steam from the radiation not required, there will be a saving of 40 per cent. to 50 per cent. of the steam that would be condensed if all the radiation is kept in service throughout the season.

An example, to reduce this possible saving in coal consumption, may give the importance of regulation a more definite meaning.

Suppose 1000 sq. ft. of radiation is filled with low pressure steam for six winter months. It would condense about 1,100,000 lbs. of steam which in an ordinary plant will require 60 to 70 tons of coal. The possible saving by properly controlling the steam supply is nearly half of this fuel.

If excess radiation is not cut off in mild weather, windows will be kept open more than necessary for ventilation, and the engineer will find his plant consuming coal to heat the outside atmosphere.

The engineer should insist that all condensed steam be returned to his plant to give hot water for feeding the boilers. Boiler feed water at 170° instead of cold water at 45° from the city mains will give over 10 per cent. saving in coal.

Traps Source of Loss

A common loss in steam plants is steam escaping through traps, especially those on high pressure piping, and by looking at the trap it will often be found that the steam passing through the trap overheats the water in the return system, escaping through vents from the receiving tank, or interferes with the condensation draining from the piping causing trouble with the pumps which is concealed by cold water being introduced.

This condition often results in a constant flow of hot water running to the sewer.

Do not allow any hot water to escape if you wish to save coal!

While the engineer and his assistants should consider themselves responsible for the service and efficiency of the steam plant, they must have constant co-operation from the owners or others in charge of the plant if satisfactory service is to be obtained.

The horsepower constant is the number of horsepower per pound of mean effective pressure developed by an engine when running at its normal speed. It will be different for different speeds. Knowing the constant, one need only multiply the mean effective pressure (obtained from an indicator diagram) by this constant to know what indicated horsepower the engine is developing. Evidently by the definition, the horsepower constant is all of the "PLAN" formula except the P.

A brass polishing paste, said to give satisfactory results, is composed of camphor gum, 1 oz.; alcohol, 2 oz.; spirits of ammonia, 2 oz.; spirits of turpentine, 4 oz.; candle paraffin, 1 lb; clean tallow, 1 lb.; tripoli, 1 lb.. For compounding, first dissolve the camphor in the alcohol, then melt down the tallow and paraffin and stir in the liquids and the tripoli. Before cooling, the paste may be packed in boxes of sizes convenient for use.

Utility of the Modern Pump in the Power Plant

By ARTHUR MURPHY

A General Description of the Characteristics of the Better Known Types, With a Few Pointers on Their Maintenance and the Modern Tendency Toward Auxiliaries

IN DISCUSSING the relative value of the many different types of pumps found in the modern power house in Canada, it is interesting to note that one of the first pumps on record was made in 1675. In that year Sir Samuel Moreland was decorated by King Charles the Second for demonstrating a "certain powerful machine to raise water."

Twenty-four years later Savery exhibited before the Royal Society of England a model engine, which consisted of two copper receivers alternately connected by a three-way hand operated valve. When the water had been driven out by the steam, cold water was poured over its outer surface creating a vacuum through condensation and causing it to fill again while the water in the other reservoir was being forced out. The modern pulsometer used for pumping dirty and abrasive liquids, where steam consumption is ignored, is in principle similar to Savery's engine.

Thomas Newcomen in 1690 invented an engine in which the steam was admitted from the boiler to a cylinder, raising a piston by its expansion, assisted by a counterweight on the other end of the beam actuated by the piston. The steam valve was then shut and the steam condensed by a jet of cold water, creating a vacuum in the cylinder, atmospheric pressure forcing the piston downward.

This type of pumping engine with automatic control of the valves, was in common use by 1725, and changed in form but little for seventy years, until James Watt separated the steam cylinder from the condenser.

From Watt's time until 1850, the steam driven pump made but slow progress, low pressures and slow speeds being used. As late as 1859 the city of Hamilton installed two vertical beam compound condensing engines directly connected to plunger pumps, using steam at 30 pounds pressure and exhausting to a 24 inch vacuum.

The flywheel alone on each engine weighed 24 tons, the complete unit standing over 51 feet high, with a capacity of 1800 gallons per minute.

A modern centrifugal unit with a capacity of 20 million gallons a day, occupies a floor space of 20 feet by 8 feet, with less than 7 feet in height.

Centrifugal More Recent

The first application of centrifugal pumps was made by Denis Papin in 1703. Over fifty years later Euler took up the problem.

In 1818 a volute pump known as the "Massachusetts" was brought out, with double suction openings and an open impeller. This was improved by R. Carthy in 1830.

In 1901 a single stage pump was constructed with backward curved vanes, discharging through a series of diverging guide passages into whirpool chamber of ordinary form. Efficiencies of 48 per cent. were obtained.

The different types of pumps which find favor to-day may be divided roughly into two main divisions: Reciprocating, including direct acting steam, crank and flywheel; plunger and pistons types; and the rotating type, including Roots type, gear pumps and centrifugal pumps.

The reciprocating pump consists of piston or plunger fitted to a cylinder and provided with suction and discharge valves. This is the oldest form of pump and to-day finds use around the power plant for pumping water, boiler feed work and in many cases for pumping oils, both lubricating and for servo-motors or operating cylinders on turbines.

Slip Reduces Efficiency

This type of pump has a constant displacement, that is the quantity of water discharged is practically the same as the plunger displacement, the slight loss of capacity being due to defective packing, leaking pistons and stuffing boxes, or delayed closing of the suction and discharge valves.

Fig. 2—Vertical Pump.

This loss, called "slip," is stated as loss in percentage of the displacement, or expressed as (1-Ev) where Ev= volumetric efficiency.

In new pumps the slip is small, rarely exceeding 2 per cent. in plunger and ring types, in slow speed outside packed plunger pumps with no leakage past the plunger it may be even less.

Excessive slip of 5 per cent. or over is an indication of leaking piston or defective valves. The hydraulic efficiency is high, the only losses being due to friction in the valves and water passages, the mechanical efficiency may be low, due to frictional losses if the packing is excessively tight.

Packing Kept Tight

A cross section of a direct acting steam pump is shown in Fig. 1. This is an outside centre packed plunger type used widely for boiler feed purposes. The valve arrangement and the air chamber necessary on all pumps with plungers are shown. The advantage of this pump lies in the fact that leakage can be kept to a minimum since any loss is to the outside.

The single acting pump is not as steady in speed as the duplex. The direct acting steam pump is simple, low in cost, requires little attention in service, and is remarkably flexible, a great range of capacities, and heads being ob-

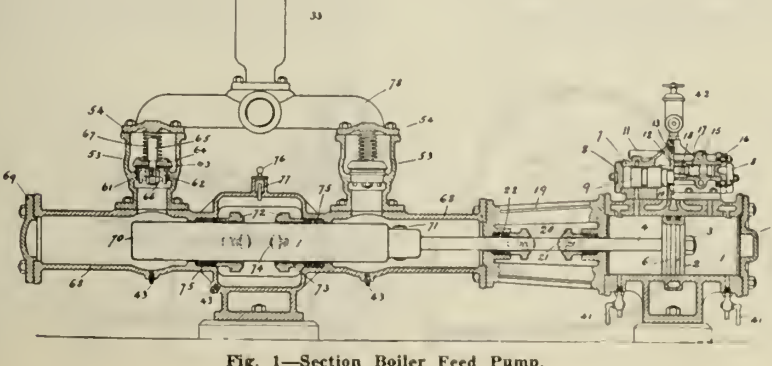


Fig. 1—Section Boiler Feed Pump.

tainable simply by controlling the steam with a throttle. It is built in capacities from 1,000 pounds to 350,000 pounds per hour, with speeds ranging from 30 to 70 strokes per minute.

The direct acting duplex steam pump gives a steady flow and requires small air chambers. The valve on one side is actuated by the motion of the piston rod on the other side, resulting in equal speeds for both sides and smooth, continuous operation. This type is sometimes made in compound and triple expansion.

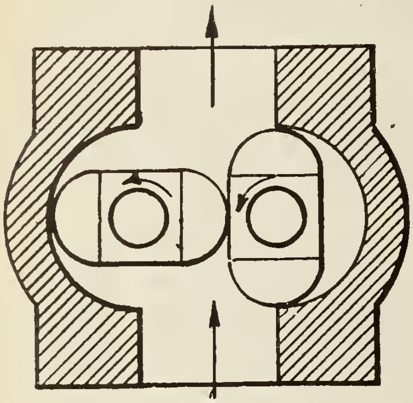


Fig. 3—Roots Pump.

The direct acting pump is used for high pressures, 3,000 to 10,000 lbs. per sq. in., because of the ease of control, a rod from the accumulator to a valve serving equally as well as complicated control mechanism, in regulating the speed.

In places where floor space is at a premium the vertical direct acting steam pump illustrated in Fig. 2 finds favor as well as being useful for deep well and mine use.

In mines it is customary to place the suction and the discharge pipe in the vertical line, the pump being raised and lowered by means of a cable as the level of the water changes.

Find Use as Vacuum Pump

The direct acting steam pump is also widely used for vacuum service, the difference between it and the general service pump being in the diameter of the cylinder and the modifications of the valves. For vacuum pumps the water cylinders are much larger than the steam end, the valves having much lighter spring tensions.

For boiler-feed pumps the plungers are about 1-3 the size of the steam cylinders; below 150 lbs. pressure pistons are used, above 150 lbs., outside packed plunger pumps find favor.

The direct acting steam pump has some disadvantages, including slow speed and the difficulty of regulating the length of the stroke. Speed is usually controlled by manual operation of a valve on the steam line; every pump, however, should have a speed regulating device which will prevent racing when the vacuum in the suction line is destroyed or when the inlet valve sticks open.

Steam consumption may be high in the simple direct acting pump, sometimes up to 200 lbs. per h. p. hour. Cut-off being at the end of the stroke advantage cannot be taken of the expansive force of the steam.

Exhaust Heats Feed Water

This, however, for boiler feed work may not be any disadvantage, if all the exhaust steam be used for feed water heating.

A few hints on operation of direct-acting pumps may be of service to the engineer; not that he is ignorant of them, but it seems to be a chronic habit in some plants to pay all the attention to the large units and think of the auxiliaries only when they fail to work —much the same attitude taken by the general public toward public utilities such as electricity and water—to be thought about only when some accident temporarily deprives them of the luxury.

The writer has been in plants where the boiler feed pumps would not operate till the steam pressure was over fifty pounds; on loosening the packing they worked quite satisfactorily on much less pressure.

Pumps Require Care

Make sure that there are no leaks in the suction side of the pump; if any air leaks, the pump will not operate properly, sometimes not at all.

The economical operation of a pump depends to a great extent on the kind and condition of the packing in the stuffing boxes and pistons, its quality, adaptability to the particular requirements, and method of placing in the stuffing boxes and plungers.

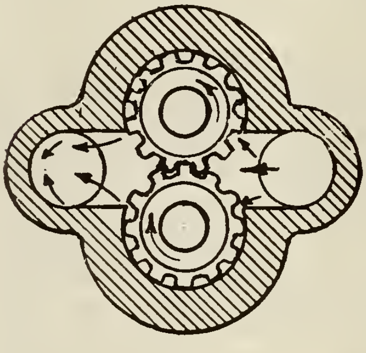


Fig. 4—Gear Pump.

A number of narrow rings are better for packing than a few wide ones. The rod should be kept tight with the least possible pressure on the packing.

When cutting packing rings, the length should be such that the ends do not come together within ⅛ inch. When put in the stuffing box, rings are put in with the joint broken, preventing leakage through the spaces.

Tighten packing only sufficiently to stop leaks; a slight leakage at the water end is not harmful.

A little cylinder oil and graphite applied to the rod will keep it smooth and bright, a condition favorable to durability of the rod and packing.

Pumps should be kept clean internally and externally.

The water end stuffing box of a pump may be lubricated by putting a heavy grease on the piston rods, or a good cylinder oil may be used. Some of the grease works into the stuffing boxes and furnishes better lubrication than can be secured by water alone. Care must be taken not to use too much oil as it must not go beyond the stuffing boxes and contaminate the water.

When one side of a duplex pump makes a quick stroke it indicates either that the stuffing box gland of the opposite side is too tight, or that the packing in the cylinder of the side making the quick stroke is wearing out or has perhaps given away. A broken discharge or suction valve will also cause a jerky motion of the pistons.

The regular inspection of the screen in the separating chamber in the suction pipe renders frequent inspection of the interior of the pump unnecessary.

When a pump has to run faster one week than another in order to supply approximately an equal supply of water, the plunger and valve should be examined because such a condition indicates leakage.

When a pump fails to lift water after standing some time it should be primed by filling the barrel with water and starting it slowly. If it stills refuses to raise water the suction pipe, valves and plungers should be examined. If the packing is dry and hard, air will leak into the pump and it will not work properly. The packing should be well soaked first and if it does not soften, be replaced with new.

Pumps that are exposed to low temperatures in winter should be provided with removable drain cocks or plugs, for emptying cylinders and valve chambers of water, also allowing the water to flow out of the suction pipe.

Stoppage of the suction pipe or chambers is generally indicated by a jerky action or pounding of the plungers or water pistons; on the other hand, a

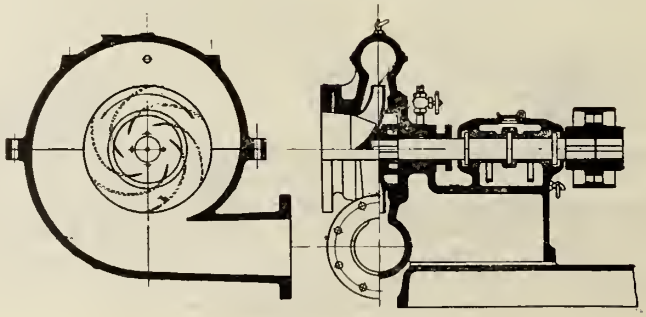


Fig. 5—Single Stage Pump.

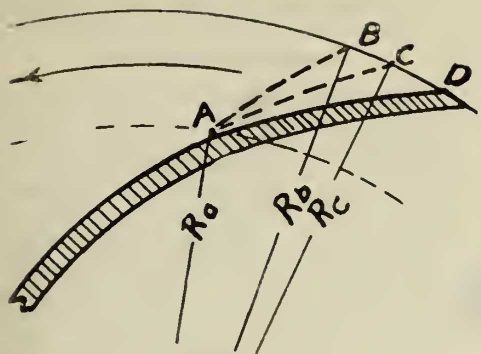


Fig. 6—Impeller Tip.

dull thud at the end of the stroke is often due to lack of air in the air chamber, or when the speed is high, its lack of capacity in the air chamber.

The steam end should be lubricated with good cylinder oil and given the same care as any engine.

Pumping Hot Water

It is difficult to lift hot water any great height by suction because of the fact that water boils at lower temperatures with decrease in pressure, releasing vapors which destroy the partial vacuum produced by a pump. For this reason any pumps handling hot water such as boiler feed pumps, should be arranged if possible so as to have the water delivered to them under pressure, or if not, to have a very short lift.

Crank and Flywheel Economical

The crank and flywheel pump may be considered to be a direct acting type with the addition of a balance wheel, driven by steam, electricity, internal combustion engine or in some cases by hydraulic turbines.

The advantages of this type over the direct acting, when using steam as motive power are many, such as steady running, uniform discharge and decreased steam consumption due to early cut off. The stroke being constant, the discharge may be approximated by counting the number of strokes and allowing a small loss due to "slip."

The large triple expansion high-duty plunger pump is used largely in water works especially in districts where electric power is not available and steam is used. It is capable of high duties, is reliable and will last for years. The valves used in this type are of rubber between three and five inches in diameter, the four and a half inch size being common, placed in valve decks in order to get a sufficient number in a small space, a large pump having several hundred valves.

A triple expansion pump in the John Street Pumping Station in Toronto, showed an overall efficiency of 96 per cent. indicated water horse-power over indicated steam horsepower.

The rotating type of pump is made with two rotating elements called pistons, impellers or lobes. The impeller is made with one or more teeth designed for continuous contact at a uniform velocity. In the Roots rotary pump shown in Fig. 3, there are but two teeth with two rotating elements rolling together as shown by the arrows. Water is trapped between the lobes and the pump case and is forced to the discharge side; the contact of the impeller at the centre preventing water returning to the suction side. The discharge is continuous but not uniform, hence air chambers are necessary. These pumps are built for heads from 10 to 200 feet, with claims for efficiency from 75 to 85 per cent.

Another type of positive displacement rotating pump is made with one rotating element eccentrically located in the casing with 3 or 4 packing blades, which are free to slide radially in the rotor. The discharge is uniform but the speed is limited and the slip may be considerable.

Used for Fire Pumps

The gear wheel type is shown in Fig. 4, the arrows indicating the flow of liquid and the direction of rotation of the gears. This type may be run at high speeds with volumetric efficiencies, if not badly worn, of from 90 to 95 per cent., the overall efficiency varying from 50 per cent. for small pumps to 70 per cent. for large, capacities going from ⅛ to 60 gallons per minute.

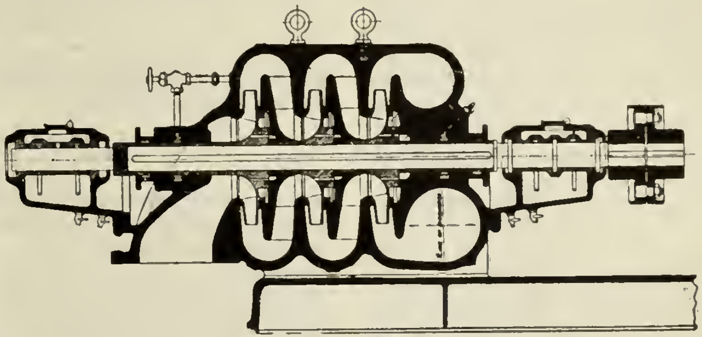


Fig. 8—Three Stage Pump.

The modern gasoline fire truck is often equipped with a gear pump. They also find a place around power plants for pumping oils.

Centrifugal Pumps

Low pressure up to 50 feet.

Medium pressure.

High pressure.

Vertical shaft. Horizontal shaft.

According to the number of inlets per impeller:

(a) Single entry; (b) Double entry.

According to the type of impeller.

(a) Radial discharge; (b) Backward discharge; (c) Forward discharge.

Number of stages:

Single stage—one impeller.

Multi-stage—two or more impellers.

The centrifugal pump consists of an impeller or impellers mounted on a shaft and surrounded by a spiral casing or discharge vanes and spiral casing. The rotating impellers due to centrifugal force increase the velocity of the water passing through; the discharge vanes, if present, and the spiral casing change the kinetic energy of the water leaving the impeller, into static head.

When the discharge vanes are present it is customary to call it a turbine pump; when only a spiral casing, a centrifugal.

The present tendency is toward the elimination of the discharge vanes, decreasing the cost of manufacture and giving a pump which retains high efficiency over a greater range of capacity. The highest efficiency ever obtained in this class of pump was made without the discharge vanes.

Impeller Important

Upon the design of the impeller probably rests the success or failure more than on any other part of the pump. Impellers are of two general types—open and closed.

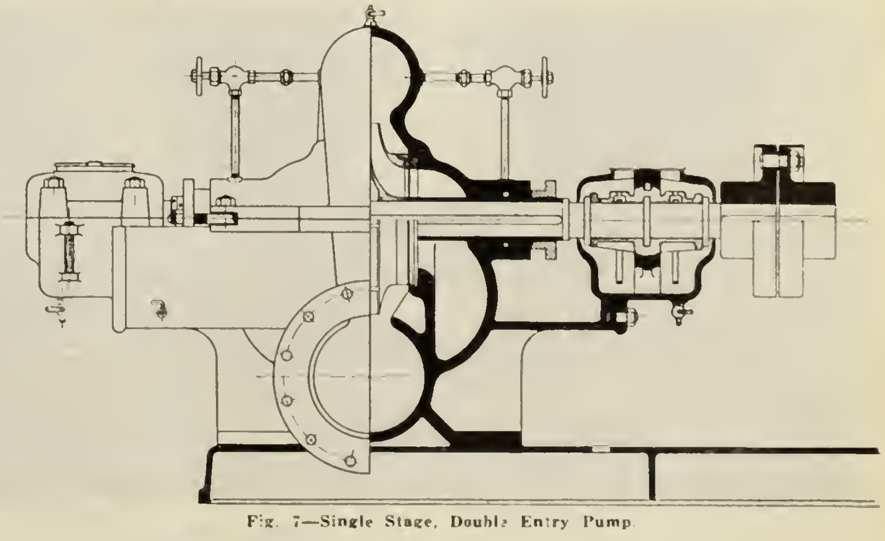


Fig. 7—Single Stage, Double Entry Pump

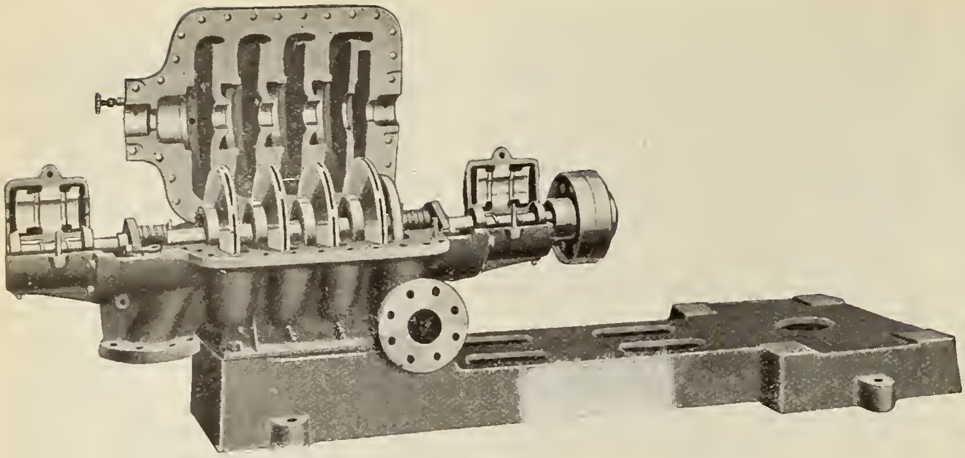


Fig. 9—Four Stage High Head Pump.

In the closed type the blades and sides are in one, in the open only the blades of the impeller are present, the casing serving as sides to guide the water.

On account of the increased leakage in the open type the trouble in keeping the impeller in its correct position and the higher frictional losses, this type has been replaced by the closed type.

The periphery of the impeller must run at such a speed that the water at exit has sufficient velocity, which on being turned to pressure in the spiral casing, will give the desired head.

Impellers should be smooth in the water passages to cut down frictional losses. In pumps for high heads and small volumes, the water passages become so narrow that it is difficult to cast them. Built up impellers are then used.

The exit and entrance angles of the impeller blade must be carefully designed, more especially the entrance. The shape of the blades between entrance and exit being of less importance as long as it is a smooth curve. The ends of the blades should be sharpened, cutting down eddy losses.

A single stage, single entry pump is illustrated in Fig. 5, the suction pipe entering at the side. With the single entry impeller there is always a heavy thrust toward the direction of the entering water. In this illustration the thrust is toward the left, requiring a substantial collar on the shaft or a thrust bearing. Thrust bearings should be water cooled or overheating will result.

On account of this feature single entry pumps are now made only in the smaller sizes, or when initial cost does not warrant much outlay such as in rough construction work, and temporary installations. The double entry impeller is free from this heavy thrust, but in order to centre it, and to take care of any slight unbalanced thrust, in the larger types it is customary to use a marine type thrust bearing. Ball thrust bearings have been used in some pumps with good results.

Cavitation and Erosion

Bad design and improper speeds result in speedy destruction of the impeller, due to cavitation. Impellers have in some pumps lasted but a few weeks, having the appearance of a sponge in places. This trouble is more pronounced in small capacity pumps in which too high a lead is attempted in one stage. Erosion is due chiefly to impurities in the water.

In the centrifugal pump there is danger of the power increasing to a point that would seriously overload the motor or the turbine should the head for any reason fall off and the discharge increase. To prevent such a condition, impellers are made with a non-overloading feature which prevents the power rising above a certain point regardless of the discharge, in some cases the power drops off with increase of capacity.

Overloading Prevented

This non-overloading feature is secured by flattening the angle of the blade tips. Referring to Fig. 6 suppose at A a small particle of water is moving along the blade to the periphery of the impeller and that it then follows the path AC. If the velocity of the water from A to C is such that the point D on the periphery of the impeller has travelled from D to C in the same time, the tip of the blade from A to D then has exerted no pushing action on the water, thus no more power is taken.

The net effect is the same as if the diameter of the impeller had been reduced from Rc to Ra. Suppose that a particle of water is travelling along the path AB and that in the same time the point D on the impeller has reached C. The power taken would then be less than in the first case mentioned, for with such an impeller the power required drops off with increase in capacity.

For these reasons a centrifugal pump should always be started with the discharge valve closed and opened slowly to the point giving the required discharge, otherwise serious overloading of the motor will occur the instant the pump has reached its normal speed.

Short Circuits Loss Stopped

There is always a tendency for water to leak from the discharge to the inlet of the impeller on account of the difference in pressures, this loss commonly being referred to as short circuiting. To lessen this loss labyrinth is used, preventing a tortuous path to the water which, with the small clearances between the rotating elements, allows little water to escape the suction side. There is also the danger of air leaking into the pump along the shaft, destroying the suction.

A packing gland is fitted on each side and a water seal is used. In Fig. 7 these glands are shown as well as the pipe from the case to the gland to make

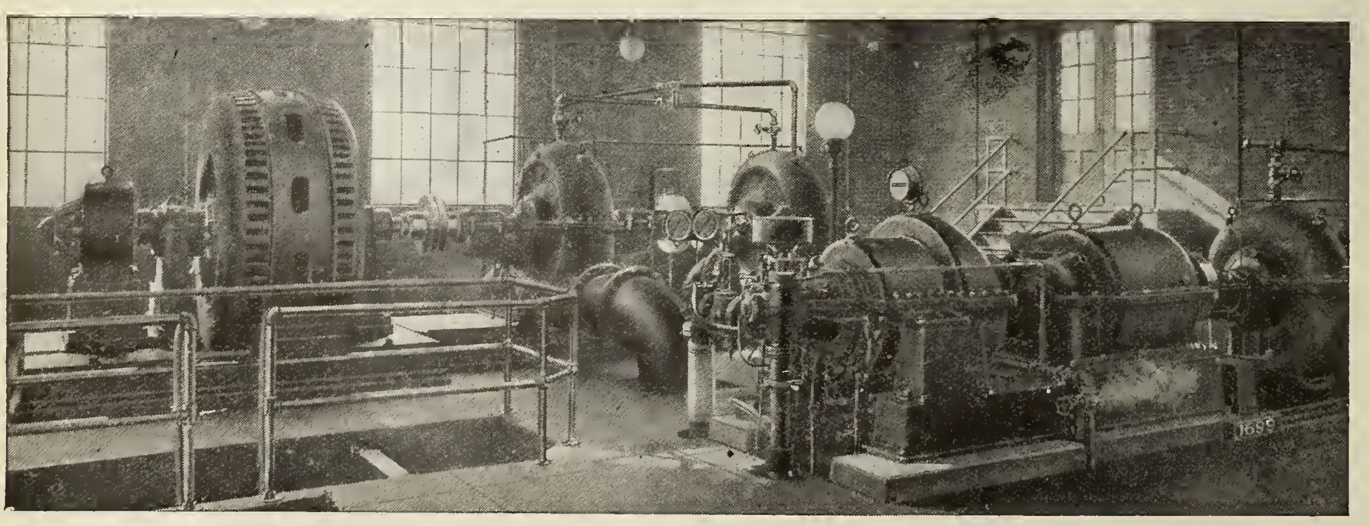


Fig. 10—Modern Waterworks Pumps.

the water seal, the labyrinth packing on both sides of the impeller is also shown.

Use Several Stages

When the head is high in comparison to the capacity, experience has shown that it is better to divide the head into two or more stages. If in a pump of small capacity an attempt be made to secure a high head with one impeller the hydraulic passages become so narrow that excessive frictional losses result, accompanied by low efficiencies, corrosion and pitting of the passages.

A cross section of a three stage medium head pump is shown in Fig. 8. The water passages are of fair size.

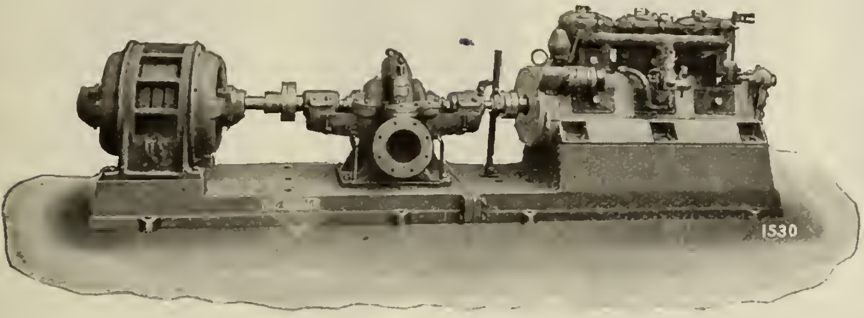


Fig. 11—Pump With Reserve Engine.

Turning to Fig. 9 we have a four stage high head pump of small capacity; 150 gallons per minute against 650 feet head. The impellers are of large diameter with narrow passages. Impellers are always single entry in multi-stage pumps.

Balance Thrust

There is considerable axial thrust to be taken care of in the multi-stage pump. In some cases this is accomplished by allowing part of the discharge pressure to act against some portion of the back of one of the impellers, using a water cushion for balancing, in other types, holes in the impeller web equalize the pressure in the space inside the labyrinth seal, clearances on the outside of the impellers are made large equalizing the pressure in the outer spaces; any small thrust remaining is taken care of by a heavy marine thrust bearing on the suction side.

Adapted to Motor Drive

The centrifugal pump owes its advance largely to the ease with which it may be adapted to drive by electric motor or the steam turbine as well as its small size for a given capacity. Motor and pump speeds are such that they may be directly connected and both run at efficient speeds. A flexible coupling is always used to connect the pump and motor shafts.

Induction motors are in wide use for this service, the synchronous motor with its high efficiency and good power factor may also be used to advantage because of the small starting torque required with centrifugal pump.

Use Reduction Gears

The speed of the steam turbine is much too high for direct connection, necessitating the use of reduction gears, the loss it is claimed being from 2 to 5 per cent. The turbine is well adapted for high superheat and high vacuum which is readily secured in water works stations making the overall efficiency of the unit high.

Fig. 10 shows two single stage pumps direct connected to a synchronous motor, in the same room may be seen a steam turbine driven pump. Fig. 11 illustrates a single stage pump with direct connected motor drive on one end and direct connected gasoline engine on the other, serving as a standby in case of failure of electrical power. Such installations find wide use in small cities and towns which have access to cheap electrical power but are not large enough to warrant building a steam plant as a standby.

Priming Necessary

Centrifugal pumps if small are fitted with foot-lift valves, to prime it is only necessary to fill it with water through an opening above the pump, or through a valve on top of the spiral casing.

Larger pumps have no foot valve, so must be primed by creating a partial vacuum in the pump. In power plants where steam is available, two methods may be used, the pump may be filled with steam which on condensing forms a partial vacuum sufficient to draw the water to the impeller or an injector may be fitted to the top of the casing, the discharge valve in each case being tightly closed. If steam is available a vacuum pump operated by hand is often used.

Fig. 10 shows two large motor driven pumps and a turbine driven unit, the steam connection to the top of each casing may be seen.

It is customary in water works plants in which steam is used as motive power to speak of the performance of the unit as duty or the number of foot pounds of work done per 1,000 pounds of steam. The efficiency is also rated in percentage.

The overall efficiency of a centrifugal pump ranges from 40 to 50 per cent., the lower figure being for small pumps running at an incorrect speed, the higher for large, carefully designed pumps in water works. The highest efficiency ever recorded for a centrifugal pump was obtained a short time ago in the John Street Pumping Station, the official test showing an efficiency of 87.2 per cent.

The duty of steam turbine driven units has reached 160,000,000 foot pounds per 1,000 pounds of dry steam.

The tendency in larger power plants when large quantities of water are being used for condensers is towards the use of centrifugals, turbine or electric motor driven. Condenser circulating pumps are low head of large capacity.

Centrifugal turbine driven boiler feed pumps are finding favor for large boilers, the exhaust steam being used to heat the feet water, the advantage being in the small size and the control of capacity. The feed water can be measured accurately with a Venturi meter when the flow is steady as with the centrifugal boiler feed pumps.

Vacuum pumps used in the larger power plants are a special adaptation of the centrifugal.

In water works stations the guides vanes have been eliminated, double entry is universal, and where high heads, two or more single stage double entry pumps are run in series, 100 preference to one multi-stage pumps.

Trade Catalogs

The Conveyors Corporation of America have just issued a handsome booklet, "Representative Installations." The booklet contains illustrations of a number of notable buildings and power plants which are equipped with the American Steam Jet Ash Conveyor.

Copies of the new booklet will be sent to any engineer who is interested.

The level fuel bed Detroit Retort Underfeed Stoker which has attracted wide attention in the power plant field, is illustrated and described in detail in the new bulletin "Built on Advanced Engineering Principles" just published by the manufacturer.

Among other subjects the bulletin covers the practical application of well developed principles in the science of combustion in the design and construction of a high duty machine to meet modern requirements for heavy overloads and severe service with large boilers.

Copies may be had by writing the Detroit Underfeed Stoker Co., 320 General Motors Bldg., Detroit, Mich.

The Jointless Fire Brick Co. are offering to engineers and power plant operators their 52 page booklet, "Modern Furnace Building."

This booklet tells the complete story of the building of monolithic furnace linings. It shows how boiler furnaces, circular furnaces, pit type brass furnaces and other furnaces may be lined with this jointless lining. There are many illustrations showing how forms for special shapes, like front door arches, are made. The chapter on the making of baffles of plastic linings is very interesting.

A post card to the Jointless Fire Brick Co., Chicago, Ill., will bring a copy of booklet to anyone interested.

C.A.S.E. Convention Opens in Toronto June 25

Advantages of Common Meeting Ground Given Engineers and Exhibitors to Promote the Maximum of Efficiency in the Operation of Power Plants in the Dominion

AT THE annual convention of the Canadian Association of Stationary Engineers, which will be preceded by the banquet of the Exhibitors' Association in the main dining room of the Hotel Carls-Rite, Toronto, Ont., at 7 p.m., Monday, June 25, unusual opportunity will be given operating engineers and exhibitors to consider mutually the part the work of each plays in attaining the maximum of efficiency in the operation of power plants in the Dominion.

It cannot be denied that a common meeting ground for engineers and manufacturers, with a frank discussion of the practical results obtained from the work of each, must prove of great value to the industrial executive, who in the last analysis, foots the fuel bills.

There is so much to be done in Canada in cheapening the generation of power; in solving the ever present fuel problem and in increasing production, if the Dominion is to win her rightful place in the competitive markets of the world, that the engineer—the most important piece of apparatus in a power plant—cannot afford to neglect the slightest improvement in methods of combustion.

The engineer who would honestly serve his employer must know an economical remedy for every power plant disease.

Faces Broad Field

The field is so broad, extending from the advisability of softening boiler feed water and selecting packing that will not harden, through such widely divergent fields as the installation of stokers and the psychology of keeping firemen contented, to the analysis of flue gases, that the man who feels he can learn nothing further is simply courting disaster.

An engineer who does not keep up with the latest practice—efficient and better ways of doing things—by attending association meetings and by studying the columns of the two publications on the American continent devoted solely to the power problems of industry—*Power House* in Canada and *Power* in the United States that he may advise his employers what to buy to obtain the most economical results,is not treating fairly the executive who is paying him.

Reference to the C.A.S.E. program at the convention proper, which begins at the Central Technical School, Harbord Street, Toronto, at 9 a.m. Tuesday morning, June 26, with the official opening of the Grand Lodge, to be followed for two days by the annual exhibition of power plant equipment, makes clear the attempt of convention officials to render available to all who attend the meeting—engineers, exhibitors, and visitors alike—the best that power plant engineering has to offer.

The speakers have been asked to avoid generalities and personalities and to follow as nearly as possible the practical treatment of their subjects.

It should be noted that the list of exhibitors includes representation from:

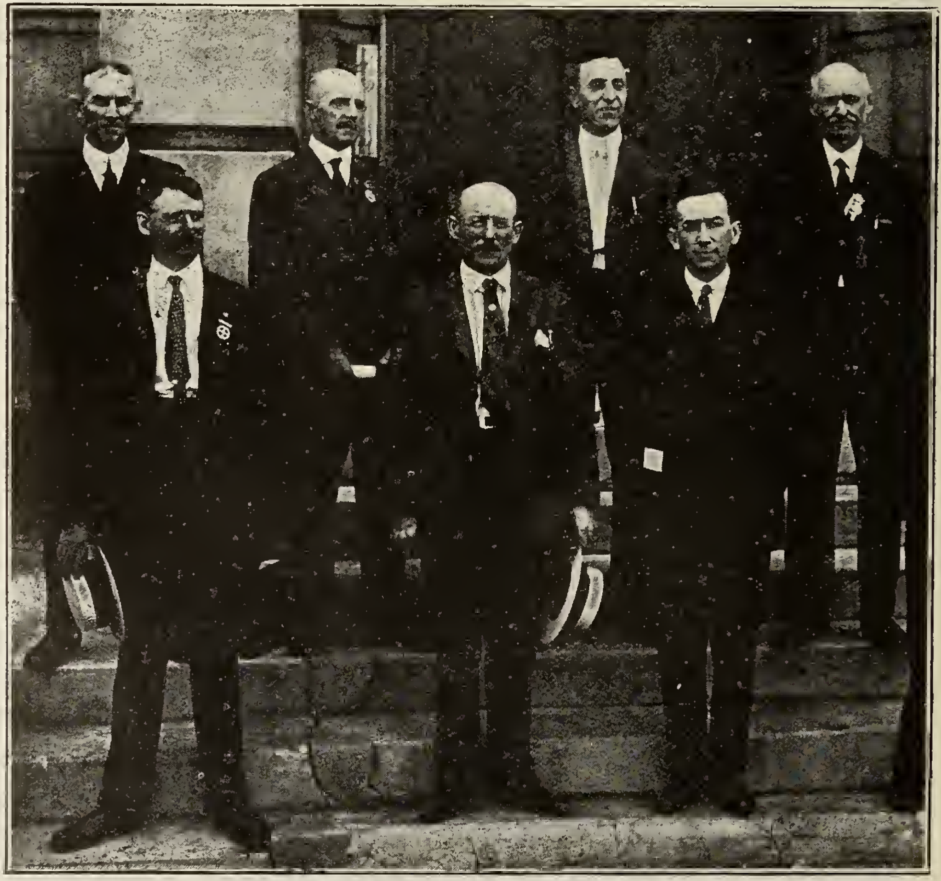
Allen General Supplies, Ltd.—fuel saving devices; The Argus Mfg. Co.—stack paints and plastic cements; Beldam Asbestos Co.—packings and grates; The Bird-Archer Co.—boiler feed water treatment; Babcock & Wilcox Ltd.—boilers; A. W. Cash Co. of Canada Ltd.—stokers; Crane Ltd.—valves; Celite Products Ltd.–heat insulation; G. E. Cole—steam traps; Darling Bros. Ltd.—pumps, heating equipment, etc.; Dearborn Chemical Co. Ltd.—boiler feed water treatment; Dart Union Co. Ltd.—unions and flanges; C. A. Dunham Co., Ltd.—radiator valves; Geo. Farrow—boiler tube cleaners; Goldie & McCulloch Co. Ltd.—boilers and engines; Imperial Oil Ltd.—lubricating oils and greases; Jenkins Bros. Ltd.—valves and packings; The Lunkenheimer Co.—valves; The James Morrison Brass Mfg. Co. Ltd.—brass goods; Magnolia Metal Co. of Canada Ltd.—bearing metals; Quaker City Rubber Co.—packing; Refinite Co. of Can. Ltd.—water treatment equipment; Shell-Bar, Boico Supply, Ltd.—feed water treatment; Stephens Chemical & Mfg. Co.–feed water treatment; Shaw Schools Ltd.—educational courses; W. R. Sexton Boiler Setting Co.—shaking and dumping grate bars; G. F. Sterne & Sons Ltd.—boiler cements; Thompson-Gordon Co. Ltd.—packings; C. B. Turner & Co.—feed water skimmers, plastic cement, etc.; W. J. Westaway Co. Ltd.—water softeners; Waterous Engine Wks. Ltd.—stokers, engines, etc.

The exhibition of power plant equipment is open to all who are interested in power plant operation.

The program for the four days follows:

Monday, June 25

7.00 p.m.—Banquet in main dining room of Hotel Carls-Rite given by the Exhibitors' Association of C.A.S.E. Following the dinner there will be an excellent program contributed by well known artists. A civic welcome will be tendered by Mayor C. Alfred Maguire of Toronto, who will formally declare the convention and exhibition open.


MEMBERS OF GRAND LODGE
Rear Row: R. E. Arnup, F. Harper, Geo. F. Galloway, and R. F. Gafton.
Front row: L. J. Ellis, Henry Wright and J. J. Sullivan.

G. C. KEITH
Secretary

EARL GORDON
2nd Vice-President

J. THOMPSON
President

HOWARD FLETCHER
1st Vice-President

GRANT E. COLE
Past President

L. M. ARCHIBALD
Treasurer

GEO. M. WILKINSON
Assistant Secretary

E. F. HETHERINGTON
Chairman Entertainment Committee

H. H. GEE
Chairman Reception Committee

C. B. TURNER
Chairman Exhibit Committee

OFFICERS OF EXHIBITORS ASSOCIATION

Jack Armour will entertain. He will be accompanied to the convention by Fred R. Low, editor of *Power*, New York, presidential nominee of the A.S.M.E.

"A big time" vaudeville act through the courtesy of Arthur Murphy, editor of *Power House*.

Brief speeches by C.A.S.E. members, including Ald. W. H. Shaw and G. J. Soucy.

Duncan R. Cowan will lead the singing with Chas. E. Musgrave at the piano.

J. Thompson, Toastmaster.

7.30 p.m.—Wives of delegates to Grand Lodge will be entertained at a theatre. Assemble at Carls-Rite before 7.30. C. B. Turner will be in charge of the party.

Tickets of Admission:

Members of C.A.S.E. in good standing will be admitted free on presentation of due card paid up to date. Tickets to others than members may be obtained from the secretary of the Exhibitors' Association or at the door of the Banquet Hall.

10.30 p.m.—Special meeting Grand Lodge Officers at Hotel Carls-Rite.

Tuesday Morning, June 26

9.00 a.m.—Official opening of Grand Lodge in Technical School Library.

Secretary Treasurer's Report.

10.00 a.m.—Official welcome to Engineers and Exhibitors by Dr. A. C. McKay; short addresses by others, R. McLaren, President Toronto No. 1 C.A.S.E. presiding.

11.00 a.m.—Official inspection of Exhibition by the Grand Lodge.

12.00 noon.—Lunch.

Tuesday Afternoon, June 26

1.00 p.m.—Grand Lodge Session. Exhibition open all afternoon.

11.00 p.m.—Tour through Technical School Mechanical Departments including Boiler, Engine, Pump Rooms, etc., conducted by M. B. Watson, director of the Department of Engineering. Mr. Watson will give an explanation of the equipment and the tour will be a real education.

Tours have been arranged for Tuesday and Wednesday to accommodate visitors and it is the wish of the director that visits to the power plant be made only at the hours specified in the program.

Tuesday Evening, June 26

8.00 p.m.—Entertainment in the Main Auditorium of the Technical School.

Radio Concert (weather permitting) conducted by M. B. Watson who will give a brief explanation of radio.

Moving picture films both comic and engineering will be shown.

Ladies are especially invited.

8.00 p.m.—Exhibition open until 10.30.

10.00 p.m.—Drawings for Prizes. Lucky numbers: Ladies—1 and 7. Engineers—1, 5 and 11.

Any prize not immediately claimed will be presented to the owner of the card next drawn.

Wednesday Morning, June 27

9.00 a.m.—Meeting Grand Lodge in the Technical School Library.

9.30 a.m.—Exhibition open until 10.30 p.m.

12.00 noon—Lunch.

Wednesday Afternoon, June 27

1.30 p.m.—Meeting Grand Lodge.

4.00 p.m.—Tour through Engineering Department conducted by M. B. Watson, director of the department. It is specially requested that visitors confine their visits to the engineering department to the hours mentioned in the program.

Wednesday Evening, June 27

8.00 p.m.—Entertainment in the Main Auditorium.

Radio concert (weather permitting).

Engineering and comic films.

GEO. F. GALLOWAY,
Vice-President and Acting Grand President.

10.00 p.m.—Prize Drawings. Lucky numbers: Ladies—2 and 6. Engineers—2, 7 and 10.
Any prize not immediately claimed will be presented to the owner of the card next drawn.

Thursday Morning, June 28

9.00 a.m.—Meeting Grand Lodge in Technical School Library.
Election of Officers.
Selecting place of next convention.
9.30 a.m.—Exhibition open until 1.00 p.m.
10.00 a.m.—Annual Meeting Exhibitors' Association.
11.00 a.m.—Open Meeting Grand Lodge for the Installation of New Officers.

Thursday Afternoon, June 28

1.30 p.m.—Tour of City—Free to delegates and their wives, leaving Technical School at 1.30 and landing at Picnic Grounds at 2.30.

GEO. J. SOUCY,
Chairman Convention Committee.

2.30 p.m.—Picnic at Exhibition Park given by Toronto No. 1 C.A.S.E.
Supper will be served in the Horticultural Building, where the presentation of prizes will be made.

PICNIC

Thursday Afternoon, June 28

At Exhibition Park, Toronto,
Under the auspices of Toronto Lodge
No. 1, C.A.S.E.

1. One Hundred Yards Dash—Engineers and Exhibitors.
   1st Prize......................
   2nd Prize......................
2. Balloon Race—Engineers' wives only.
   1st Prize......................
   2nd Prize......................
3. One Foot Hop Race—Engineers and Exhibitors.
   1st Prize......................
   2nd Prize......................
4. Ladies Candle Race.
   1st Prize......................
   2nd Prize......................
5. Backward Running Race—Engineers only.
   1st Prize......................
   2nd Prize......................
6. Ladies' Clothes Pin Race.
   1st Prize......................
   2nd Prize......................
7. Men's Smoking Race, 75 Yards and Return—Engineers only.
   1st Prize......................
   2nd Prize......................
8. Potato Race—Engineers' Wives or Daughters only.
   1st Prize......................
   2nd Prize......................
9. Wheelbarrow Race, 50 Yards and Return. Each team to consist of Engineer and Exhibitor. 1st Prize only.
10. Little Boys' Race—Sons of Engineers.
    1st Prize......................
    2nd Prize......................
11. Little Girls' Race—Daughters of Engineers.
    1st Prize......................
    2nd Prize......................
12. Soft Ball Game—Engineers vs. Exhibitors. Box of cigars to winners.

The Stoker Manufacturers' Association held the annual meeting at the Lake Placid Club, Essex Co., New York, from May 29-31. S. A. Armstrong, president, spoke of the benefits that must accrue to the association from the facts given by papers on stokers that were presented at the Fuel Section of the A.S.M.E. last December. He also recommended the addition of a standing committee on industrial relations, which would permit of study tending to the promoting of friendly relations and mutual confidence between employer and employee.

The Under-Feed Stoker Co. of Canada, Ltd., 146 King St. W., Toronto, are installing three Riley Stokers under 500 h.p. B. & W. boilers in the plant of J. R. Booth Co., Ottawa, Ont.; four standard side-dump stokers in the new power house of the departmental store of the Morgan Realties, Ltd., Montreal, P. Q.; three stokers under 150 h.p. return tubular boilers at the Chateau Lake Louise C. P. R. Hotel, in Alberta; and two Riley stokers at the Donnacona Pulp & Paper Co.'s plant, Donnacona, P. Q.

C. H. Raessner has been appointed district sales manager for the Foxboro Co., Inc., manufacturers of recording and indicating instruments. His central office is at 1510 Monadnock Bldg., Chicago, Ill.

After making repairs on a pipe line connecting with an engine, it should be blown out, the steam being allowed to flow into the steam chest, the ports of which have been either plugged or covered by the valve.

Drains for steam pipes should be provided at all points where it is possible for water to accumulate. Some may be for use only when putting the line into points where there is even slight difference in pressure should not be joined together or to the same trap, as the difference will prevent the proper operation of the one of lower pressure. If a still lower pressure or constant discharge is maintained beyond the point of junction, as in the Holley loop, the foregoing does not apply.

UNCOVERED IN ANY OLD SPOT

In packing valve stems or piston rods, never use old packing that has been removed. It has lost its elasticity and there is danger of it scoring the rods.

* * *

Can you beat it? The fireman thought a Skye Terrier was an Irish angel.

* * *

For running condensing, the principal change required in the valve setting would be to secure earlier closing of the exhaust valves of the low-pressure cylinder so as to obtain the same cushioning effect from compression of exhaust steam of lower pressure.

* * *

Wife of Engineer (on visit to Toronto with hubby to attend C. A. S. E. convention)—Horrors! I forgot to turn off the electric iron!

Husband (thinking of banquet in the main dining room of Hotel Carls-Rite given by Exhibitor's Association)—S'all right. Nothing will burn long. I forgot to turn off the water in the bath tub.

* * *

Load factor is defined as the ratio of the average load to the maximum load during a certain period, such as a week or a month. This should be distinguished from plant factor, which is the ratio of the average load to the rated capacity of the plant.

* * *

There was a Galt flapper with flapping
goloshes
Who married a fireman who used to
fight Boches.
But the flap and the fight
Didn't mix up just right—
She's gone to see what kind of firemen
Oshawa has.

* * *

A two-phase induction motor may be reversed by changing two leads of either phase if it be a four-wire machine, or by interchanging the outside leads if it be a three-wire machine.

* * *

Some buy the lowest-priced oil because it is the cheapest they can get; others buy oil best suited to their use even if high priced, because it is the cheapest in the end.

* * *

The total friction of a given engine remains practically constant under all loads and should not exceed 5 to 8 per cent. of the full load capacity of the engine. It increases with steam pressure from 30 to 70 lb. after which only slight increase is noted. Increased speed generally increases the total friction, but not always.

* * *

The furnace temperature must be kept high enough to combust the gases but not so high as to melt the ash.

Developing Hydro Electric Plants in Ontario

By FREDERICK A. GABY, B.A.Sc., A.S.M.E.[*]

Phenomenal Growth of Market for Electrical Energy in Province Due to Fact That Commission Has Discharged Its Trust by Distributing Power to Municipalities at Cost

THE province of Ontario is richly endowed with water powers, widely distributed over an extensive area. Its boundaries comprise an area of over 400,000 square miles, and its surface waters drain both to the Atlantic and to the Arctic oceans.

It is customary to present round numbers representing total water power potentialities for various districts, and for various countries, and when such totals have been given for Ontario it has been usual to estimate the total water power of the province at about 6,000,000 horsepower, but this estimate is of relatively little significance for purposes of comparison with other provinces unless first of all a uniform basis for comparison has been established.

We are aware of the fact that the character and extent of the hydrometric and other data available for a determination of the water-power potentialities of many rivers varies greatly and subsequent investigation of particular streams not infrequently has resulted in greatly increasing early estimates of water power available from such streams, while, in other instances, the reverse has been the case.

Such an experience has been encountered in Ontario. In view of such facts, the known water-power possibilities of the province cannot satisfactorily be compared with other countries where estimates may include a greater percentage of hypothetical considerations.

Needs Much Research

There remains much research yet to be prosecuted in connection with undeveloped water storage.

Any person looking over detailed maps of the northerly portions of the province cannot fail to be greatly impressed with the great number, and in the aggregate, the extensive area of the lakes spotted over these areas.

We shall leave therefore, the question of grand totals of water powers by stating that preliminary estimates, which include Ontario's share in the water powers of her international waters, have indicated a total of some 6,000,000 horsepower, of which some 1,300,000 horsepower has already been developed.

Ontario is the owner of Canada's equity in the water power of the Niagara river and of the international portion of the St. Lawrence river, and even if the actual power that can be developed under the present limitations of Treaty regulations or of engineering considerations be considered, it will be found that the power potentialities of these streams constitute a very large proportion of the available power in the Province.

Shared With Quebec

Next in importance to the Niagara and the St. Lawrence rivers is the Ottawa river and its tributaries, the more important of which in Ontario are the Blanche, the Montreal, the Petawawa and the Madawaska rivers. The power on the main stream, which constitutes part of an interprovincial boundary, is shared by the provinces of Ontario and of Quebec.

Frederick Arthur Gaby graduated from the University of Toronto in mechanical and electrical engineering in 1902. In 1907 he was appointed assistant chief engineer of the Hydro-Electric Power Commission, being appointed chief engineer in 1912. Prior to this Mr. Gaby was with the Canadian General Electric Co., the Nova Scotia Steel & Coal Co., and the Toronto Niagara Co. He is a Fellow of the Royal Society of Arts of Great Britain, and a prominent member of the Lakeshore Golf and Country Club.

Other important water powers are found in the Trent River watershed, tributary to Lake Ontario. There are nearly thirty sites, of which about one-half have been developed with an aggregate capacity of 50,000 horsepower, leaving undeveloped sites with an aggregate capacity of some 15,000 horsepower. Tributary to Lake Huron are water power streams with an aggregate potentiality at known sites of nearly 300,000 horsepower, of which about 100,000 horsepower is developed.

The chief streams are the Mississagi, the Spanish, the Aux Sables, the Onaping, the Wanapitei, the Sturgeon and the French rivers.

Tributary to Lake Superior are water-power streams with an aggregate potentiality of about 300,000 continuous horsepower. About half of this total is on the Nipigon river, on which an initial development has been made for the municipalities of Port Arthur and Fort William by the Hydro-Electric Power Commission of Ontario.

Important Power Site

The outflow from Lake Superior through what is known as the St. Mary river constitutes an important water-power site, which has been partially developed. In the extreme west of the Province, the English and Winnipeg rivers, which flow into the province of Manitoba, have important water powers; in Ontario these powers aggregate over 250,000 horsepower.

There remains to be mentioned the water powers of the streams flowing from Ontario into James Bay and Hudson Bay. The more important of these streams from the viewpoint of water-power possibilities are the Mattagami, the Abitibi, the Missinaibi and the Albany rivers.

The development of manufacturing industries in the Province necessitated the use of power. Ontario has no natural supply of coal and has required to import this necessity—both bituminous and anthracite—chiefly from the state of Pennsylvania.

The rising cost of this fuel and the fact that manufacturers were dependent upon outside sources for their supply, have been phases of the power situation in the province of Ontario which have greatly stimulated, and which doubtless will continue to stimulate, the utilization of the water powers of the Province along the lines of hydro-electric development.

The most important *early* hydro-electric developments, from the standpoint of magnitude and extensive transmission, is the plant at DeCew Falls. This plant takes its water from Lake Erie at the level of the upper reach of the Welland Canal at Allanburg.

Hamilton Was Objective

It is a high head development of about 50,000 horsepower capacity. The head developed is approximately 265 feet. Current is generated at 2,400 volts, 3-phase 66 cycles. The transmission voltage is 44,000 volts. The main objective of this DeCew power was the city of Hamilton, in the industrial life of which it has played a most important part.

It was in 1889 that negotiations by a group of United States capitalists were carried on with the Queen Victoria Niagara Falls Park Commission with a view to the development of power within the area controlled by the Park Commissioners. These negotiations eventuated in the formation of the Canadian Niagara Power Company —an ally of the Niagara Falls Power Company of Niagara Falls, New York

The nominal installed capacity of this plant, including a spare unit, is 121,000 horsepower. The ground was broken for the tunnel on October 4, 1890, and the first commercial power was delivered to the Pittsburg Reduction Company for the reduction of aluminum ore on the 26th of August, 1895.

The next important development at Niagara was that of the Ontario Power Company which commenced operation by the delivery of commercial power in 1905. This plant has its intake near the Dufferin

---

[*] Chief Engineer, Hydro Electric Power Commission, Toronto, Ont.

Islands above the falls. The water is conveyed a distance of over 6,000 feet by means of underground conduits, two of 18 feet internal diameter, and one, installed by the Commission as a war necessity, of 13½ feet internal diameter.

Made Original Contract

It was with the Ontario Power Company that the Hydro-Electric Power Commission made its original contract for 100,000 horsepower, the terms being $9.40 per horsepower per annum for power at 12,000 volts until 25,000 horsepower or more are taken, then $9.00 for all additional power supplied. The terms for power at 60,000 volts were $10.40 until 25,000 horsepower are taken, then $10.00 for all additional requirements.

In 1917 the Hydro-Electric Power Commission acquired the whole of the assets, including the generating plant at Niagara Falls, of the Ontario Power Company. This plant is now operated by the Commission.

In 1903, the Electrical Development Company entered into an agreement with the Commissioners of the Queen Victoria Niagara Falls Park whereby the Company was to utilize the waters of the Niagara river for the development of 125,000 electrical horsepower. The plant of the Electrical Development Company—now known as the Toronto Power Company—is situated above the Falls and about midway between the headworks at Dufferin Islands of the Ontario Power Company and of the Canadian Niagara Power Company.

Bought Assets in 1922

In 1922, the assets of the Toronto Power Company, including the development just described, were acquired by purchase by the municipalities of the Niagara district, and the operation of the plant of the Toronto Power Company was placed under the jurisdiction of the Hydro-Electric Power Commission.

From an initial investment in 1910 of some $3,750,000.00 the operations of the Commission have extended until at the present time it administers properties to the value of approximately $200,000,000.00, delivering upwards of 625,000 h.p. to fourteen different systems in various parts of Ontario, serving some 350 municipalities, the systems comprising some 3,500 miles of transmission lines.

Municipalities in the more newly opened up portions of the province of Ontario are, naturally, seeking opportunities for growth through the utilization of the natural resources tributary to them. The Hydro-Electric Power Commission is sympathetic to such development and stands ready, upon authoritative request from municipalities, to investigate and report upon the feasibility of new water-power development for the supply of communities desiring large quantities of electrical energy.

Ottawa First City

The city of Ottawa—the capital city of the Dominion—was the first municipality to receive its supply of electricity through the Hydro-Electric Power Commission.

In July, 1907, agreements were signed between the Ottawa and Hull Power Company and the Commission, and also between the Commission and the City of Ottawa, covering the delivery of electrical energy to the city of Ottawa to a limit of 2,500 horsepower. During 1910, this limit was reached, and in September of that year, the new contracts were signed increasing the load limit to 4,000 horsepower. This output was all required by February, 1914, when a third agreement was consummated, extending the limit to 20,000 horsepower.

The demand by the city of Ottawa has continued to increase and has now reached over 12,000 horsepower. In addition to serving the City, the Commission has extended its transmission lines for the purpose of serving a number of rural districts in the general vicinity of Ottawa.

We have now arrived at the place where it is proposed to describe some of the important features of the largest development in Ontario, in fact—the largest single electric development in the world, the Queenston-Chippawa installation.

In Service in 1922

The Queenston Chippawa Development, which was placed in service by the Commission on February 11th, 1922, is the latest addition to the Niagara System operated by the Hydro Electric Power Commission of Ontario.

True conservation in the use of the waters of the Niagara River for power purposes demands that practically the whole fall of approximately 327 feet between Lake Erie and Lake Ontario be utilized. The various power plants now operating at Niagara Falls vary in head from 130 feet to 210 feet, and with widely different degrees of efficiency.

The Queenston-Chippawa power development, the first unit of which was operated first in December, 1921, will have a normal operating head of 294 feet to 305 feet when the installation is complete. The conservation of head effected by the reduction of hydraulic losses to a minimum, and by refinements in the design of the various essential elements of the project as a whole, has resulted in the production of a power development which is believed to represent the best in modern engineering practice.

The plant in operation and in course of construction will consist of ten 60,000 H. P. to 65,000 H. P. 187.5 rev. per min. units, generating power at 12 kv., three-phase, 25 cycles, which in turn is transformed to 110 kv. for transmission with an ultimate capacity of 575,000—650,000 horse power.

Ice an Obstacle

On the Niagara River one of the great obstacles to securing continuity of service is the annual formation and flow of ice. Great fields of ice, formed in Lake Erie with its shallow bays and shores, are discharged down the Niagara River every spring, and at frequent intervals during the winter, under certain wind and temperature conditions.

In order to eliminate as far as possible interference of operation due to ice, a special form of intake has been provided.

The complete intake structure is approximately 1,100 feet in length and is made up of an entrance with lock gates for navigation, a bulkhead section, and the intake proper, the latter combining two forms of intake; the conventional or surface intake consisting of a concrete barrier or boom with fifteen openings each 18 feet in width, normally having eight feet of submergence, which submergence can be increased however by means of drop gates, to any amount up to the full depth of water or 35 feet; and the submerged intake consisting of gathering tubes or draft distributors, six in number and 675 feet in length.

A Sluggish Stream

For a great many miles above its mouth the Welland River is a sluggish stream, meandering slightly in a depression that can hardly be called a valley. The canal leaves the river channel near the crossing of the Michigan Central Railway and turning through a deflection of 28 degrees takes a course almost due north for over three miles.

The Control Gate is located at the upper end of the canal, where the earth section merges into the rock section.

This is the largest single leaf, roller type, motor operated gate ever built, and, before its installation was decided upon, an extensive study was made to determine the construction and operating economies in comparison with a two leaf gate with an intermediate pier.

Gate Motor Operated

The gate is motor operated by means of a worm drive connected to double hoisting gears on the top of the end towers. Roller chains pass over these gears connected at one end to counter-weights and at the other to the gate. The skin plate is riveted to the upstream face of the girders and beams, and consists of 7-16" plate which under full head is stressed to 11,000 lbs. per sq. in. The maximum stress in the rollers has been kept down to 625 lbs. per sq. in. the full diameter of the roller.

When the gate is raised to its full height it leaves a clearance of 14 feet above the water level in the canal, which will permit the passage of patrol tugs throughout the length of the waterway.

The total pull on the two chains in raising the gate is 316,000 lbs. The chains are made up of pairs of links, 9" x 1¼" each in cross-section, and rollers 4½" in diameter. The speed of lift is 4.6 feet per minute, thus requiring 12 minutes to operate the gate from closed to full open position.

Serves as a Dam

At the lower end of the forebay, and serving as a dam, is the screen house. This structure forms the entrance and the control for the penstocks. The entrance to each of the main penstocks is a modified bell-mouth consisting of three openings 12 feet 8 inches wide and 29 feet high at the rack supports. These three openings gradually converge into one opening 16 feet in diameter at the point of connection to the penstocks. Immediately behind the curtain wall, steel-lined gate checks are provided to support structural steel gates.

On account of the provision of Johnson valves at the lower end of the penstocks, permanent gates were not installed in the screen house at the entrances to the penstocks. Movable gates have been provided consisting of sectionalized leaves which can be dropped into checks in the piers by means of a travelling crane in the screen house.

The screen house, as constructed, provides for nine main units, a service unit and an ice chute, and is arranged so that a further unit entrance may be added at the north end.

The generating and transformer station is located below the escarpment and close to the river's edge.

Length to be Doubled

The structure required to house five main units and the service equipment is 350 feet long, and ultimately this length will be doubled. The substructure is of massive concrete construction carried down to rock foundations, and provides chambers and tunnels for housing and giving access to various kinds of apparatus. The superstructure consists of a structural steel frame work with reinforced concrete floors and roofs, and concrete, brick and tile walls and partitions.

The location of the transformer and switching portion of the plant on the top of the escarpment was considered, but owing to the difficulties in carrying the current at 12 kv. from the generators to the transformers up the cliff; and to operating advantages in having a combined station; also to the space between the generator room and the cliff being sufficient for the purpose, the decision was made to have the building to house the transformers and switching equipment combined with the generator room.

The steel columns are spaced longitudinally 26 and 24 feet alternately starting at the south end. The strength of the generator room steel was primarily determined by the necessity of providing cranes to handle the generator rotors which weigh about 300 tons each. The structural steel was so designed that it could be erected and the crane operated before the concrete walls were poured.

Guard Against Flooding

To guard against flooding due to the river level rising, the walls are designed to resist water pressure up to elevation 300, which is 16 feet above the base of the generators. No openings which might admit water from the river were permitted below this elevation, although temporarily a railway track is brought in at the south end and is protected by stop logs.

A 300 ton crane consisting of two separate units each having a capacity of 150 tons is provided in the generator room for handling generators, transformers and other apparatus. When the crane is to be used in lifting the generator rotor, which is the heaviest piece, an equalizer beam is used. This crane is supplied with a.c. motors and control.

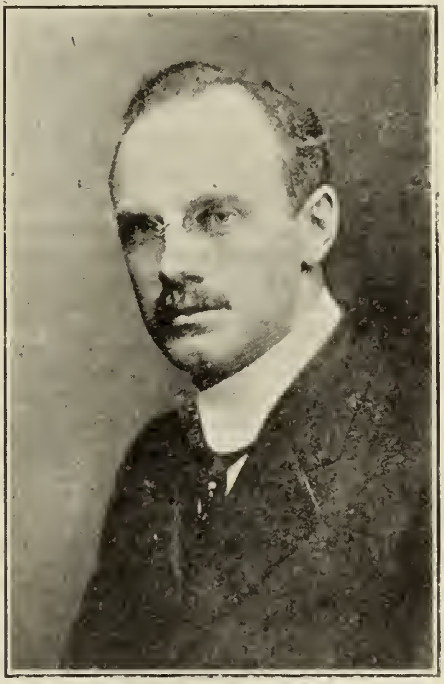
The entrance elevator, from screen house to entrance tunnel, operates at a speed of 450 feet per minute, and is equipped with a 25-cycle 550 volt, three-phase, variable speed motor of the commutator type with brush and shifting gear.

The main elevator in the power house is in the southerly portion of the building and serves all floors. It operates at a speed of 350 feet per minute and is equipped with a two-speed, 25 cycle, 550 volt, three phase induction motor. An automatic elevator located near the control room for the use of the operators, is also operated by a 25-cycle, 550 volt, three phase induction motor.

Nos. 1 and 2 turbines are designed for 52,000 H. P., and Nos. 3, 4 and 5, for 55,000 H. P., all at 305 foot head, the speed being 187-5 r.p.m. They are of the single runner vertical type set in spiral cast steel casings. The inlet diameter of the casings is 10 feet.

In Nos. 1 and 2, manufactured by the Wellman-Seaver-Morgan Company, of Cleveland, the casings are divided into nine sections with a separate speed ring, while in Nos. 3, 4 and 5, manufactured by the Wm. Cramp & Sons, Ship and Engine Building Company, of Philadelphia, the speed ring is case integral with the casings and the whole divided into 12 sections. The weight of the casing and speed ring in Nos. 1 and 2 is 240,000 lbs. while in 3, 4 and 5, it is 180,000 pounds.

The runners are made of cast steel in one piece, and provided with special renewable seal rings. Nos. 1 and 2 are 125 inches in diameter, and Nos. 3, 4, and 5 are 121 inches in diameter.



FREDERICK A. GABY, A.S., M.E.

The gate control is the usual double regulating cylinder typeope rating through rods to a shifting ring connecting to the individual gates through specially designed breaking links.

Made of Special Steel

All parts of the turbines adjacent to rotating elements, and to water passages subjected to high velocities are made of special steel and renewable. The main journal guide bearing on each unit is of the water lubricated lignum vitae type, such as has been used on all modern vertical turbine plants. This type of bearing was selected on account of its simplicity and low maintenance cost.

The governor actuator is set on the generator floor, the flyballs being driven by belt from the turbine shaft. The main valve is located adjacent to the turbine regulating cylinders, 35 feet below the actuator. To meet the conditions of this layout the pilot valve is hydraulically coupled to a small piston valve which is mechanically connected to the pilot valve of the main dog valve. The hand control stand is located on the generator floor and operates the regulating cylinders through the governor pressure system.

The governors are operated on the "Central" type of pressure system. Two motor driven centrifugal pumps, each delivering 500 Imperial gallons per minute, and located adjacent to two 3,000 gallon pump tanks built into the concrete substructure of the powerhouse, deliver the governor fluid at a pressure of 200 pounds per sq. in. to a header from which branches are connected to the governors through individual pressure tanks. The capacity of one pump is sufficient to operate five governors. An additional emergency pump is now being installed to operate the governor system in case of failure of the electric supply to the motor driven pumps.

The new pump will be turbine driven and will automatically come into service when the pressure on the governor system falls below a predetermined amount, by means of a specially constructed Johnson valve on the supply line to the turbine.

Does Not Corrode

The fluid in the governor system is filtered water in which a small amount of potassium bichromate is dissolved, the proportion being 7 pounds of potassium bichromate to 1,000 gallons of water. This fluid does not corrode the valve seats and has proven satisfactory in service.

The two service turbine casings are 30 inches inlet diameter, and the runner 42 inches outside diameter. The gate mechanism is of the "outside" type, similar to the main turbine. On account of the length of the shaft an intermediate guide bearing was installed. This bearing is of the oil lubricated type and furnished with a rotary oil pump, all arranged to be self-contained.

The governor is the "direct-connected" type, and the pressure liquid is ordinary lubricating oil. The flyballs are mounted upon the main turbine shaft, and the governor stand with self-contained pumping unit is placed on the turbine floor.

Furnish Quick Stop

A band brake is furnished in order to assist in bringing the unit to a quick stop when necessary.

A Johnson valve is located on each penstock near the entrance to the turbine casing. The action of this type of valve has been frequently described in other papers. The control of the Queenston valve is made through the operation of three small Johnson valves which automatically adjust the flow into the central and annular chambers so that the main valve plunger cannot travel at a dangerous rate.

The closing stroke is cushioned at the end, and in the opening stroke the plunger moves just sufficiently to permit the wheel case to be primed before completing its stroke. An emergency handle is located on the control stand on the generator floor by which an operator can close the Johnson valve in case of trouble. The valve can be opened only from the control located adjacent to the valve itself.

The present five units are each rated at 45,000 kv-a., 80 per cent. power factor, 12,000 volts, three-phase, 25 cycles at 187.5 r. p. m. They are capable of being operated continuously at 49,500 kv-a., with either voltage or current 10 per cent. in excess of the rated values. The type is vertical with direct-connected shunt-field commutating-pole, 250-volt, 150-kw. exciter.

Aid High Efficiency

The over-all efficiency of the generating units is slightly in excess of 97 per cent. at 80 per cent. power factor. The thrust bearing is designed to support a load of one million pounds which is slightly in excess of the weight of the rotor plus the hydraulic thrust imposed by the turbine. Upper and lower guide bearings are provided, the latter on account of the length of shaft and to keep the generator a self-contained unit.

The over-all diameter of these units is 25 feet, the diameter of rotor over pole faces being 18 feet approximately. The shafts are 30 inches in diameter in the guide bearings, and are provided with flange at lower end for bolting to corresponding flange on turbine shaft. The shafts are hollow with 8-inch diameter bore and are 30 feet 3 inches in total length. The over-all height of generators above the generator floor is 26 feet 10 inches, thus above the main floor only the top of the frame and the upper bracket, thrust bearing housing and exciter are visible.

The weight of the complete generator is 1,400,000 pounds, that of the rotor 615,000 pounds. The largest piece to be handled by the cranes weighs 600,000 pounds. Generators—45,000 and 55,000 kv-a.

A Partial Description

The foregoing is a partial description of the Queenston-Chippawa development, giving special attention to the mechanical features of this development. The first five units are now in operation and the other units are being installed as rapidly as possible, and when completed the Commission will have a generating capacity for the Niagara District of over 900,000 horsepower, including the Toronto Power Company and the Ontario Power Company plants.

The growth of the demand for "Hydro" service from the Commission is well shown by the following table:—

	Number of Customers			Total load for October	
	Urban Municipalities	Townships	Total Consumers	Ontario only (Horsepower)	Ontario plus exported power. (Horsepower)
1910	10	..	......	750	......
1911	26		......	15,214	......
1912	36		34,967	31,019	......
1913	51	7	65,689	45,502	......
1914	82	12	96,844	76,977	......
1915	112	18	120,828	103,959	......
1916*	166	25	148,732	167,661	
1917	179	34	170,916	266,214	333,399
1918	193	41	183,987	253,562	316,592
1919	208	42	216,086	262,281	328,175
1920	217	43	244,388	283,372	355,798
1921	236	44	265,000	305,247	375,010
1922*	250	97	335,000	553,000	628,000

*Central Ontario System purchased by Provincial Government and operated by the Hydro Electric Power Commission.
Ontario Power Company taken over by Hydro Electric Power Commission
*Toronto Power Company purchased by the Commission.

Realizing as it does the large amount of time—often several years—that must elapse between the initiation of a new, extensive water-power development and its being brought to the stage where commercial power can be delivered, the Hydro-Electric Power Commission has always been compelled to take early action on behalf of municipalities for the creation of new sources of supply for electrical energy.

It has sometimes required a good deal of courage on the part of the officers of the Commission to incur heavy financial outlay years in advance of the actual demonstration of markets to absorb electrical output, but, in no instance, has the judgment of the Commission eventually been found to have been in error.

Use Up Spare Power

At the present time, all evidences point to the fact that by the end of the year 1926, the present provisions made for the supply of electrical energy to Hydro municipalities will be fully taxed and no spare power will be available. The output of the Queenston-Chippawa plant will have been absorbed. The Commission has considered the possibility of producing further power at Niagara Falls, but the Chairman of the Commission, Sir Adam Beck, has stated from the public platform that he believes that it would be more profitable for all concerned to turn to the St. Lawrence river for the next large hydro-electric development.

It has already been stated that one of the basic principles upon which the Hydro-Electric Power Commission of Ontario operates is the furnishing of electrical energy to consumers *at cost*. Time and again, it has been stated—too often by those who knew practically nothing of the subject they were discussing— that the rates for light and power resulting from the efforts of the Hydro-Electric Power Commission were much less favorable than rates prevailing in other places. It remains, however, yet to be disproven that nowhere in the world over such extensive areas do communities and citizens obtain electrical power and light at such low rates as prevail throughout the Hydro municipalities in the province of Ontario.

And now, in concluding, I believe I have answered a question which may have arisen in the minds of many, namely, how does it come about that the operations of a new organization like the Hydro-Electric Power Commission of Ontario have attained such a phenomenal growth, and how has it been possible, so rapidly, to market such large supplies of electrical energy?

In a word, the secret lies in the fact that the Commission, as trustee and agent of cooperating municipalities, has sought to discharge its trust—and in point of fact has discharged its trust—so that the electrical energy has been made available *at cost* and then has been distributed to, and again vended by, municipalities to their individul consumers at *as near cost as possible*. Moreover, the Commission has made its distribution of energy to small municipalities and to rural districts, and the demand of these small municipalities aggregates a substantial load.

To sharpen dull and worn out files, lay them in dilute sulphuric acid, one part acid to two parts of water, over night, then rinse well in clear water. Put the acid in an earthenware vessel.

A method of detecting piston leaks is to place the engine on either centre and open the indicator cock from the opposite end from which the steam is being admitted. In this test, however, the steam valves must be tight.

A cylinder oil containing acid will probably cause pitting of the cylinder walls, hence it is advisable to watch the condition of cylinders after changing from an oil that is known to give good satisfaction to another grade.

Safety valves have blow down or huddling rings for adjusting the blow down. If a valve opens at the correct pressure, but does not close until the pressure has dropped, say, 5 lbs., instead of the usual 3 lbs., the huddling ring needs adjustment.

If the striking points of the piston against the cylinder head are not known, marks should be placed on the guide so that it can be clearly seen at any time that the piston has sufficient clearance at the end of the stroke, which should be kept equal at each end.

To cement leatehr to leather, soak ordinary glue or isinglass for 12 hours in sufficient water to cover it. Boil, and add pure tannin until the solution becomes sticky and has the appearance of the white of egg. The cement is then ready for use.

A crankpin will heat if it is not large enough to do the work, if good lubrication is not provided, if dirt gets inside brasses, if the brasses are not properly fitted, or if the brasses or pin are not of good material and in a smooth condition. Being out of line or keyed too tightly also causes it to heat.

Play Ball! U.C.C. of E. on Frolic Bent June 23

Members of Queen City Council, No. 27, to Drive Away Dull Care With Bumper Sports Program at Ward's Island—Be Sure to Be There

MEMBERS of the Universal Craftsmen Council of Engineers—"chalk up" an engagement on Saturday, June 23, that cannot under any circumstances be broken. For on that day at 2 p.m., or better still at five minutes to two, you must be at Bay St. dock, Toronto, with your wife and children, or if you are "unfortunate" enough to lack a wife, your best girl will do, to take passage to Ward's Island for the gayest frolic of the year.

Bring along your bathing suit, your running shoes, and the sunny side of your disposition, for with this crowd there'll be room for nothing else. Everything imaginable is on the program by way of amusement, and it certainly will be work for the judges to ascertain the various winners of the many contests scheduled by Queen City Council, No. 27.

For instance, when the staid married men are in line, braced and ready for the word "go," can't you hear twenty or thirty fond wives shouting encouragement to their better halves. and later when in turn the weaker sex prepare to run down the stretch, the shouts of hubby will differ only in that they will be a bit stronger, for everyone likes athletic honors to be kept in the family, and with so many families represented, —well, there's going to be some fun!

Chase Each Other

The bachelors and lonely single maids will also have an opportunity to see which one can do the chasing with the most success, and boys and girls and tiny tots will have every chance to show which one has had the most practice in running away, for everyone is going to take part in the races, and while all the ladies expected are, as Grand Worthy Chief Patton said at the anniversary banquet of Canada Council No. 27, flower-like, not one will be allowed to resemble in any way, a wall-flower.

The ladies are going to have a special blowing race, just by way of giving them a chance to do what their husbands and male friends do all the year 'round, and the men will have a measuring race. Mrs. E. M. Longmoor, chairman of the picnic committee, says she had to even them up to save argument! Power House will be responsible for a shackle race for the men, but not for any injuries which may be received, and the ladies can begin to practice up for for the spoon and egg race. The starter of these two races will be Arthur Murphy, editor of Power House, so he's the man to watch! And the crowning sport of all,—for the men!—will be watching the fair participants in the nail driving contest.

It is to be hoped there are a few ladies present who have had experience in hitting something on the head, for it is a case of reputation going before! However, when supper is ready at 6 o'clock, everyone will be in good trim to do it justice, and it is unlikely anyone will be burdened with "leftovers" to be consumed on Sunday.

Today we are learning a very old and simple truth all over again—the truth that the best way to make a living and to store up a competence is to get out among our fellow men and work for it. That method may induce brain fag and make muscles tired and sore, but if one goes at it right he is pretty sure to gain nightly the refreshing sleep that he needs. To many men—and women, too, for that matter—brains and brawn are out-of-date tools with which to carve a fortune.

Play Ball at Night

After the supper has been digested the sports committee will once more get everybody on their feet, segregate them evenly as to sprinting and throwing ability, and, oh, boy! we're off to a ball game with bells on. Why worry about a stiff arm in that old boiler room on the morrow, for here comes the ball and it's up to you to wallop it.

Among those who have promised to root for their favorites are, H. E. Terry, Past Grand Worthy Chief; L. J. Cudbird, Grand Trustee; Chas. L. Holmes, Worthy Chief; and W. J. Hudson, Secretary; Mr. and Mrs. A. M. Auchterlonie, Mr. and Mrs. Darbyshire, Mrs. Stephen and Mrs. Albert Baker.

The Program Follows

1. Tot's Race—Prize for each.
2. Girl's Race, 8-12 years—1st, 2nd, and 3rd prize.
3. Boy's Race, 8-12 years—1st, 2nd and 3rd prize.
4. Girl's Race, 12-15—1st and 2nd prize.
5. Boy's Race, 12-15—1st and 2nd prize.
6. Ladies' Spoon and Egg Race—Prizes given by Power House.
7. Men's Obstacle Race—Prizes given by Power House.
8. Single Ladies' Race—1st. and 2nd prize.
9. Single Men's Race—1st and 2nd prize.
10. Married Ladies' Race—1st and 2nd prize.
11. Married Men's Race—1st and 2nd prize.
12. Ladies Blowing Balloons—1st and 2nd prize.
13. Men's Measuring Race—1st and 2nd prize.
14. Queen City Officers (Past and Present.)—1st and 2nd prize.
15. Ladies Nail Driving Contest—1st and 2nd prize.

6 p.m. Supper.
Baseball.

The highly economical steam turbine must necessarily be operated condensing, but there are many cases where high steam economy is not the most important and the non-condensing turbine finds favor over the steam engine.

Bring along the little tots.

Burning Pulverized Fuel in Ford Motor Plant

By A. J. T. TAYLOR,* A.S.M.E.

Walkerville Installation to be Largest in Canada as Result of High Efficiency Effected at River Rouge With Boilers of 2,640 Normal H.P. Each

THE use of pulverized fuel as a step in fuel economy and high boiler efficiencies deserves a great deal of attention, and there is no single development in the matter of the utilization of Canadian coals that merits more careful consideration than the burning of coal in pulverized form.

This method of using fuel not only presents a means of obtaining results with the present available commercial fuels, but makes possible a still greater conservation of these fuels by replacing them with many of the lower grade fuels that are at present unsuited for burning by ordinary means.

It is now known that any of the coals native to Canada can be successfully burnt at a high efficiency in pulverized form regardless of whether they are the high sulphur coals of our Maritime Provinces, or the lignites of Saskatchewan.

Now Beyond Experiment

The literature on the subject of pulverized fuel is not abreast of the development of the art, with the result that it is not as widely known as it should be that the burning of fuel in pulverized form is now entirely out of the experimental stage.

The Ford Motor Company at Walkerville, Ontario, are at present installing a plant, which will be the largest pulverized fuel installation in Canada. The Ford Company have been pioneers in the matter of burning fuel in pulverized form, and their River Rouge plant near Detroit equipped with a pulverized fuel system is world famous, containing as it does some of the largest boilers ever built, these being 2,640 nominal H.P. each, and have on occasions been forced to a capacity of over 300,000 lbs. evaporation per hour.

The Oneida Street Station and the Lakeside Station of the Milwaukee Electric Railway & Light Company, and the Brunot's Island Plant of the Duquesne Light Company, have firmly and lastingly demonstrated to those responsible for the mechanical and financial success of those companies, and to their associated engineers, the economy to be derived from this method of fuel burning.

Confirms Conclusion

A further confirmation of the correctness of their conclusions, if such are needed, is evidenced by the action of such progressive engineering firms as McClellan & Junkerfeld, Sanderson & Porter and Dwight P. Robinson & Co., all of which firms are at present charged with the responsibility for large new utility projects, and each of them are recommending and installing systems for burning pulverized fuel for their clients under widely varying conditions of operation and fuel.

It would therefore seem unnecessary to bring forth further argument as to the work, reliability, adaptability or the dependability of the burning of fuel in pulverized form, which must be acknowledged with one exception to be the ultimate method of economically utilizing the full heat value of any available solid fuel.

The one exception is, of course, the process of low temperature distillation, wherein the lighter volatiles of the fuel are driven off at a relatively low temperature, and the residue pulverized and burned in suspension. Much thought and study is being given to this process at the present time, and it is expected that practical developments may be looked for in the near future.

Long, Expensive Study

In advocating the use of pulverized fuel, it should be definitely borne in mind that this is a special field of endeavour; that while the burning of coal pulverized and in suspension appears from observation of a correctly designed and properly installed system, much simpler than any other method of fuel burning, such simplicity of installation and operation was not achieved without long, difficult and expensive study and experimentation.

The development of one system required some seven years of intensive endeavour by an association of engineers of national repute, and the expenditure of nearly $700,000 to bring it to its present point of perfection.

As each pulverized fuel installation is made under widely varying conditions of load, fuel and operating conditions, each installation must be studied as a distinct engineering problem, and the work should only be entrusted to those who have shown by past accomplishment their knowledge of the subject, and ability to handle the several mechanical, physical and economic problems involved.

Demands High To-day

The present day demands for higher boiler ratings, the rapidly increasing demand for energy made upon most stations, the ever-present demand upon the Central Station operator for greater economy in meeting such conditions, make the accomplishment of the past five years in actual commercial installations an obligation upon the forward looking engineer to give his serious consideration to the advantages a change from his present method to pulverized fuel would effect. Where new stations are contemplated, it would appear that these advantages cannot be ignored.

Some of these advantages may be summed up briefly as follows:

First: The ability to burn any available fuel, either solid, liquid, or gaseous, in the same furnace without change, either simultaneously or separately.

Second: The ability to secure maximum evaporation per lb. of coal under all conditions.

Third: The ability to meet widely varying capacity conditions with any available fuel.

Fourth: The ability to maintain practically the maximum efficiency over a wide capacity range.

Fifth: The ability to instantaneously meet any sudden peak demands without later interruption to continuous service.

Sixth: The ability to bank over long periods with a minimum fuel loss.

The ability to burn any available fuel is of peculiar interest to Canada due to the widely varying qualities of coal which lie adjacent in many of our areas.

Gave Record Efficiency

The world's record for boiler plant efficiency has recently been made in Milwaukee where the system of pulverized coal burning gave during some tests an overall efficiency for the boiler, superheater and economizer of 91.3 per cent.

Pulverized fuel has now been so perfected that the cost of labor and handling complete (conveying, crushing, drying and pulverizing) together with wear and tear and depreciation is no greater than mechanical stoking.

It seems hardly necessary to add that where the size of the plant warrants the capital investment pulverized fuel has established itself as a commercially efficient system.

A self-contained engine is dependent upon its own frame to hold all of its parts together.

Adjust the catch plates on a Corliss engine so as to give them sufficient surface on their working edges, and they will wear longer. Also see that the working edges strike each other squarely. If the springs are weak, strengthen them by carefully pressing the ends towards each other in a vise, or get a new set of springs.

Upon taking charge of a new plant, do not begin by making promiscuous adjustments. It is better to wait a day or two until the apparatus is thoroughly understood, and then changes should be made only after the object to be attained is definitely known.

A right-hand engine is one the flywheel of which is to the right when looked at from the cylinder.

---

*President, Combustion Engineering Corporation, Limited, Toronto, Ont.

How to Save Millions of Tons of Coal Yearly!

By W. H. CASMEY*

Power Plant Engineers Find Want of Consideration of the Question of Excess or Insufficient Air Costly, Although Subject is Entirely Free From Complexity

TO WASTE coal at any time is proof we are not true to the trust we hold for future generations.

Combustion in its widest sense may be defined as the chemical combination of two or more substances, attended by the evolution of light and heat. For the purpose in view we have to consider the combination of "coal and air."

Coal is compressed mineralized vegetable matter. It contains from 75 to 90 per cent. of carbon, with varying percentages of hydrogen, oxygen and nitrogen.

Air consists mainly of a mixture of oxygen (21 per cent.) and nitrogen (78 per cent.); the remaining 1 per cent. consisting of elements and compounds in minute quantities which do not concern the power plant engineer.

Nitrogen is known as an inert gas—that is to say, it does not readily unite with other substances, and concerns us only as a diluent; it is the oxygen combined with the coal which results in the evolution of heat. The nitrogen becomes heated in passing through the furnace or fire, and carries away into the atmosphere a quantity of heat, which is definite loss.

Proportions Definite

Without going deeply into the chemical reactions which take place, it is necessary to point out that in chemical combination the elements uniting always do so in definite proportions.

In the case in point, it has been found that carbon and oxygen always unite in one of two proportions.

(1) If insufficient air is present, carbon monoxide is produced—C plus O equals CO. As this is capable of further combustion, it follows that its passage through the chimney to the air means a waste of fuel. Thus its detection in the flue gases is an indication that more air is required in the furnace.

(2) With the correct proportion of air one atom of carbon will unite with two of oxygen, producing carbon dioxide (carbonic acid gas) CO_2. In this case combustion is complete, for one atom of carbon will not unite with more than two of oxygen. The only effect of the introduction of too large a quantity of air being to cool the furnaces below the "point of combustion." This leads to imperfect combustion, smoke production, and, therefore, waste.

Indicator is Useful

It follows, then, that a "carbon dioxide indicator" will be as useful in assisting the boiler fireman in his knowledge of the conditions of his fires as are his steam pressure and water gauges for the internal conditions of the boiler. It is surprising so little has been done with this type of instrument, seeing it is the one positive method of knowing whether or not we are wasting coal.

The writer does not wish to infer the duty of a furnace, however, can be always accurately arrived at by a CO_2 indicator, for under certain conditions it may even lead astray.

Although the Editor does not entirely agree with the author's line of reasoning in this article, the practical conclusions arrived at by Mr. Casmey, after thirty years' practical experience with boilers and boiler users, must be heartily endorsed by Canadian engineers. The author's aim is to persuade all engineers in power plants in Canada to use for their own advantage the means placed at their disposal by the scientist; in other words, to bridge the gap between the laboratory and the boiler room.

For instance, if the air supply is too small for the weight of coal stoked, a high record of CO_2 is possible, but together with it there may be a small percentage of carbon monoxide (CO) which reduces the heat value of combustion indicated by the CO_2 readings. There is, however, but little danger of CO with a good draught and CO_2 readings in the neighborhood of 13 per cent.

The calorific or steam-raising power of coal is judged from the heat units contained per lb., one British thermal unit being the heat required to raise the temperature of 1 lb. of water 1 deg. F., so that to raise 1 gallon of water (10 lbs.) from 32 deg to boiling point (212 deg.) 1 180 B. t.u. would be required.

Calorific Value Low

One pound of good coal contains over 14,000, but for steam raising purposes coal with a calorific value of about 12,000 B. t. u. is generally used, but the writer has often tested boilers using fuel containing less than 10,000 units.

If coal and air are supplied in the proportion of 1 to 12, the resulting temperature will be 5,000 deg., which is much too high for steam-raising purposes; therefore it is good practice to allow 50 per cent. excess air, making the total required for good practical working 18 lbs. of air per lb. of coal, the temperature with this mixture being 2,700 deg.

It is want of consideration of the question of excess air for combustion which leads to the wastage of millions of tons of coal yearly, and yet the subject is so free from complexity that one cannot understand why, in a sense, general practice in the boiler-house is no better than during James Watt's life 100 years ago.

To burn 1 lb. of coal perfectly, 12 lbs. of air would be required. This would be 9½ lb. nitrogen and 2½ lb. oxygen. The latter gas, as already pointed out, would unite with the carbon. The gases leaving the furnaces would be 9½ parts nitrogen as before, but in place of oxygen we find 2½ parts, or say, 20 per cent. CO_2, the furnace temperature being 5,000 deg.

All Oxygen Not Used

If one pound of coal is burnt, allowing 18 lbs. of air, it will be found that all the oxygen will not be used, and the gases on testing will be found to contain 13 per cent. CO_2, the furnace temperature being 2,700 deg.

It is general practice to allow from 30 to 35 lbs. of air with each lb. of coal, and taking the minimum figure 1 lb. of coal and 30 lbs. of air, the CO_2 reading will be 7 per cent. and the furnace temperature only 1,700 deg., thus indicating that owing to the increased air supply of 12 lbs., a direct fuel loss of over 20 per cent. results.

When the temperature of a furnace falls below 900 deg. through the addition of fresh fuel, smoke will be produced and will continue until the furnace temperature is sufficiently high to ignite the gases.

During a black-smoke period each cubic of smoke is taking away two grains of carbon, and with 30 lbs. of air per lb. of coal—i.e., 390 cubic feet—780 grains or 11 per cent. of the coal escapes, and this could be entirely prevented by stoking when the fires are good, which is the only time they should be stoked.

A smoking chimney announces to the neighborhood that the man at the fires is either ignorant or neglecting his duty.

Color of Fires

It will be of service to firemen to know how from the color of their fires they can tell when getting good results.

Very faint red	977 deg. F.
Dull red	1,290 deg. F.
Dull cherry red	1,470 deg. F.
Red	1,650 deg. F.
Bright red	1,830 deg. F.
Deep orange	2,000 deg. F.

---

*Lecturer on Boiler Efficiency, The South Wales Institute of Engineers.

Clear orange	2,180 deg. F.
White heat	2,370 deg. F.
Bright white	2,550 deg. F.
Dazzling white	2,730 deg. F.

The 977 deg. would be secured with 47 lbs. of air per lb. of coal, the last temperature given, 2,730 deg. when the air suply was 17½ lbs.

The main causes of coal wastage in the production of steam may be summarized as follows:—

Area of fires too big for the gas outlets at the rear end of the boilers; fires too thin; stoking at the wrong time and often too heavily; fires given too much or too little air; boiler badly seated; leaky brickwork; boilers dirty inside; boilers and steam pipes exposed; damp and dirty fuel; lack of suitable proportion between grate area and chimney; heat in chimney gases.

In the manufacture of steel, iron, brass, or, in fact, any commodity, definite proportions of various ingredients are used, and the manufacturer is never in doubt as to the results.

Chaos Usually Reigns

In making steam, however, the cost of which is the foundation of practically all manufacture, chaos, as a rule, reigns, and it is the writer's object to place the boiler-house on the same common sense lines as any of the industries which depend upon it.

We know the temperature of combustion is constant—i.e., that a mixture of 1 lb. of coal and 12 lbs. of air produces a temperature of 5,000 deg.; also that when the mixture of coal and air is in the proportion of 1 to 18 the temperature of 2,700 deg. is constant, and that with every 1 lb. additional excess air the furnace temperature falls approximately 100 deg., so that when the coal and air are in proportion of 1 to 30 (which may be taken as general practice) the furnace temperature is only 1,700 deg., and since 1 square foot of grate at 2,700 deg. will radiate over twice as much heat in a unit of time as a square foot at 1,700 deg., the value of the smaller air supply as a means to economy is apparent.

Coal Saving Hints

To illustrate how a 2 to 1 radio or modified grate will assist in reducing coal consumption, let us take a 30 ft. x 7 ft. boiler. We find the ratio of grate to outlet is 4 to 1, so that to adopt the 2 to 1 ratio its gate must be reduced to 3 feet in length, its area is then 16.5 square feet, and consequently the air velocity through the furnaces is increased 750 feet per minute, and it can now burn if necessary 28 lbs. of coal per square foot of grate.

It is proposed to see, first, the cost of coal for producing the previous evaporations of 3,168 lbs., and then the actual boiler duty.

With a coal consumption of 40 lbs. per foot of grate thicker fires must be used than with 6-feet grates, and there is no difficulty in maintaining a CO_2 reading of 13 per cent. which equals an air supply of 18 lbs. per pound of coal, and assuming the gases leaving the boiler are 700 deg., as in the previous calculations the gases are, therefore, taking away 24 per cent. of the heat liberated, as against 39 per cent. with the longer grates.

By adding 8 per cent. for radiation and other losses the boiler efficiency may be taken as 68 per cent. which equals an evaporation of 8.4 lbs. per pound of coal; therefore, to give the previous evaporation of 3,168, only 387 lbs. of coal would be used, as against 462 lbs., or a coal saving of 17 per cent.

Evaporation Increases

By allowing the furnaces to burn 462 lbs. of coal, say 28 lbs. per square foot of grate per hour, the hourly evaporation of the boiler increases to 3,880 lbs., or nearly 19 per cent. more water for the same weight of coal burned on the longer grates; in other words, four boilers working with the 2 to 1 ratio will evaporate as much water as five similar boilers with standard grates, or will evaporate the same weight of water for 16½ cwts. of coal as the longer grates will do for 20 cwts., indicating a saving in fuel of 17 per cent.

There is money in carbon dioxide gas, and every consumer of fuel manufactures it as a by-product. The way to take the profit out of it is simply to produce as high a percentage of it as possible, and then let it escape up the chimney. That is all that is necessary—the profit appears immediately as a savings on the fuel bill. The only attention nedeed is to see that maximum production is maintained.

These results are quite understandable by looking even in a cursory manner over the factors brought into play; the shorter fires use less air, and the temporature of the furnaces will be approximately 2,700 deg., resulting in a more rapid transference of heat to the water, and added to this the ratio of heating surface to grate area is increased from 25 to 1 to 50 to 1. Thus the reason for the increased duty and efficiency becomes clear.

Having outlined his ideas so far as the boiler grates are concerned, the writer will now point out minor defects in the general practice of steam plants.

Fire 10 Inches Thick

A fire to be effective should not be less than 10 inches thick, it should be maintained at its maximum temperature, and this can be done by stoking it when at its best, for the liberated gases then quickly ignite and heat, instead of smoke, is produced.

To secure a smokeless fire stoking should be on the sides of the fire only and alternately—i.e., with two boilers a fireman should stoke the right-hand side of each fire, and after waiting a few minutes stoke the left sides—and by this means the required supply of hot air is provided for combustion.

If the fuel used is of the coking kind, the fireman should discard the drag or rake and use the poker only for allowing the air free access into the body of the fires.

The fuel should be kept as dry as possible, for damp coal not only minimizes the draught, but part of its heat has to be used for evaporating the moisture, and also for superheating the steam thus produced.

When mechanical stokers are in use, provision should be made for the clinker passing over a long deadplate behind the bars, as this enables a thicker fire to be maintained than is possible when the ash pit is close to the end of the bars.

Sweating Takes Place

Where the feed water entering an economizer is below 90 deg. F., and steam jets are used for producing draught, the gases become charged with moisture, and as their temperature is reduced below the dew point, condensation, or as it is generally termed, sweating, on the tube takes place, and this moisture gets under the soot on the bottom boxes and corrosion soon follows, especially when the fuel used contains sulphur.

The economizer, one of the most valuable helps we have outside the boiler, owes its birth and existence to our generally wasteful habits, and will continue to be needed until we learn to set, fit up, and stoke our boilers on more scientific lines.

If boilers are worked on the economical lines already indicated, the duty of the economizer is comparatively small, but for boiler plants such as the writer has recently seen, where over 30 lbs. of air per pound of coal were used, the economizers were doing nearly 25 per cent. of the total work.

Many steam users to-day are lulled into false security by the thermometer indicating the temperature of the water in the economizer as nearly equal to that of the steam in the boiler, whereas such a temperature is one of the best indications of wastage, since it can only be attained by the high temperature of the gases leaving the boiler, a condition not conducive to economy.

Others, again, are satisfied if the temperature of the gases at the chimney is low, the impression being that the low temperature is proof that the heat generated to the furnaces has been transmitted to the water in the boiler, and if all things are right, that assumption may be correct.

Detrimental to Life

As ebullition in a boiler can only take place above the furnace flues, the present practice of delivering the feed water into this section of the boiler is detrimental both to the life and efficiency of the boiler, since lime and other foreign matter in the water settles on the furnace flues and creates scale, which increases the cost of steam production and increases the danger of furnace flues collapsing.

Water is a poor conductor but a good carrier of heat, and it is, therefore, advantageous to deliver the feed water at or near the bottom of the boiler, and by fixing a suitable circular over the fireboxes where rapid ebullition takes place, a motion parallel to the boiler flues is given to the water, thus distributing the heat, with the result that ebullition is maintained the full length of the boiler.

The value of equal distribution of the heat inside of a boiler is very great, as a flue when covered with water boiling rapidly will transmit about 50 per cent. more heat per unit of area than when the water is stagnant, free circulation is, therefore, a factor in favor of coal economy.

Cut Heat Losses

Division walls between boilers should not be less than 16 inches thick, with a 2-inch cavity in the centre filled with flue dust, and all external walls should befitted with a similar dust cavity, the effect of which is to reduce to a minimum heat losses through the brickwork.

Along the centre of each furnace flue a 4½-inch brickwork wall should be erected, starting 4 feet behind the bridge and continuing for 15 feet, and along the centre of the bottom flue to within 6 feet of the front end of boiler, a midfeather 9-inch wall to be built to within 3 inches of the boiler plates.

The object of midfeather walls is to convert the carried heat of the gases into radiant heat, thus enabling the boiler to receive a larger share of the heat liberated than is at present possible; further, such heat accumulators neutralizes the effect of cold air passing along the flues during stoking and cleaning periods, and act in the same capacity to the furnaces as the flywheel to the engine.

Under normal working conditions about 18 per cent. of the fuel used by a boiler is used in banking up and restarting the furnaces, and where the brickwork walls are in use part of the heat taken up by the brickwork during working hours is given up to the boiler during meal-times or through the night. In several cases known to the writer the firemen, since the introduction of these heat accumulators, commence work at 5.50 a.m. instead of 5 a. m. as previously, since they find the steam near blowing off on their arrival, forcing the fires is thus not necessary, and economy is affected.

Chimney Vital Factor

The cost of natural draught varies from 10 to 25 per cent. of the value of the coal used, the chimney is therefore, one of the factors to which the coal economist should pay careful attention. The general boast of the steam user who has a good chimney is "I can burn anything in my furnaces. No fan draught can help me." Yet the truth is that the draught produced is proportional to the weight of coal wasted.

Induced draught is produced by means of a centrifugal fan placed between the economizer and the chimney, and in such a manner that by the changing positions of two dampers the fan draught or chimney only can be used as desired.

An induced-draught fan enables the attendant to supply exactly the weight of air required for combustion. and thus secure a high furnace temperature, a smokeless chimney, and the maximum transmission of heat per pound of coal burned.

It is a common practice for three boilers under fan draught to give the same evaporation as four boilers with natural draught, as the rate of consumption is simply the measure of the speed at which the fan is running.

Overall Efficiency

The writer has seen many cases where the overall efficiency of the plant has increased from 7 to 10 per cent. after the adoption of fan draught, and such improvements are constant, not being effected in any way by atmospheric changes.

The more important conclusions to be drawn may be summarized as follows:—

The temperature of combustion is constant, but too high for steam-raising; but with a constant supply of air, say 18 lbs. per pound of coal, the resulting temperature is also constant, every pound of excess of air is directly or indirectly equivalent to an additional 1 per cent. loss in fuel.

A flame flued boiler gives its highest duty and efficiency when the fire-grates are not more than twice the area of the outlet for the products of combustion at the ends of the furnace flues.

Radiate Twice Heat

A furnace of 20 square feet area fed with coal and air in the proportion of 1 to 18 will radiate twice as much heat per unit of time as a furnace of 30 square feet area fed with coal and air in the proportion of 1 to 30.

The terminal temperature alone is no guide to a boiler's efficiency or duty, a boiler is giving the best results which has the greatest difference between its initial and terminal temperature.

As water is a poor conductor of heat, circulation should be made compulsory.

A chimney draught costs approximately 20 per cent. of the value of the coal used on the boilers.

To drive an induced draught fan costs 2 per cent. of the steam generated. Saving by induced draught not less than 8 per cent. and often more.

Heat accumulators in furnace flues and bottom flues are beneficial both to life and duty of boilers.

This does not by any means exhaust the subject, but indicates in what direction economy may be effected, and in conclusion the writer submits a few notes specially written for the assistance of stationary engineers in Canada.

For stoking a boiler, air is just as necessary as coal, and the best results are secured with 240 cubic feet of air per pound of coal, this mixture giving a furnace temperature of nearly 2,700 deg. F.

390 Cubic Feet of Air

In general practice 390 cubic feet of air, or even more, are supplied per pound of coal, and this gives a temperature of not more than 1,700 deg. The first-mentioned mixture in a well-set boiler and with good fuel evaporates about 10 lbs. of water, but the second less than 7 lbs.

If a furnace temperature falls below 1,200 deg. F., black smoke will be formed, and as each cubic foot of black smoke contains 2 grains of coal, by allowing 390 cubic feet of air per pound of coal, 11 per cent. is wasted during a black-smoked period.

A dull-red fire has a temperature of about 1,290 deg. F., but a white fire 2,500 deg. to 2,700.

Heat passes quickly through a clean boiler plate, but very slowly through a plate covered with scale; therefore, keep the boiler clean.

Economy in raising steam is secured when the furnace temperature is high, and the temperature of the gases leaving the economizer is low.

Do not use more than four shovelfuls at a stoking. Keep the bars well covered, especially at the back.

Do not let the steam gauge indicate when to fire, nor let the chimney tell the smoke inspector when the boiler has been fired.

Stoke when the fires are at their best, but never stoke when the chimneys still smoke, since this is a sure indication that the fires are not hot enough to ignite the gases, and more coals only make bad worse.

Do not keep the furnace doors open for any purpose longer than can possibly be helped.

Do not forget that a fire-grate 4½ feet long is more economical than one 6 feet long.

Do not forget to keep stokers clean and well oiled. Do not have the fires on the dead plates, for this burns the doors away and allows cold air to get over the fires.

Do not forget to brush well the brickwork of the side flues each time that the boiler is blown off for cleaning.

Do not have the water in the boiler above the ordinary working level.

Do not have any air leakages through the brickwork of the boilers or the economizer.

Finally, remember that the above suggestions are the outcome of practical experience, and if adopted will reduce work, save employer's money and give a purer air for all to breathe.

The turbine can be designed to operate on very low terminal pressures with comparatively slight increase of cost; its action as a heat machine is such that a greater expansion can be utilized and the economy is greatly improved by any increase in vacuum. When run non-condensing the turbine is less economical than the non-condensing engine.

One of the large heat losses incurred in the steam engine is that due to cylinder condensation, and one of the common methods of reducing it is to limit the range of temperature through which the steam is allowed to work in a single cylinder. For this reason simple engines are better adapted for low steam pressure, while compound and triple-expansion engines are advisable for high-pressure and high-temperature ranges, particularly if the load is uniform.

Rich Hydro Electric Possibilities in Quebec

By JULIAN C. SMITH,* M.E.I.C.

Present Rate of Increase Shows More Than Seven Million Horse Power Will be Developed and Utilized in Province in the Next Twenty-Nine Years

THE province of Quebec comprises that vast stretch of territory lying East of the River Ottawa and North of the United States boundary line, bounded on the North by Hudson's Strait, on the West by Hudson's Bay, and on the East by Labrador. The Province is 2,000 miles in width from the North to South, and 1,350 from East to West.

The northern section is for the most part uninhabited, but the southwestern portion lying along the lower part of the Ottawa and St. Lawrence Rivers, and extending south to the American border and east to the Saguenay River is an important and rapidly growing industrial section.

Topographically, the country north of the River St. Lawrence is divided into three great water-sheds; south of the river and west of the town of Levis, which is opposite the city of Quebec the country is a low lying fertile plain. East of the town of Levis the land rises gently to between one thousand and two thousand feet, with elevations of nearly five thousand feet in the Gaspe Peninsula. On this south side of the river there is no large waterpower as the watershed is comparatively narrow and although well watered is traversed by only a few rivers of any magnitude.

Drains Large Rivers

The north watershed is drained by many large rivers flowing into James Bay, and when the development of the country has progressed far enough to permit the waterpowers of these rivers to be utilized, enormous amounts of power will become available on the Nottaway, Rupert, East Main, and Kaniapiskau Rivers.

The east watershed is drained principally by the Hamilton River on which is situated a waterpower estimated at 700,000 horse-power at Great Falls, some 350 miles from the mouth of the river, and 200 miles north of the St. Lawrence River at the west end of the Anticosti Island.

The ultimate source of the water power of any country is the precipitation and the total potential water power produced by the precipitation may be estimated by calculating the potential energy of this precipitation in its descent from the high lands to the sea.

To calculate the total potential waterpower of the Province of Quebec we may superimpose a map of the precipitation upon a topographical map of the province and then divide the province into areas having the same average elevation and approximately the same precipitation. An estimate of the potential energy due to the precipitations can then easily be made. The precipitation in inches per year at different points of the province is as follows:—

Montreal—40.
Quebec—40.5.
Brome—34.3.
Father Point—33.58.
Shawinigan—37.61.
La Loutre—
Chicoutimi—30.
Anticosti Is.—36.

Julian C. Smith, the author of this article and president of the St. Maurice Power Company, Public Service Corporation, Quebec City; Canada Carbide Co.; Canadian Electric Products & North Shore Power Co.; vice-president and general manager of the Shawinigan Water & Power Co., consulting engineer and director of the Manitoba Power Co., has been appointed president of the Quebec Railway.

Half Energy Lost

While it is impossible to state accurately the percentage of energy lost before the gathering together of water takes place, it may be conservatively estimated at 50 per cent. on an average over the steep and shallow valleys that go to make up the different drainage basins.

As continuity of supply is an essential condition to all power service, due allowance must be made for the fact that while the precipitation is more or less equally distributed during the year, the run-off from the precipitation is unequally divided among the different seasons.

During the spring thaw the melting and running away of the accumulated winter snowfall produce flood conditions on all rivers and streams, raising the flow to as much as 20 to 100 times the minimum. The necessary waste of the greater part of the water reduces still further the quantity of energy which may be considered as available for industrial uses even under ultimate conditions of development.

Combining the sources of lost energy enumerated we may assume therefore that the actual potential electric energy of the Province of Quebec is approximately thirteen to fifteen millions of continuous kilowatts.

Cuts Power Available

In the present stage of the art of the development and distribution of hydroelectric power, only those sites near industrial centres and at which water power exists in considerable quantities are capable of being developed. The theoretical available quantity of fifteen to eighteen million kilowatts of continuous power must therefore be very considerably reduced in considering the quantity of power that is actually adaptable to industrial purposes.

From recent surveys of the waterpowers of the province, and considering only those rivers on which waterpower is available in such quantities and in such locations as could be economically developed either now or in the near future, the quantity of actually available waterpower in the province is estimated at approximately 5.25 million kilowatts of continuous power, of which some 800,000 kilowatts have now been developed and utilized. There remains therefore in the province of Quebec an available commercial waterpower about 4.5 million kilowatts of continuous power or about 12 million horse-power at 50 per cent. load factor.

The various amounts of power mentioned in this article so far have been described as continuous power, by which it is meant that the flow of water producing this power is sufficient to provide the full quantity of power twenty-four hours a day, three hundred and sixty-five days in the year, and I am now going to digress for a moment from the main subject of this paper to say a few words upon the subject of "Load Factor" or the proportionate duration of use of power.

Using "Load Factor"

It must be borne in mind that no industry is able to make continuous use of the power which it requires and therefore no power company supplying power for industrial purposes is called upon to supply the total amount of contracted power all day every day in the year. The term "Load Factor" is used as a measure of the duration of use of power and is defined as average power divided by peak power.

The load factors of different industrial loads in Quebec differ considerably.

---

*President, Quebec Railway, Light, Heat and Power Company. Extracts from a paper presented at the Annual Convention of the A.S.M.E. in Montreal.

For instance, power mills operate at a load factor of between 65 per cent. and 75 per cent. averaging more nearly 65 per cent., carbide and electro chemical plants operate at 85-90 per cent. load factor, cement mills 80 per cent. to 90 per cent. load factor, asbestos and mining industries 45 per cent. load factor.

The load factor of hydro-electric stations supplying various industrial establishments and providing power and lighting service to communities will obviously be the average of the combined load factors of the various loads. Such plants will therefore, not require to use continuously the flow of its water which will produce maximum output.

Providing sufficient water storage capacity exists, the surplus energy that the normal flow of the river could produce may be stored in the form of water, but otherwise a certain portion of the available energy which might be very great at certain seasons in the year must be allowed to run to waste. In estimating the amount of energy available for industrial uses from the flow of the river at a given head, due consideration must therefore always be given to the storage capacity of the watershed and to the amount of regulation of flow which is possible with full utilization of the storage capacity.

Increased Water Flow

In plants where no storage capacity exists, the installation of sufficient generating capacity to consume the increased flow of water during the six high water months becomes economically justifiable by the use of electric steam generators as an adjunct to the plant to make possible the utilization of the excess energy produced during these months by its conversion into steam.

The ability to obtain a return from all the energy available at all times of the year will make possible the development of many power sites, which is dependent solely upon the sale of continuous electric power as such, might remain undeveloped.

The earliest water power developments in the province were the old seigniorial mills constructed by the French Seignoirs, to grind the grain of their dependents. These mills were in existence as early as 1650.

These little grist mills were almost always developed by the construction of a small canal which carried the water to an overshot or undershot wheel where the heads used varied from about five or six feet up to ten or fifteen feet.

Built in 1895

The first hydro-electric development was the Montmorency plant near the mounth of the Montmerency River, seven miles below Quebec, built in 1895 and having an installed capacity of five 600 K. W. generators.

The two great developments existing to-day in the Province, are located at Cedars Rapids in the St. Lawrence River, thirty miles west of Montreal, and the developments on the St. Maurice River at Shawinigan Falls and Grand Mere. The third great power which ultimately may eclipse these is now being constructed on the Saguenay River just below the outlet of Lake St. John.

In addition to the above plants which generate electricity for use in public utility service or for industrial service in the neighborhood of power developments, there are a large number of hydraulic developments supplying power for grinding wood. These plants are widely scattered throughout the province, most of them having been built prior to 1910.

The total amount of hydraulic power used directly for this purpose in the Province, has been stated by the Water Power Branch to the 162,825 h.p.

With the advent of the vertical turbine and the increase in the size of electrical generating units, it became in many cases more economical to develop the power in the form of electricity to be transmitted to Pulp and Paper Mills constructed in favourable positions rather than to locate the mills at the site of the power development. The amount of hydro-electric power so used is stated to be 157,367 h.p., making a total of 320,193 h.p. of hydraulic turbines employed in the pulp and paper industry.

JULIAN C. SMITH, M.E.I.C.

Joins St. Lawrence

The St. Maurice River is a large tributary of the St. Lawrence, and flowing from the north joins the St. Lawrence at Three Rivers, halfway between Montreal and Quebec. The main power developments on the river are located at Shawinigan Falls and Grand Mere, twenty-one and twenty-seven miles respectively north of the city of Three Rivers.

The plants of the Shawinigan Water & Power Company are located at Shawinigan Falls, where the natural formation of the Falls furnishes an ideal location for power development. The available head is about 150 feet and after the dams and headworks had been constructed, the first two units in power house No. 1 of 5,000 h.p. capacity each, were put into commission in 1902. In 1909 the capacity of the station was 58,500 h.p., all the generators being of the horizontal type.

Power house No. 2 with two horizontal units of 18,700 h.p. capacity each, was in operation in 1911. Later three additional units of similar size were installed. The output of this station now totals 136,500 h.p., the latest unit put in commission in October 1922 being of the vertical type and having a rating of 43,000 h.p.

The water is carried to the turbine of the latest unit through a tunnel cut through the solid rock, while in all earlier installations of both power houses, concrete covered steel penstocks were used. At present the combined generating capacity of the two stations is 195,000 h.p., with provision for two more 43,000 units.

Operate Two Plants

The Northern Aluminum Company at Shawinigan Falls operates two power plants generating direct current for use in its own works. The total capacity of these plants is about 40,000 h.p., the units being of the horizontal type with each turbine driving two direct current generators.

At Grand Mere, six miles above Shawinigan Falls, is located the plant of the Laurentide Power Company. There is a head of about eighty-four feet and work on the power development was completed in 1916. The power house is built on the dam, and at present there are installed eight vertical units of 20,000 h.p. capacity each, with provision for one more unit.

The efficient operation at all times of the year of these hydro-electric developments on the St. Maurice River is largely due to the extensions of the Gouin Dam at La Loutre, two hundred miles above Shawinigan Falls. This dam is owned by the Provincial Government and creates the second largest storage basin in the world.

Serve City of Montreal

The Montreal Light, Heat and Power Consolidated, which serves most of the city of Montreal and surrounding district, besides taking a large amount of power from the Shawinigan Company, also owns and operates four hydro electric plants. The largest of these is located at Cedars Rapids on the St. Lawrence River about thirty miles above Montreal.

The plant is on the north side of the river, where a rock-filled dyke two miles long and paralleling the shore gives a headrace canal one thousand feet wide whose lower end terminates with the power house. The turbines operate under a head of thirty-two feet, and the present installation consists of twelve 12,500 h.p. and two 13,200 h.p. generators with four 1,500 h.p. water-wheel-driven exciter units. All units are of the vertical type.

The Montreal Light, Heat & Power Company also operates Soulanges plant, located on the St. Lawrence River about thirty miles above Montreal, with a head of fifty feet and an output of 15,000 h.p.; the Lachine plant at the Lachine Rapids, six miles above Montreal on the St. Lawrence, with a head of fourteen feet and twelve units giving an output of 13,000 h.p., and the Chambly plant on the Richelieu River, with an installation of eight units and a total output of 31,000 h.p.

The Quebec-New England Hydro Electric Corporation, formerly the Montreal Public Service Corporation, distributes power in the city of Montreal which is generated at its hydro electric plant at St. Timothee. St. Timothee is on the south side of the St. Lawrence River about thirty miles above Montreal.

Use has been made of a portion of the old Beauharnois Canal, which has been enlarged, and the drop due to the Coteau and Cedar Rapids is utilized to obtain a head of fifty feet. The plant was put in commission in 1911, and four 5,300 h.p. horizontal units are installed, giving an output of 21,000 h.p. The power is transmitted to Montreal at 44,000 volts.

Used as Reserve

At Hull, on the Ottawa River, the Ottawa and Hull Power & Manufacturing Company operate two hydro-electric plants. Their older plant of 10,000 h.p. capacity is now used as a reserve, depending on water conditions, while in their No. 2 plant there are two 10,000 h.p. horizontal units with the turbines operating under a head of forty feet.

The Southern Canada Power Company have a hydro-electric plant at Drummondville on the St. Francis River which is a tributary of the St. Lawrence on the south side. There are at present in operation two 3,350 h.p. units in the Drummondville plant with provision for the installation of two more units of similar size. The available head is 32 ft.

Construction Started

Construction has been started on several new developments during the last twelve months and the work is being actively carried on at the present time. Of chief importance, due to the size of the undertaking, is the project of the Quebec Development Co., on the Saguenay River.

The source of the Saguenay is Lake St. John, one hundred miles from its mouth, and the elevation of the lake is about 315 feet above mean sea level. Its watershed is approximately 30,000 square miles and the area of the lake varies from three hundred and twelve square miles at the extreme low water, to four hundred and two square miles at flood time. About 300 feet of the total drop from Lake St. John to Tidewater takes place within 25 miles and may be concentrated at two points. It is planned to develop 400,000 horsepower at the outlet of the lake, and 800,000 horsepower lower down the river; giving finally a total output of 1,200,000 horsepower. Work is at present proceeding on the 400,000 h.p. plant, which is expected to be delivering power in two or three years.

Develop Water Power

The Shawinigan Water & Power Company, through the St. Maurice Power Co., a subsidiary company, is developing the water power at the Gres Falls and La Gabelle Rapids on the St. Maurice River, six miles below Shawinigan Falls. By utilizing the total drop of the rapids and falls, which are close together, a head of sixty-five feet will be obtained, and four units of 33,000 h.p. each will be installed, giving a maximum output of 132,000 h.p., which will be fed into the Shawinigan Company's transmission system.

Another new plant upon which construction has commenced is the Calumet Island development of the Ottawa and Hull Power & Manufacturing Company. The site is near the town of Bryson, about forty-eight miles above Ottawa on the Ottawa River. When the dam is completed a head of 60 feet will be obtained and units will be installed to give a total output of 60,000 h. p.

There are certain difficulties which occur in waterpower engineering in this province, which meet engineers in every locality where the climatic conditions are similar to those which obtain in this latitude. Ice troubles in the past have caused serious interruptions of service and reductions in the available amount of power.

Two Broad Divisions

These troubles may be divided into two broad divisions:

a. Ice troubles occurring in the power house itself, due to the presence of ice on the racks on the waterwheels.

b. Troubles occurring in the water channels above or below the power house affecting the head acting on the turbine.

To a large extent the troubles in classification "a" have been overcome by better design of the power house and better knowledge of the cause of these troubles. By enclosing the rack structure and by getting the turbine chambers warm and in general by the use of larger units, much of the trouble which was experienced formerly, has vanished. The other trouble is more difficult to remedy, and inasmuch as the change of levels may be due to blockades of considerable area the remedy in most cases is peculiar to the power development.

Most plants on the St. Lawrence River experience variations in height of headwater or tailwater due to ice blockades at long distances from the power house. On smaller streams and particularly very small streams, these blockades may be extremely serious, as they may and do affect a large portion of the flow of the river.

Minimize Difficulties

In large power developments ways and means have been developed which minimize to a considerable extent these difficulties, and the expense of carrying out such efforts is justified in case of large plants where it would not be in a small one.

By keeping the channels open to permit the frazile ice to come up to the surface, and by the use of various skimming devices for keeping rid of this ice, a very considerable degree of success has been obtained at the Cedars plant on the St. Lawrence River. It may fairly be stated that while this ice difficulty was a serious menace some years ago, now such is not the case, provided the plant is a large one and has been located and built with the knowledge acquired from the operation of existing installations.

At the present rate of increase the total available amount of hydraulic power which is estimated at 5.25 million kilowatts or about seven million horsepower will be developed and utilized in the next twenty-nine years.

As the increase in the development will in general follow the increase in the population, the developments will increase at an increasing rate and the period before the development of all the power now in sight will be therefore considerably shorter than twenty-nine years arrived at by assuming a uniform rate of increase. A careful study indicates that in twenty to twenty-five years the seven million horse-power will be used up.

This time might be materially shortened if any large amount of power were exported from Canada.

ICE AND COLD STORAGE TRADES DIRECTORY FOR THE UNITED KINGDOM FOR 1923

Published by Iliffe & Sons, Ltd., London. Price $2.75.

The present edition has been revised and brought up-to-date, the addition of over six hundred new names in the alphabetical section, with the corresponding insertions in the classified trade section, necessitating an increase of 45 pages. Several new headings have been added for the first time, thus again marking the ever-increasing application of refrigeration to new branches of trade.

The directory is of great value, not only to those directly connected with cold storage and ice-making, but also to the many firms manufacturing requisites for those industries. A leading feature of the directory has always been the list of vessels fitted with refrigeration, and no effort has been spared in making it as complete as possible. In this section a large number of new vessels are included, while many former vessels have had to be inserted under new names owing to the assignment of certain ships to new owners under the reparation clauses of the Peace Treaty.

When the packing sticks in the stuffing-box of an engine, remove the flange, place the engine on the crank-end dead-centre and admit steam, which will blow the packing out on the rod.

Editorial Comment

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

NITA C. SHATFORD
News Editor

Associations of Value

STATIONARY engineers in Canada are to-day reaching forward to careers of essential service to their employers, that is unmistakably the meaning of the phenomenal success assured the C.A.S.E. convention in Toronto next week.

Behind such a gathering are years of arduous work—a continual putting forth of effort on the part of a few to inspire the many to a realization of the opportunities for advancement in their profession and to a practical vision of what may be done to brighten the rather humdrum day in the average power plant.

Practical Work Best

IT is so much easier to learn how a thing is done than how to do it, that there is a great tendency at the present day to exalt academic instruction at the expense of practical training.

Boob work alone will never make an engineer, and much less will it teach the art of handling men which is so essential in the larger power plants.

From the university graduate in honors at one end of the scale down to the ambitious youth who puts a cross opposite the profession he would like to enter and then takes an advertised course of lessons by mail, no man can master the art of engineering without acquiring the most essential part of the knowledge by practical work in the boiler room.

On the Editorial Sea

PASSING events shape the editorial course, but the inspiration—the power to accomplish—comes when readers respond in no uncertain way to what they feel are right steps and commendable innovations.

The enthusiastic response that has come in the last few weeks from engineers throughout the Dominion has made this issue of Power House bigger and better in order to present in it a completely rounded exposition of the best in power plant methods.

Never forget for a moment that readers of the only Canadian newspaper devoted to the development of power for all industries, alone shape its course. Power House is published with the serious purpose of instructing and inspiring toward the best use of combustion methods, to reduce the cost of power generation and increase in a tangible manner the value of the operating engineer to his employer, a purpose which it must be admitted, needs constant revitalizing and inspiration.

This can only be obtained when every reader becomes an active member of the editorial staff, giving freely all his comments, suggestions, criticisms or approval.

The Fuel Demon Air

THE air demon is usually the cause of one of the greatest losses in a steam power plant. It may penetrate through a sudden crack or fissure in the fuel bed, and the up-to-date engineer must know where and why it entered because the answer directly affects his operating procedure.

He may ignore the air leaks which are always present around the breeching and uptake for minor losses beyond the point where the gases leave the last heating surface of the boiler itself can have little bearing on combustion problems.

Firemen are aware of the fact that coal doors must be open as little and as infrequently as possible. They understand that if they were left open between firings, or not closed instantly after firing, the steam pressure gauge would drop at once, and firemen are accustomed to running their boilers by the gauge—no matter what the cost. Yet although the destructive effect of cold air entering through the fuel doors is fully realized, the average fireman gives scant attention to this very same cold air when it enters through cracks and bare areas on the grates themselves and still less is he concerned over leaks in the brick setting of the boiler.

Prime Movers Report

THE report of the Prime Movers Committee of the N.E. L.A. this year took on a new form. It came rather as an abstract and a forecast than as a report. It is, however, possibly more informative and more enlightening to see what the committee believes to be of sufficient importance to spotlight.

All through its pages there is unmistakable evidence of a keen appreciation of the changes that are taking place in the central station, particularly in regard to furnaces and their relation to the boiler, to the introduction of air heaters, and to the realization of the absence of any real data of an up-to-date character on stacks and their construction with relation to the needs of the modern plant.

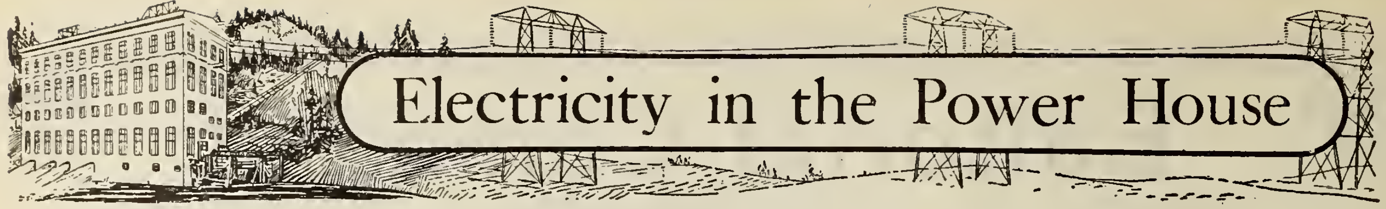
There is no mention of the super-power survey and it is evident that this subject is not looming as large in the minds of the industry as its romantic possibilities would naturally lead one to assume. However, time is an element in all such matters, and it may be that with the lapse of time, the thought of the industry will crystallize and become definite on the point.

Practical Knowledge Best

SCARCELY a day passes in which the engineer does not make some mention of B.t.u.—those little somethings that are produced by the burning of fuel and turned into useful work by the engine or turbine, yet, were the average engineer to be asked, "What is heat?" he would reply in words similar to, "Motion of the minute particles or molecules of the body."

The more learned would give a longer explanation, but the fact remains that its exact composition is a secret of nature just as much as electricity.

The engineer, however, does not need to know what heat is, but he must know how to produce steam economically. To be able merely to state that a B.t.u. is the heat required to raise 1 lb. of water 1 F. and that a pound of good coal contains about 13,500 B.t.u. is but one side; to be able to keep a boiler clean, to detect and stop infiltration of air through cracks in the boiler setting, to regulate the damper, to anticipate overloads and be ready with clean fires to meet them, will do more to keep down fuel costs than text book information.



Electricity in the Power House

WHY MOTORS STALL

In doing repair work in different shops not infrequently a motor would go bad and the shop would want an opinion as to the cause.

Invariably the symptoms were an apparent lack of power or a slowing up, lasting for days or weeks, growing worse, and then blown fuses and stalled motors. As the current used was a.c. and the motors all induction motors, there was never any chance of wrong connections or commutation troubles. When the motors displayed this lack of power, the first thing the operator would do would be to fill the oil reservoirs, to overflowing, of course. Actually this made matters worse because the oil that spilled over ran down the frame and on to the windings.

Dirt Causes Trouble

In every case of this sort we found that the trouble lay in dirt between the rotor and the laminations of the stator. This dirt was gummy enough to form a grip between these two close-working members and drag and drag, requiring the full power of the motor to turn it over light, without supplying any to the machine.

Taking the rotor out is the only remedy. Then its external metal surface is scraped free of the accumulation and washed with soda water. The inside of the coil ring is also thoroughly cleaned by scraping. As this gummy substance gets stuck to the coils too, it is a good plan to go over the coils as far as possible with a soft brush, dipped in the hot soda water, scrubbing off all the wires that can be reached. Whatever accumulation of any sort is upon the wires should always be cleaned off on general principles.

When the motor is assembled it will be found to turn "as free as water," and it will have plenty of power when hooked up to its load.

It is very easy to detect the kind of trouble mentioned, once you realize that the source of trouble is self evident.

Matter is Puzzling

With the gummy drag on the rotor, however, there is practically no indication of the reason for stalling and, unless one has been through it before, the matter is puzzling. The quickest way to determine it, is to throw off the belt or slip off the pinion and see if the rotor turns freely. If an otherwise satisfactory motor has blown fuses, it will be found that the rotor cannot be turned by hand, so great is the drag of the gum that has built up in that thirty-second of space between the two members.

Usually this trouble occurs where a motor is easy to get at and the operator is tempted to overdo the oiling. The excess of oil sticks and it travels slowly inward, aided by the fan action of the rotor and abetted by the dust of the room. The writer has found that motors well overhead in the dustiest of rooms were freer from this trouble than those in much cleaner rooms but in more accessible locations. —L. Thomson.

CORRECTING POLARITY

Four methods for correcting reversed polarity of direct-current generators are given in an operating code published this week.

The first method is applicable only to compound-wound generators which can be paralelled with one or more compound-wound generators of correct polarity carrying load. The equalizer switches of these machines, when closed, connect the inner terminals of the series field windings of two or more generators in parallel, equalizing the potential at these points and thereby causing proper division of the total load current among the series-field windings.

When the equalizer switches of all the machines in operation are closed and when the equalizer switch and the bus switch on the same side of the reversed machine are also closed, the series field of the reversed machine is placed in parallel with those of the machines in operation and so takes its normal share of the total load current.

Direction of Current

The current in the series field of the reversed machine is in the same direction as the normal operating current and thus tends to build up a field of proper polarity; if strong enough to overcome the residual magnetism, it will reverse the polarity to normal.

If this method fails to reverse the polarity, the method about to be described should be used. This method applies to shunt-wound or compound-wound generators when the bus can be energized from a source of correct polarity.

By this method, with the positive machine switch open and the positive shunt-field lead connected to the positive bus, current flows through the shunt field circuit, but not through the armature when the negative and circuit breaker and negative machine switch are closed. This develops a field of correct polarity in the field circuit, and when the machine is shut down the residual magnetism will be of correct polarity. Therefore, when the machine is again started up, it will build up with correct polarity.

Method of "Flashing"

When no source of correct polarity is available, a third method known as "flashing" may be used. In this case the shunt-field leads are reversed and the circuit through the shunt field is closed for an instant while in this reversed condition. This causes a wave of current to flow through the shunt-field circuit in the normal direction and of sufficient strength to reverse the existing residual magnetism. If the machine is then started up normally, the field will build up with correct polarity.

The fourth method is applicable to motor-generators which can be started from the direct-current end. This method is based on the fact that a shunt-wound or compound-wound generator of given polarity must be supplied with current of the same polarity in order to operate as a motor in the same direction. When current of normal polarity is supplied to such a machine, it re-establishes the normal polarity of the field and, consequently, that of the generator.

Convention Notes

The Universal Craftsmen Council of Engineers will hold its 21st annual convention in Rochester, N. Y., from August 7th to 10th. An elaborate program has been arranged by the Convention Committee in conjunction with the Ladies' Convention Committee.

Book Reviews

Doubleday, Page & Company have published for the Underwriters Laboratories a book entitled "A Symbol of Safety" which outlines the activity and functions of the company. Numerous illustrations show the nature of the experiments and research in testing materials and appliances used in fire and accident prevention.

The advantages of small, high-velocity steam piping are: Lower first cost for pipe, valves and covering, etc.; less erecting and maintenance cost; less weight; less radiation loss; less chance for water to accumulate and less difficulty with valves of smaller size.

The engine as a rule develops mechanical troubles with high superheat, especially where the steam valves have much travel under unbalanced pressures. The consensus of opinion seems to be that for slide or gridiron-valve gears a temperature of 400 to 425 deg. F. should not be exceeded, while the best point for the Corliss-type engine will be found below 450 deg. F. Above these limits lubrication is unsatisfactory and distortion of the parts is apt to give trouble.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

REPAIRING CROWN SHEET

The crown sheet in a locomotive type boiler used on the road was allowed to become dry for about one-quarter of its length from the front, resulting in a very noticeable sag around one stay bolt, causing serious leakage when steam was being raised. The leakage stops after the pressure reaches 50 lbs. but reappears when the pressure drops. The boiler has been in use about 8 years, operating at 150 lbs. pressure. Very dirty feed water has been used at times.

Would you advise lowering the pressure till the necessary repairs were made? Is the plate damaged and could a satisfactory repair be made by installing a new oversize staybolt?

Are boilers of this class inspected by the government when built at the factory?

In the gas engine h.p. formula given on page 28, December 5 issue of Power House, are the measurements for diameter and radius of pulleys and also the length of levers computed in feet or inches? —Roy J. Brodie, Forest, Ont.

Answer:—It is not possible to say whether or not the boiler would be dangerous, but it should be repaired at once. In all probability the plate has not been burnt so that putting in a slightly oversize stay bolt should make a satisfactory repair. It would be better to heat the plate by oxy-acetylene and drive the plate back to place before putting in the new staybolt, taking care not to heat the plate too locally. When putting in the new staybolt, allow it to project through the plate to hold a thin nut about the diameter of the stay, calking the plate tight around the staybolt before screwing the nut tight. This is done quite extensively with marine boilers.

All boilers in Ontario are subject to inspection by the Steam Boiler Branch of the Department of Labor when under construction.

In the gas engine formula in the Dec. 5 issue all measurements are in feet.

PUMP CAPACITY

One electrically-driven turbine pump delivers 538 gallons per minute through a 12-in. vertical pipe when another pump of the same capacity is delivering to the same vertical pipe, the combined discharge is only 958 gallons per minute. What capacity would three pumps give, delivering to the same pump against a head of 80 lbs.?—C. M. V., Nova Scotia.

Answer:—The discharge of 958 gallons instead of 1,076 gallons is due to the increased head against which the pump must work. The velocity of the water in the 12-in. pipe has nearly doubled, resulting in increased functional losses. The addition of a third pump would probably result in a loss of capacity greater in proportion than loss due to two pumps. The combined discharge of the three pumps might be between 1,200 and 1,300 gallons per minute.

CONNECTING TWO PUMPS

An electrically-driven turbine pump delivers 500 gallons per minute against an 80-lb. head, through a 12-in. vertical pipe. Is it practical to connect the discharge of a 1,000-gallon-per-minute pump to the same 12-in. line, running both pumps together? What would the combined discharge be? Is it good practice to use the same diameter pipes in the suction and discharge of a pump?

—C. M. V., Nova Scotia.

Answer:—If two pumps of the same characteristics are used, they could run together and the combined discharge would only be slightly less than 1,500 gallons per minute due to increased functional losses. On the other hand, if one pump had a flat characteristic and the other a falling, the combined discharge would be cut down considerably. It is a common practice to use the same size discharge and suction pipes on large pumps. A larger suction pipe gives only slightly less frictional losses, it is more important to keep sharp bends out of the suction cline. Many pump manufacturers use a taper connection on the suction and discharge of the pump.

THERMAL EFFICIENCY

How would you find the thermal efficiency of a boiler? —A. N.

Answer:—By subtracting the temperature of the gases at the uptake from the temperature of the furnace and dividing by the absolute temperature of the furnace. For example, what will be the thermal efficiency of a boiler having the temperature of the gases at the uptake 600 degrees and the temperature of the furnace 2800 degrees. Thus (2800—600, divided by (2800 plus 460) equals .6748 and multiplied by 100 equals 67.48%. This is the percentage of the heat that has been absorbed by the water in the boiler. The balance or 31.52% has been given to the furnace walls, settings and has passed up the stack.

CIRCULATION IN B. & W. BOILER

Explain the circulation of water in a B. & W. boiler.

Answer:—The circulation of water in a B. & W. boiler is from front to rear of steam drum, down rear tubes and headers thence through inclined tubes to front headers, up through front headers and into the steam drum.

FUSIBLE PLUGS

Where should a fusible plug be placed in the following types of boilers: (a) horizontal tubular, (b) vertical tubular, (c) locomotive, (d) Babcock and Wilcox.

Answer:—(a) On a drop pipe from the top of shell or in backhead above tubes. (b) In one of the tubes about two inches below lower gauge cock, a handhole being cut through the shell for the purpose of inserting the plug. (c) In the crown sheet. (d) In a drop tube through top of shell.

FUSIBLE PLUG

How should a fusible plug be constructed and of what material?

Answer:—The body is of brass, threaded, standard pipe size, or 1¼ in. The hole through the plug is made conical to prevent the fusible plug being forced out by the pressure; the large end of the cone should always be on the pressure side. The small end of the cone should not be less than ½ in. diameter. Banca tin has been found to be the most reliable metal to use for the cone, its melting point being about 445 deg. F.

PLUG MELTS WITH STEAM

Why will a fusible plug melt when covered with steam, and not melt when covered with water, all other conditions being the same?

Answer:—When a fusible plug is covered with water, the heat entering the plug from the fire is absorbed by the water; but when the plug is covered with steam, the steam will not absorb the heat entering the plug, owing to the fact that steam is only able to absorb heat less than one-third as rapidly as water.

CLEANING SINKS

What is a suitable solution for removing fatty substances from sink drains and sump pits? —Morton Mason, Rumford.

Answer:—A strong solution of lye would remove the fatty substance, but it is sometimes claimed the lye has a tendency to clog the pipes. If, however, after the lye has done its work, the pipes and drains be thoroughly flushed with water, no harm can be done to them.

LAYING UP BOILER

What precaution should be taken when laying up a return tubular boiler for any length of time?

Answer:—Blow out the boiler when warm and clean out thoroughly. If in a dry place leave off manhole and handhole plates. If in a damp place cover the inside of the boiler with black oil, remove all ashes and soot in direct contact with the shell of the boiler.

CUTTING IN BOILERS

What precautions should be observed in cutting in a boiler on a steam main which is under pressure; and when a boiler is to be cut out under the same condition?

Answer:—The steam pressure in the boiler should be brought up to the same as that in the main, all pipe connections should be drained and the by-pass, if any, opened to allow the pressure to equalize before opening the main valve, which should be opened cautiously at all times. To cut out the boiler the fire should be drawn off very low and the valve then closed.

BOILER BRACES

How do you find the number of braces required to stay a flat surface above the tubes of a boiler? —A Reader.

Answer:—By multiplying the area to be braced by the pressure to be carried, and dividing it by the area of the brace multiplied by the allowable strain per sq. inch. For exemple, the area to be braced is 955 in. and the pressure to be carried is 100 lbs. per sq. in. How many braces of the 1⅛" type will be required? The load to be supported will be 994 x 100 which equals 99,400 lbs. Now the area of an 1⅛" brace will be 1⅛ x 1⅛ x .7854 or .994", and allowing 7,500 lbs. per sq. in. the brace will be good for .994 x 7,500 or 7,455 lbs. Therefore 99,400 divided by 7,455 will equal 13 plus or 14 braces.

INSPECTING BOILERS

How would you prepare a boiler for inspection? —T. M.

Answer:—After allowing the fire to die out, and the boiler to cool enough to handle, punch out the tubes, remove all soot and ashes from beneath the shell and sweep off the heads and the shell. By this time the boiler will be ready to empty, open the blowoff valve, and remove the top manhole plate, and wash off the interior parts of the shell using a stream of water as hot as possible. Remove the lower plate and wash out the parts below the tubes, being sure to remove all loose sediment. Remove all plugs to the water column and feed pipe connections and disconnect the steam gauge for the inspector to test. If the boiler is of the internal firebox type, remove the grates.

BOILER INSPECTION

How would you make a general inspection of a Scotch marine type of boiler? —A. N.

Answer:—Look carefully about the seam for deterioration and pitting of the rivet heads of the furnace fronts by the action of the ashes; for pitting and corrosion at the bridgewall; for signs of leakage, broken rivets, pitting and corrosion at the joints or seams; for signs of pitting or corrosion at the fire line or about the grate bars; for leakage and crystallization of the tube ends, and fractures of the tube sheets; see that the uptakes are not burnt through and that the front connections are tight. Examine the interior of the shell to see that there are no signs of pitting or corrosion and that the braces are sound and taut. And finally look to see that the fusible plug is intact.

Personals

M. F. Trudel, superintendent of electrical energy of the city of Hull, P. Q., has formally tendered his resignation.

Hugh McNair, former gas engineer of the Manitoba Public Utilities Commission, has been appointed gas engineer for the Winnipeg Electric Railway Company.

Richard Allman, for several years first assistant engineer at Central Technical School, Toronto, Ont., has been appointed engineer at Riverdale Branch Technical School, appointment to date from Sept. 1.

WALTER J. FRANCIS, C.E., M.E.I.C.

Peter McMichael, managing director of the Dominion Radiator Company, was recently entertained at a banquet in the King Edward Hotel by Joseph Wright, president of the company, and the office staff.

A. R. Goldie, of the Goldie-McCulloch Co., Galt, Ont., was elected to the executive committee of the American Boiler Manufacturers' Association, at the thirty-fifth annual convention held at Hot Springs, Va.

F. W. Purple, of Tulsa, Oklahoma, constructions engineer and gasoline absorption plant expert, is now in Calgary, Alta., to take charge of the construction of the gasoline absorption plant to be erected at the Illinois-Alberta well. Work is being commenced at once.

Geo. Callard, the Montreal boiler setting specialist, who has been seriously ill at the Royal Victoria Hospital, is now convalescing. It will be some time, however, before Mr. Callard is able to resume work, as his physician has advised absolute rest for several months.

William S. Murray, Chairman of the Super-Power Survey Commission of the United States Geological Survey, in an address at the commencement of Lehigh University, on June 12, declared that "a saving of 158,000,000 tons of coal annually is possible by the utilization of the water now going to waste in the Niagara and St. Lawrence Rivers."

Walter J. Francis, C.E., M.E.I.C., has been elected to the office of president of the Engineering Institute of Canada. Mr. Francis was born in Toronto in 1872, graduated from the U. of T. in 1893 with the degree of C.E. His first practical work was assistant to the chief engineer in charge of design and construction, Toronto Union Station.

After engaging in many lines of engineering on his own account, he formed a partnership with F. B. Brown, which still continues under the name of Walter J. Francis and Co.

Mr. Francis has been actively interested in many of the large development schemes of recent years, one of these being his appointment to the position of consulting engineer to the Royal Commission appointed to make a complete report on the activities of the Hydro-Electric Power Commission of Ontario. This work has taken up the major portion of his time for the past twelve months.

Obituary

Frederick Grant, of the Incandescent Electric Light Co., Toronto, died at his home, 1291 Dundas St., West, Toronto, on May 25th, after a brief illness. Mr. Grant was formerly on the staff of The Toronto Globe as its engineer and later assistant engineer at the King Edward Hotel.

George Henry Ogden, mechanical engineer, connected with the Canadian Pacific Railway, died on June 2nd after several months' illness at his home in Outremont, P. Q. Mr. Ogden was a member of the Amalgamated Engineering Union.

Harry L. Shepherd died suddenly on May 31 at Simcoe Hall, Allandale, following a severe nervous breakdown. Mr. Shepherd was a graduate of McGill University in electrical engineering in 1900, and was for many years connected with the Allis-Chalmers Company, Toronto. Quiet, retiring and held in the highest esteem by his friends and acquaintances, Mr. Shepherd is survived by a widow and four children.

Practical Ideas From Practical Men

REMOVING CORRODED PIPE

Some time ago I had occasion to remove a pipe that leaked and was so corroded and burned that it was too weak to stand the pipe wrench.

I took a blunt cape chisel and hammer and bent the pipe in at the seams against the boiler shell, thus starting the pipe joint where it screwed into the boiler shell. Then I put plenty of thin oil on the portion of the threads that were dented in with the cape chisel. By turning the pipe back and forth as much as possible the oil was worked in on all the threads and the pipe loosened easily.

The use of oil prevents the unpleasant experience of breaking a portion of the threads off in the female fitting.

—C. F. Rye, Wesley College, Winnipeg.

HOW MUCH LUBRICANT

The flywheel test is the best one I know of for determining the proper quantity of oil to use in a steam engine. The test is very simple. Just pull out your watch and take the time required for the engine to come to a stop after shutting off the steam. The longer the stopping time the better.

It is plain that if a flywheel weighs, say, 2,000 pounds, it has a definite amount of energy stored in it when running at normal speed. Therefore, when steam is suddenly shut off, an equal amount of energy is dissipated every time the engine stops. With all conditions the same, then, an exactly identical length of time will be consumed in stopping every time the throttle is closed. By noting the stopping time every night and by altering the quantity of lubricant fed to the engine every day, the proper amount is in time determined.

The important thing is that external conditions must be the same every time the stop test is made. If the engine drives a belted machine, it is therefore best to throw off the belt and take the stopping time with the engine running unloaded. Under that condition longer time is consumed in coming to a stop and comparison of stopping times is made easier. In other words, the test is more delicate.

—W. F. Schaphorst, M.E.

STEAM BY-PASSES

There would be fewer accidents to large steam lines if by-passes were more often installed to heat up the main gradually instead of having to open the main valve, which is often done carelessly, allowing a large quantity of steam into a cold and perhaps badly-drained pipe, the result being a broken fitting caused by water hammer or too rapid expansion.

All proper precaution should be taken to prevent such accidents. The cost of installing by-passes on large steam lines is a good investment because it reduces the risk to life and damage to property. I known of one case where the fireman habitually uses a 24-in. trimo wrench in closing a 6-in. brass to brass-seated valve, closing the valve so tight that it is necessary to use the wrench to get the valve open. When I tried to make him realize the danger of such a proceeding, he informed me he had been doing this thing for the past five years and never had an accident, and that if there was any danger in his method it would have shown up long ago. Such men can only be convinced that such methods are wrong after an accident has happened to the equipment under their care.

Any person who is in the habit of visiting power plants will know that it is not uncommon for some employees to use long-handled wrenches in tightening bolts and nuts on large valve yokes and covers while high-pressure steam is on the line. This is a very dangerous thing to do. I was in a boiler room when the fireman cut in a boiler, one in a battery of five 66 in. x 16 ft. return tubular ones. He opened a 6-in. valve so rapidly that the vibration on the main shook the whole place and there was a rumbling noise like distant thunder. I was not glad that I was there.

Although the boiler could have been cut in by any capable fireman with no danger, a by-pass installation would have probably prevented any danger, for even an ignorant attendant will use a by-pass if it is there. When there is no by-pass he is liable to turn in steam much faster than safe practice calls for.

There are many cases on record where lives have been lost and much property destroyed through the careless handling of steam valves. Much of this danger would have been prevented if by-passes had been installed and used.

—James E. Noble.

TESTING STEAM TRAPS

The efficient operation of steam trap equipment is given varying degrees of attention by engineers. In one plant a card record is made of every trap, some 600 or more, and the history of the operation of each trap is maintained carefully. In another place a trap inspector is devoting all of his attention to steam traps. In other larger plants steam traps are given practically no attention, and so it goes.

Some engineers are very much interested in determining the efficiency of different types of traps and whether or not after a period of service they leak steam. Following is a method for testing traps for steam loss; the test is not absolutely accurate, for the radiation of heat to the atmosphere and other elements are not taken into consideration, but these are of minor importance. For a quick and approximately correct test the following will suffice.

To Explain Test

It might be well to explain the principle of this test. The water or condensate coming from a steam trap draining a line on a given pressure should contain not over so many heat units. Each pound of water is at a given temperature that will contain a given number of heat units.

The heat units in a pound of water at different temperatures and pressures can be obtained from the steam tables given in hand books.

In making the test the discharge from the trap is carried into a known amount of cold water of a known temperature. The test is conducted for an interval of time and at the end of this time the weight and temperature of the water is taken.

The original weight of water multiplied by number of degrees that the temperature of water is above 32 (temperature of water minus 32) will give the heat units in the water to start. A like computation will give the heat units in the water at completion of the test (degrees temperature minus 32 multiplied by total weight).

Gives Heat Units

The difference between the heat units in the water at the start and at the completion of the test will give the heat units added.

Now if it is found that the heat in the water that has come from the trap (the final weight less the original weight) is greater than that contained in an equal number of pounds of water at the temperature of the steam, then the additional heat represents steam loss and the trap is wasting steam. Take a quantity of water, 10, 20 or 30 lbs., or any number of pounds, and note the temperature as well as the number of pounds. Pipe the discharge from the steam trap into this water, well submerging the end of the pipe. Continue the test until the temperature of the water reaches around 100 degrees, stirring the water carefully to insure a uniform temperature, remove the container from the discharge and carefully note the temperature of the water, then weigh the water.

Use Table Provided

This test can be made by the engineer by following the directions given below and by using the table provided, which will show the increase in weight required for different pressures to indicate that the trap is not leaking steam. If a less amount of water is obtained, during the interval that the temperature is raised, than is given in the table, the additional heat indicates a steam loss.

Pressure	Increase in Weight	Pressure	Increase in Weight
5 lbs.	3 lbs. 2 oz.	120 lbs.	1 lb. 9¼ oz.
10 lbs.	2 lbs. 13½ oz.	130 lbs.	1 lb. 8¾ oz.
25 lbs.	2 lbs. 5 oz.	160 lbs.	1 lb. 7¼ oz.
50 lbs.	2 lbs.	250 lbs.	1 lb. 4 oz.

The following figures are from a test which will give the engineer a better idea as to the method of making the test and also how he may figure out the test for himself if he wishes to do so:

Steam pressure on trap—this must be actual gauge pressure—not a guess	100 lbs.
Quantity of water at start of test	10 lbs.
Temperature of water at start of test	60°
Heat units in water at start of test 60-32 (freezing point) equals 28 degrees x 10 (amount of water)	280 B.t.u.
Quantity of water at end of test	11.70 lbs.
Temperature of water at end of test	100°
Heat units in water at end of test 100-32 equals 68 degrees x 11.7 (amount of water)	795.6 B.t.u.
Heat units added to water, 795.6-280	515.6 B.t.u.
Heat in 1 lb. of water at 100 lbs. pressure	308.8 B.t.u.
Weight of water at above temperature required to bring in heat found 515.6 divided by 308.8	1.66 lbs.
Weight of water actually discharged (11.70-10)	1.70 lbs.

Provide a pail containing 10 lbs. of water at a temperature of 60 degrees, arrange the discharge of the trap to enter the water in the pail, the end of the discharge pipe must be well submerged. Stir the water in the pail constantly until a temperature of 100 degrees is reached, then remove the pail from the discharge so that no more water from the trap will enter. Weigh the water and compare the increase in weight to the amounts given in the table under the pressure at which the test is made.

As the weight of water discharged was greater than that actually required to raise the water to the final temperature the trap does not leak steam.

—L. D. Goff.

STEAM TIGHT GASKETS

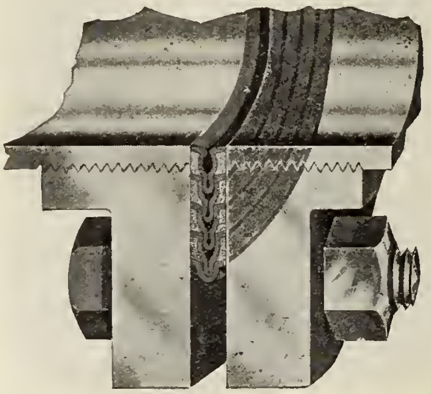
The writer has read with great interest the letter by James E. Noble in the May 5th number of Power House, page 34, in which he criticizes a few of the statements made in my article, "Practical Gasket Hints," which appeared on page 31 of the April 5th issue of Power House.

Regarding the thickness of sheet rubber or combination rubber and asbestos gaskets, the writer does not deny that such gaskets should be made as thin as possible. In fact, it has been aptly said that they should be made so thin as to have zero thickness.

In the writer's ten years experience with sheet gaskets he finds the combination of asbestos with steel in the form of a flexible metallic gasket is so far superior that there is really no comparison and as it is impossible to make a flexible metallic gasket thin and yet make it properly take care of expansion and contraction, this point becomes one that is hardly debatable. The writer does know that in his ten years of experience he has found the thick flexible metallic gasket to give far better service than the thin sheet gasket regardless of material.

Special Lengths Made

As for the length of wrenches, it is true that special lengths are made for certain kinds of work. Thus, a short wrench must necessarily be used, as pointed out by Mr. Noble, in places where a long handled wrench would be impracticable or impossible. However, it is easy to show that for every diameter of bolt there is a proper length of wrench, provided the bolt has a standard number of threads per inch, as most of them have. Where the number of threads varies the length of handle may also vary. Under no circumstances, however, should the wrench be so long that it is liable to stretch the bolt beyond its elastic limits or strip the threads with ordinary arm power.


Gasket.

Very good judgment must be used when tightening a bolt with a wrench that is too long. In this connection it might be interesting to readers of Power House to make note of the following which appears in Marks' Mechanical Engineers Handbook, regarding the sizes of wrenches in bolting up flanges:

Tests made by Crane Company show that a compression of about 12,000 lb. can be obtained by one man using a 16 in. wrench on ¾ to 1 in. bolts, a 36-in. wrench on 1⅛ to 1⅜ in. bolts, a 60-in. wrench on 1½ to 1¾ in. bolts, and a 72-in. wrench on 1⅞ and 2 in. bolts. Square nuts give from 20 to 25 per cent. less compression than hexagon nuts with a given effort on the wrench. Roughcut or uneven threads reduce compression 10 to 15 per cent. Lubrication of threads and bearing surfaces increases compression about 50 per cent. over that obtained with dry thread and surfaces. It is not necessary to overstrain bolts specified in the American Standard if proper wrenches are used, almost impossible to overstrain bolts larger than 1 in. in diameter. The following overall lengths of box wrenches are recommended (interpolate for intermediate sizes).

Size of bolt, in.	½	⅝	¾	⅞	1	1¼	1½	1¾	2	2¼
Length of wrench in.	7¾	9⅞	11½	13¼	15	19	23	27	30½	34

The above quotation, therefore, indicates that there is a proper length of wrench even for ordinary flanges with ordinary gaskets. With flexible metallic gaskets such as have come within the range of the writer's experience these wrenches may be used, but they must be used more carefully than where the old style thin sheet rubber or combination rubber and asbestos gaskets are used.

Using Extension Handle

True, where the wrench handle is too short, that is, shorter than standard length, the writer agrees with Mr. Noble when he says: "It is not bad practice to use an extension handle 6 or 8 inches long on a short handled wrench when tightening large bolt nuts."

Mr. Noble seems to doubt that a gasket can take care of expansion and contraction within a limited range. The writer is herewith sending an illustration of this modern thick flexible metallic gasket which clearly shows its construction. The gasket is made of a single piece of sheet steel which is bent so as to contain a sort of "U" at its center. It is then wound spirally beginning on the inside and building outward so that the "U"s dovetail one into the other with a layer of asbestos wound solidly between so as to form an impervious, strong, and at the same time flexible gasket. There are about 19 plies to every inch width of flange,

As for taking care of extremely long steam lines, without the use of expansion joints, bends, or other provision for expansion and contraction that always takes place in long lines, it would of course be ridiculous to make any such claims for a gasket that is only 3/16 or ¼ of an inch thick. It could be done if there was a sufficient number of joints, thus requiring enough gaskets to take care of the entire expansion.

Henry Bohmer, Jr., Flexitallic Gasket Co., Camden, N. J.

Visitors at the

C. A. S. E. Convention

Can Obtain Information from Our Representative Regarding

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
POWER PLANT ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents For :

LAGONDA
TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK & WILCOX, LIMITED

Toronto Office :
Bank of Hamilton Building

ST. HENRY—MONTREAL

Progress in New Power Equipment

A SINGLE PHASE MOTOR

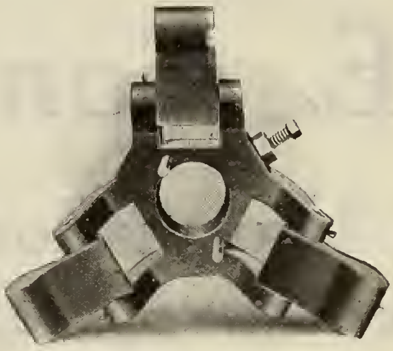
A new single phase motor that shows a distinct advance in motor construction, has recently been put on the market. It is not necessary to lift the brushes from the commutator and as a result the manufacturers have been able to use a short circuiting device that is simple and rugged.

The short circuiting device is composed of a disc built up of laminated copper and is held against the commutator with a high pressure; this pressure remains even when the motor speed has been reduced well below the normal full load speed; the resistance is consequently low and motor efficiency and output are not reduced by a material reduction in speed.

The short circuiting device is actuated by means of centrifugal weights counterbalanced and held from operating until the motor has reached the desired speed. With this arrangement the weights operate very rapidly and noislessly, giving an almost instantaneous short circuit.

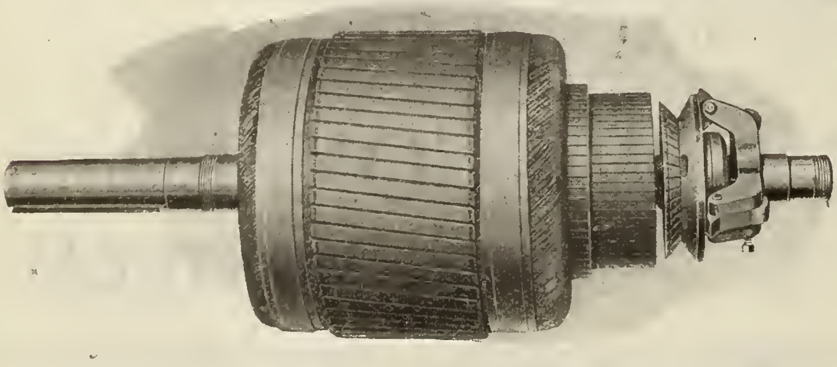
The brushes are in action only during the starting period, and after the motor has reached a pre-determined speed the short circuiting device short circuits every bar in the commutator, shutting all current from the brushes.

The device is so constructed that in its operation it has a wiping action against the commutator exactly similar to the wiping action present in the well-known circuit breaker. After the commutator is shorted the brushes rest on the commutator, but carry no current, and they have a polishing action which keeps the commutator in perfect condition and insures exceedingly long life of brushes and commutator. Under a recent test with stops two or three times a minute the motor was started and stopped 600,000 times. The only renewal necessary during this time was one set of brushes.



Simple motor governor.

Another feature of this motor, which is manufactured by the Canadian Fairbanks-Morse Co., Limited, is that ball bearings are used instead of sleeve bearings, and periodical oiling is not necessary. In addition, the fact that ball bearings do not wear keeps the rotor in the centre of the stator, eliminating failures due to the rotor striking the stator. A great many failures are caused by insulation failure due to oil; here again the new motor avoids this trouble by having its ball bearings packed in grease.



Complete rotor, showing commutator.

RELAY THAT THINKS

A "Relay That Thinks" is the term applied to a new relay invented by L. N. Crichton, design engineer of the Westinghouse Electric & Manufacturing Co. This relay, technically known as the Type CZ distance relay was described in a paper presented recently at a meeting of the Institute of Electrical Engineers.

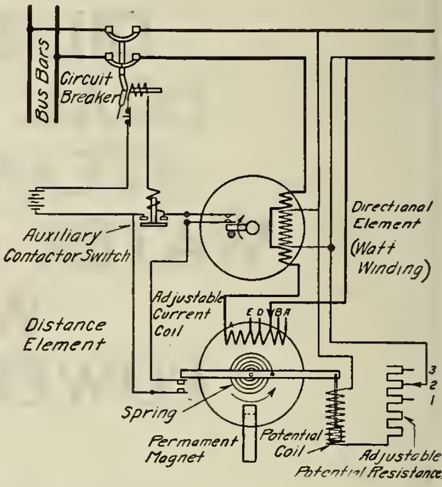
Mr. Crichton described in considerable detail the new relay, which has been called "the relay that thinks" because, when trouble occurs on a transmission system, it makes a calculation to determine the location of this trouble.

If close to the switching point, the relay will operate quickly to disconnect the disabled section, but if the trouble is some distance away the relay will operate slowly in order to allow any other relay which might be nearer to the trouble to act first. Because this device adjusts its time of operation to suit the location of the trouble it can be applied to almost any transmission or distribution system no matter how complex such a system may be.

The relay is of the induction type using many parts common to watt hour meters and resembling previous relays of this type in appearance. The new principle involved is shown in Fig 2. As shown in the figure, the current coil which is operated by the current in the main line revolves the disc which in turn tightens the spring.

Closes the Contact

When the spring is stretched it closes the contact and trips the circuit breaker, provided the voltage coil allows it to do so. This voltage coil is connected across the line so that if a short circuit occurs close to the relay with a consequent voltage across the coil it allows the disc to close the contacts instantly. However, if the short circuit is some distance away from the relay there will be voltage across the coil and therefore it will be necessary for the disc to revolve and stretch the spring enough to overcome the pull of the voltage coil before the contacts can be closed. This of course, requires some time since the speed of the disc is held down by the damping magnet.



Assuming that the spring must be stretched from point A to point B in Figure 2 before the pull of the voltage coil can be overcome and consequently the contacts closed, the time required to do this depends upon the speed of the disc which in turn depends upon the magnitude of the current flowing in the current coil.

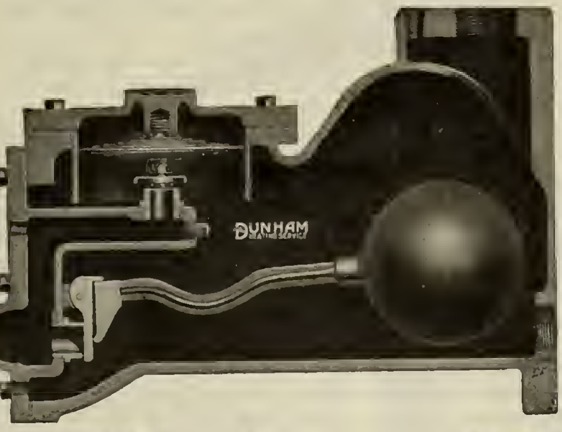
Since the speed of the disc is directly proportional to the current, the time required for the disc to move a given distance is inversely proportional to the current, or, treated mathematically, T varies as Ii. Also the space between A and B, and consequently the time re-

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE

(Made in Canada)

Dunham No. 8 Trap

Automatically keeps heaters free from air and water without wasting steam. It has a wide application in many industrial plants.



This Heavy Duty Trap Serves Many Purposes

Dunham No. 8 Trap is unusually effective where steam condensation is great and where a large amount of air and condensate must be handled at all times. It is successfully applied to evaporating pans, large jacketed kettles, milk condensers, various types of blast coils and paper mill driers that operate under a vacuum and where the pressure does not exceed ten to fifteen pounds.

Besides the thermostatic disc there is a float control to handle large volumes of water and sudden calls for maximum duty. All metal is non-corrosive; mechanism positive in action.

Write for the Dunham Hand Book which describes this and other Dunham Heating Specialties.

C. A. DUNHAM CO., Limited
Toronto, Ontario
Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary.
London, Eng., 18 St. Thomas St., S.E. 1.

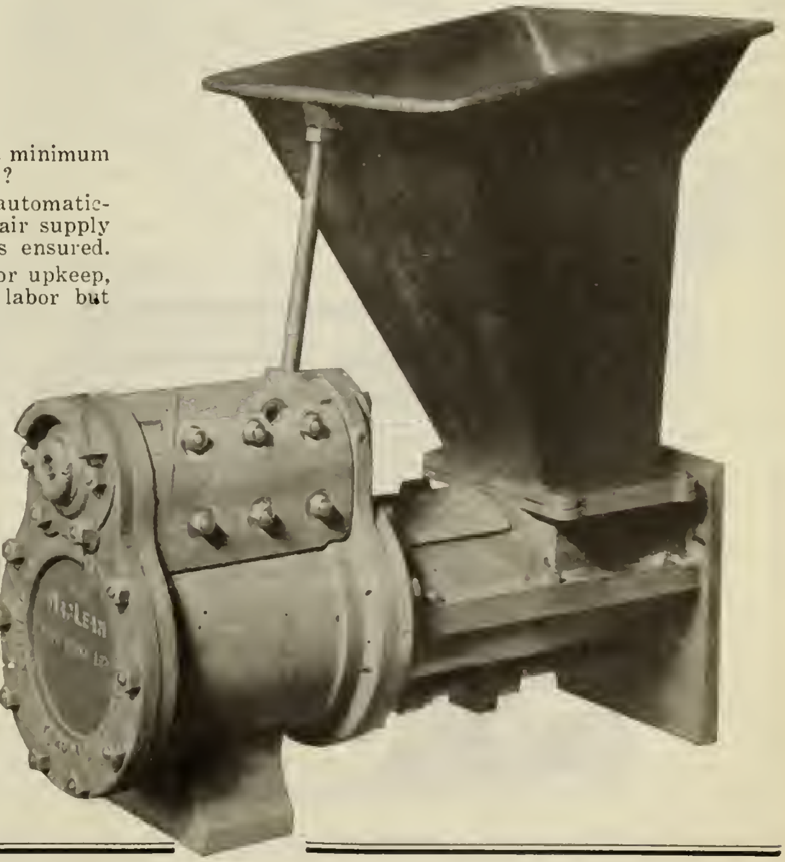
MACLEAN STOKERS

MEMBERS OF THE C. A. S. E. IS IT NOT A FACT

that one of the biggest problems to-day is to maintain at minimum cost the exact head of steam to meet varying demands?

The MACLEAN STOKER takes care of this problem—automatically. It controls the feed, at the same time adjusts the air supply so that complete combustion of every pound of fuel is ensured.

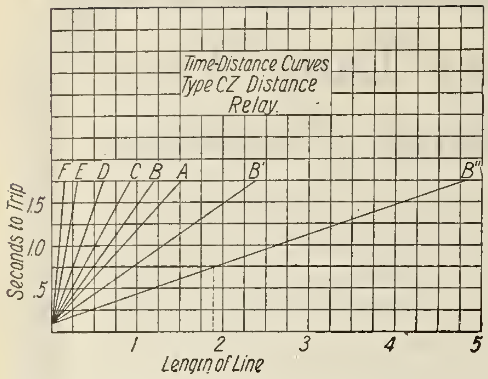
Easy to install, easy to operate and costing but little for upkeep, the MACLEAN STOKER not only saves considerable labor but soon pays its cost by the coal it saves.



DESIGNED BUILT AND CONTROLLED BY CANADIANS
TRADE MARK REGISTERED

May we estimate the saving to be made in your plant? No obligation whatever. Write us.

MacLean Underfeed Stoker Company
Limited
95-97 King Street East TORONTO



quired to lift the contact depends directly upon the force exerted by the holding coil, or in other words by the voltage across the circuit. This stated mathematically is T varies as E. Combining these two conditions we have T varies as E-i equals Z (impedance) which is equivalent to distance.

Geared to Wheel

The actual construction details of the relay are of course not those of the schematic diagram Fig. 2. but are more nearly like the view in Fig. 3. The main shaft of the relay is geared to a larger wheel which in turn tightens a spiral spring. This spring acts upon a lever arm which has the contact on one end and the voltage restraining coil on the other. The voltage coil is so designed that it will discriminate between voltages of very small value. For instance it will easily discriminate between zero voltage and 5 per cent. of normal voltage. It will also of course, withstand normal voltage continuously, and in order to assist in radiating its heat, cooling ribs are employed as shown in the illustration.

In order to eliminate the effect of residual magnetism the voltage core and stop are constructed of a special low hysteresis steel developed by Dr. T. D. Yensen of the Westinghouse Research Department. In order to minimize the effect of friction and other errors all moving parts are carefully jewelled and the actuating forces are much greater than is customary in other induction type instruments. For example the pull exerted by the voltage coil at full voltage is almost 1-2 pound and of course, the other forces must be in proportion.

Operates on Length

The relay is not adjusted to operate on a certain current and with a certain time limit as has been customary with present types but is adjusted to operate on the particular length of line to which it is applied. The current coils have a number of taps and the tap which is used determines the speed of the disc. Similarly the voltage coil is connected in series with a resistor having several taps so that its pull can be varied.

From the charts and curves furnished by the manufacturer the proper current and voltage adjustment can be made so that the relay will fit the particular section of line which is to be protected. Since the instruction book contains all the data for adjusting the relay, practically no calculations are required. In Figure 4 is shown a sketch of the time-distance curve for various adjustments of the relay.

A Relay that Thinks

The element which has just been described determines the distance from the short circuit to the relay, but it is also necessary in many locations to determine the direction of the short circuit. For instance, if a line loops through a substation it is important that the relay on each circuit breaker should be able not only to determine the distance of the short circuit, but should be able also to determine upon which side of the substation the short circuit is located. The directional element consists of a very sensitive contact making wattmeter of the induction type, which closes its contacts whenever its power is flowing away from the substation. These contacts are in series with the contacts on the distance element, and act as a sort of "check valve."

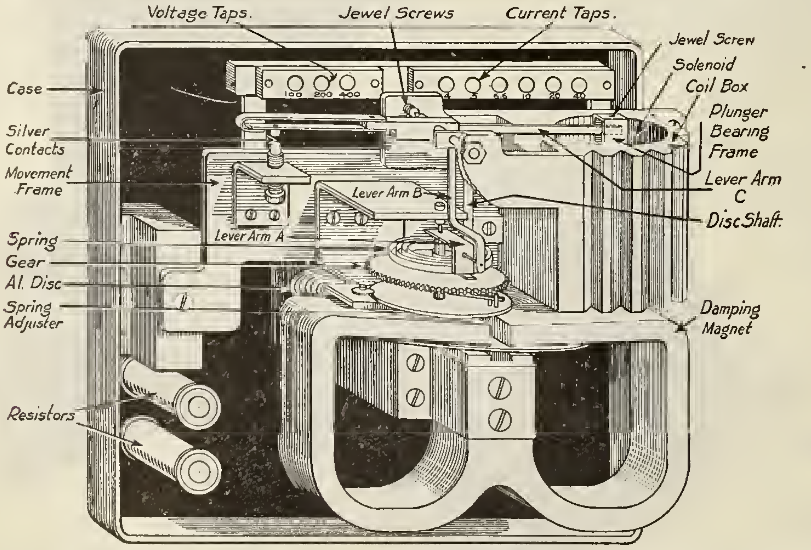
Whenever power is flowing into the substation, trouble is of course, not on that section of line, and therefore, the "check valve" prevents the distance element in series with it from operating even if it should desire to do so.

Directional Element

A schematic diagram of the distance relay equipped with directional element is shown in Fig. 5, and a general view of it with and without cover, in Fig. 6. The directional element is necessary at practically all substations and switching stations on any distribution system, but the distance element alone can be used at generating stations and other points where the power must always be flowing away from the bus bars under trouble conditions.

Some of the advantages of the distance relay claimed by Mr. Crichton are:

It does not require an excessive amount of mathematical calculations when applied to a complicated system. All dead short circuits will be cleared within one second and the majority of them in considerably less than that time; troubles on sections of line close to the generating station will be cleared just as rapidly as troubles on the more remote parts of the system; the breaker furthest from the trouble opens last, thus insuring the insertion of considerable impedance in the path of the short circuit before finally interrupting it which reduces the strain on the breaker and in effect converts every breaker on the system into a "resistance type" breaker; if trouble occurs on the bus bars in any switching station the relays on all the lines feeding power into this substation will open their breakers and thus kill the station in trouble without dropping any other loads; and, if for any reason the circuit breaker should fail to clear a section of line in trouble, the next set of relays in series with it would operate to clear the trouble and thus finally isolate the defective section.



Distance Relay - Type C Z

Power Notes

Owing to increasing business and the desire to be of greater service to its customers, the B. F. Sturtevant Company has long felt the need of a manufacturing plant in the middle west.

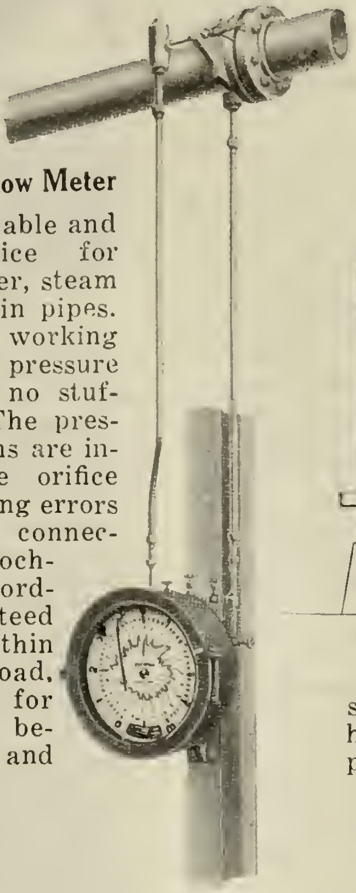
As almost every installation calls for specific engineering, it has been found difficult at times, to give full attention to this westward business from the big plant at Hyde Park, Boston, Mass., therefore, the Sturtevant Company has purchased the plant of the Wisconsin Engine Co., makers of Corliss Pumping Engines at Corliss, Wisconsin.

This new acquisition covers nearly ten acres and the buildings have approximately 150,000 feet of floor space.

A full manufacturing and engineering staff will be maintained and closer co-operation given to western customers. Shipping raw material east and the finished product west, adds a good

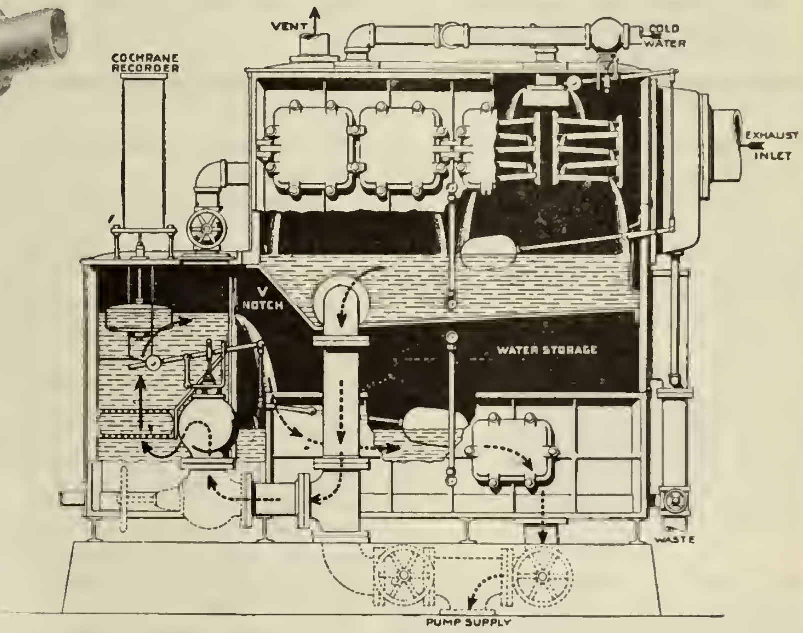
"TO ECONOMIZE—COCHRANIZE"

Let us show you how the Cochrane Equipment Will find and stop waste in your Boiler Plant



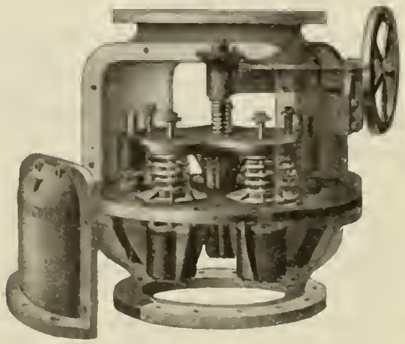
The Cochrane Flow Meter

is a simple, reliable and accurate device for measuring water, steam or air flowing in pipes. There are no working parts in the pressure chambers and no stuffing boxes. The pressure connections are included in the orifice plate, eliminating errors from faulty connections. The Cochrane Flow Recorder is guaranteed accurate within 1% of full load, plus or minus, for flows ranging between 20% and full load.



The Cochrane Metering Heater

saves coal by heating the feed water and helps save coal by telling whether or not the plant is being operated economically.



The Cochrane Multiport Back-Pressure Valve

differs from the ordinary back-pressure valve in that a number of small disks are used instead of one large disk, thus reducing the size, weight and travel of the disks. The back pressure can be controlled from a distance. The Multiport is built in all sizes for vertical, angle and horizontal pipes, also with provision for water-sealing for vacuum service.

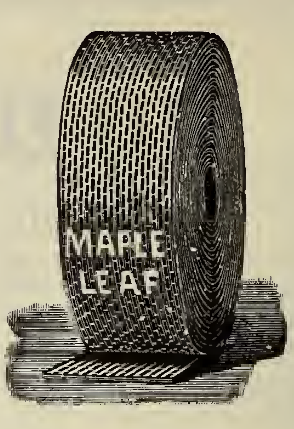
Without any obligation, may we send you combined catalogue No. 1080 illustrating and describing all Cochrane apparatus.

CANADIAN ALLIS-CHALMERS
LIMITED
Head Office - - - - Toronto

Branch Offices: Halifax, Sydney, St. John, Montreal, Quebec, Sherbrooke, Ottawa, Hamilton, London, Windsor, Cobalt, South Porcupine, Winnipeg, Calgary, Edmonton, Vancouver, Nelson and Victoria

DOMINION BELTING CO. LIMITED
HAMILTON - CANADA
Quebec Branch, 51 Duluth Bldg., Montreal
Sole Manufacturers:
"Maple Leaf" Brand Stitched Cotton
Duck Belting, Belt and Dressing

The demand for our products has steadily increased because the standard of quality has been strictly maintained. We make only one grade, the best that can be produced. Write for prices and further information.



deal to the ultimate cost because of freight charge. The situation at Corliss will make a substantial reduction in transportation costs.

The new plant will be under the same direction as the other factories at Hyde Park, Galt, San Francisco, and Philadelphia with Ex-Governor E. N. Foss as president.

Harry W. Page has been selected as general manager and will be in entire charge of the Wisconsin plant.

For the past six years, Mr. Page was assistant general manager and was located at the main office of the B. F. Sturtevant Co.

The Canadian Fairbanks-Morse Company have recently supplied Nash pumps to the Rolland Ford Paper Company, the Spanish River Pulp & Paper Co., and the Donnacona Paper Co.

The Southern Canada Power Company have decided to proceed with the development of the power site at Hemmings Falls, P. Q., where it is planned to develop 30,000 h.p., for which the company have an immediate market.

The British Columbia Electric Railway Co., for further development of water resources, propose raising the total turbine capacity of the company from 52,000 to 268,000 h.p. at a total expenditure of $10,000,000.

The Canadian Fairbanks-Morse Co. have supplied to the Belgo Pulp & Paper Co. a 75 h.p. type "Y" crude oil engine for driving wood-carrying equipment at Van Bruzel.

The Great Northern Power Co. has selected June 23 for the official turning-on of hydro-electric power at their new plant at Indian Chutes, on the Montreal River. Officers and directors of the company from Toronto will attend.

The General Electric Company at Pittsfield, Mass., are said to have surpassed any previous accomplishment in high voltage, when on June 5 artificial lightning of 2,000,000 volts was produced in the high voltage engineering laboratory of their plant.

The Harris Abattoir Company, Keele and St. Clair Avenue, Toronto, recently suffered a loss of about $25,000 when a tank containing 9,000 cubic feet of hydrogen exploded in the generating plant.

Taylor Stoker Co., Ltd., have closed a contract with the Belgo Paper Co., Ltd., of Shawinigan Falls, for four type H stokers with steam power dump.

The Public Utilities Committee of Winnipeg, Man., have approved the appointment of Samuel G. Neiler, consulting engineer and steam heating plant expert, of Chicago, to make a report for the Winnipeg city council on the proposed central heating plant proposal fostered by the Hydro Electric System. J. C. Glassco, manager of the Hydro Electric in Winnipeg, recommended that the opinion of an outside expert be obtained to convince the council that the scheme was feasible and advantageous.

Announcements

C. S. Webber, of Page Hersey Tubes, Ltd., Toronto, was in Pittsburg last week investigating business conditions.

The Harland Engineering Co., of Canada, Ltd., are now located at 291 Mountain Street, Montreal, P. Q.

Letters patent have been issued incorporating Jacques Perron, Auguste Mathieu, Montreal, under the name of the Central Quebec Power Co., with a capital of $1,000,000.

The Lieutenant-Governor of Ontario has formally signed an order-in-council authorizing the construction of a radial railway from Port Credit to Oakville, Ont. The amount approved for the work is $1,065,667.

When the Canadian Electrical Association meets in Montreal, Friday, June 22, will be devoted entirely to those who have been engaged in the electrical business for twenty years or more. It promises to be a real event for the "veterans."

Moreland & Jones have opened a school at 755 Yonge street, Toronto, to prepare engineers for examinations of the second, third and fourth grades. Mr. Moreland is a mechanical engineer holding chief engineer certificates, and Mr. Jones is a marine and stationary engineer. This school offers a system of tuition, it is claimed, which is practical and includes illustrations of practical power plant operation.

Construction

The Hydro Electric Commission has been granted its application to construct turn-out switches at different points on the old Metropolitan Line, North Yonge St. This permission was asked in order to facilitate the handling of traffic.

The Hydro Commission have preparations under way for the construction of a $500,000 power development at Campbellford, Ont. The plans for the dam and power house have been completed, and work will be commenced as soon as the present dam and power house being built at Belmont Lake are finished.

The Nujol Laboratories, of Bayonne, N. J., have leased through J. H. Walker, of the Realty Service Co., Ltd., premises on Dufferin Street, Toronto, Ont. Machinery for the work to be carried is now being installed. The Wayne Pump & Tank Co. are also installing machinery in their new premises on Dufferin Street. Heretofore they have operated only a selling office under the name of the Canadian Pump & Tank Co.

At the spring meeting of The American Society of Mechanical Engineers in Montreal, May 28-31, the nominating committee presented the following nominees for the offices of the society. Election by ballot will be held in the fall. President, Fred R. Low, editor, "Power," New York City; vice-presidents, George I. Rockwood, president and treasurer, Rockwood Sprinkler Company, Worcester, Mass.; M. L. Cooke, consulting engineer in management, Philadelphia, Pa.; W. J. Sando, consulting engineer, Milwaukee, Wis.; managers, E. O. Eastwood, professor of mechanical engineering, University of Washington, Seattle, Wash.; F. A. Scott, president, The Warner and Swasey Company, Cleveland, Ohio; E. R. Fish, vice-president, The Heine Boiler Company, St. Louis, Mo.; treasurer, W. H. Willey, president, John Willey & Sons, Inc., New York City.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers.--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________________

Occupation ____________________

Employed by ____________________

Residence ____________________

Reference ____________________

GEO. CALLARD

Builder and Contractor
Furnace and Boiler Work a Specialty
Highest References from All the Leading
Engineers of the City.
Phone: Uptown 1590
210 Quesnel Street, Montreal

POSITIONS WANTED

FACTORY SUPERINTENDENT OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

REFRIGERATING AND MECHANICAL ENGINEER with 10 years' operating record, also with experience in heating and lighting work, desires employment in Toronto. Apply Box 108, Power House.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order. Apply Box, 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

TAYLOR SAFES FOR SALE—RARE OPPORTUNITY to secure a safe at small cost. They are in splendid condition. Inside dimensions and prices are as follows: 15" deep, 2 ft. 6" wide, 3 ft. 11½" high, fitted with built-in compartment. Price $250.00. 18" deep, 2 ft. 8" wide, 4 ft. 5" high, fitted with steel compartment. Price $200.00. Apply Box 10, POWER HOUSE.

WELDING

ELECTRIC AND ACETYLENE WELDING—of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

M. BARRY WATSON

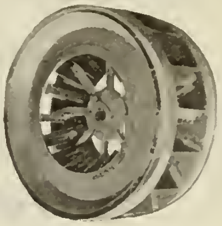
B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer

Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W



Eliminate Cinders

More draft and total cinder elimination follow the use of the Sturtevant Cindervane.

Ask for Folder 609.

B. F. STURTEVANT CO.
OF CANADA, LTD.
MONTREAL GALT TORONTO

See
Buyers' Guide
Pages
66, 68, 70

YORK Ice Making & Refrigerating **MACHINERY**

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO., LIMITED

Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

OIL BURNING SYSTEMS.

INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.

LAURIE ENGINE CO.

(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's, Ltd., Calgary, Alta.

Why Fire Brick Can Never Rival Plibrico

HOW many times—when looking at a wrecked furnace wall--have you wished that the joints were as good as the brick? No furnace—regardless of the quality of fire brick used—can be better than its weakest joint. And therefore fire brick can never be made good enough to even rival jointless Plibrico.

Plibrico eliminates the joints.

This superior refractory comes to you in plastic form. It is pounded into any shape desired with a mallet, then trowelled smooth. Heat vitrifies it into a rock-like, air-tight, gas-tight lining that resists temperatures to 3100°F. Use it wherever fire brick can be used. Use it for front door arches, back arches, ignition arches, baffles. Wherever you put it it pays its way in longer, trouble-free service. Get the right start in ending furnace troubles by sending for "Modern Furnace Building"—the interesting 50 page story of Plibrico. It's free.

Plibrico is delivered only in steel containers of distinctive appearance, as shown below.

JOINTLESS FIRE BRICK CO.
1142 CLAY ST. CHICAGO

To the Delegates, Members and Friends who will attend the C.A.S.E. Convention at Toronto on June 25th to 28th, we most cordially invite you to visit our Booth.

We will have on exhibit the many articles which we manufacture in the rubber line, that are so essential to the engineer, consisting of a complete line of Mechanical Rubber Goods, including our specialties:

Daniel's P.P.P. Rod Packing
Ebonite Sheet Packing
Ebonite Valve Stem Packing

Make the exhibit of Quaker City Rubber Company your headquarters. Meet and chat with your friends. A cordial welcome awaits you at our Booth.

SOLE MANUFACTURERS

Quaker City Rubber Company - Philadelphia, Pa.

Canadian Agents

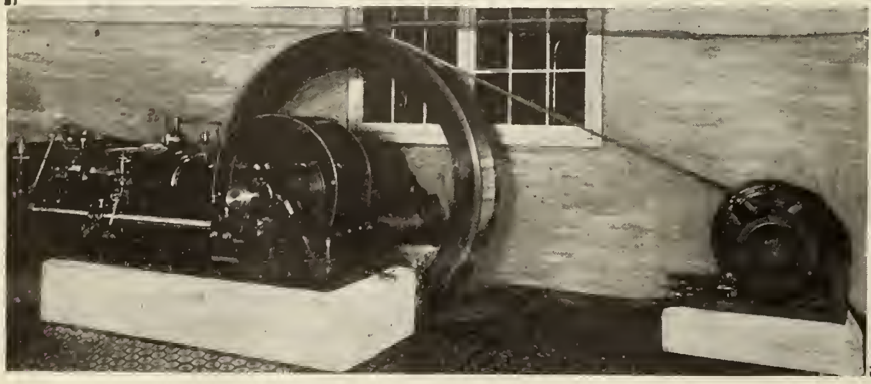
St. Lawrence Supply Co., Ltd.,
117 Commissioners St. W., Montreal

Kirby & Company,
50 Lake Street, Toronto

Thomson-Gordon, Ltd.,
Hamilton

---

13 Years Constant Service Without Repairs



THIS cut represents one of our engines operating in the Mt. Albert (Ont.) electric light plant since December 23, 1910; nearly 13 years. The owner, Mr. Albert Dyke, says, "The main bearings have never been touched, not even tightened, and are still in perfect condition."

Catalogues of Heavy Oil Engines, Vertical Electric Sets, Pumping Sets, etc., mailed upon application.

Keighley Gas & Oil Engine Co.
Limited
of England

Canadian Office : 131 Front St., Toronto

Genuine
"V" PILOT
FOR
STEAM, AIR and WATER PACKING
Also other styles.

Made in England by
Beldam Packing & Rubber Co.
Limited

Sole Ontario Agents:
KIRBY & COMPANY
50 Lake Street Toronto
Main 4443

Specializing in
ENGINE AND BOILER ROOM
SUPPLIES OF EVERY DESCRIPTION.

Inquiries invited and
promptly attended to.

Adamant H.P. Gauge Glasses
Ideal Tube Cleaners
Kirbyco Boiler Scale Remover

QUALITY - SERVICE

The Hardest Test of a Feed Water Regulator

"Does it give correct feed on flash type boilers?"

The COPES System gives smooth regulation even under the very difficult conditions imposed by flash type boilers, *because the* COPES *follows true water level, without lag*. It does not dance wildly up and down with the boiling hump.

When the load suddenly increases, the COPES temporarily cuts down the feed rate over the peak. When the load suddenly drops, the COPES increases the water input. Fuel savings of 2% to 8% are recorded.

The action of the COPES is positive, certain, "trouble-proof"—because of its simplicity. It has no springs or diaphragms, no floats or displacement members—just a sturdy expansion tube and a balanced valve. And in actual test, COPES Regulation has proven accurate to 1 5 of 1%.

Write for Catalog D, explaining why nearly all important power plants use the COPES.

NORTHERN EQUIPMENT CO., 112 West 11th St., Erie, Pa.
Branch Plants: Hamilton, Ontario, Canada; London, England; Paris, France; Merseburg, Germany; Vienna, Austria; Milan, Italy.

COPES
SYSTEM OF BOILER FEED CONTROL

STERNSON SERVICE

No Mystery—Just Chemistry

You Are Cordially Invited

to see our
exhibit at the

**C. A. S. E.
CONVENTION
June 26, 27, 28**

The basis of most expensive boiler compounds is nothing but Silicate of Soda, which, properly graded, will remove and prevent all boiler scale.

BOILER BRAND—This is but one of our many grades of Silicate of Soda. Its action is similar to the most expensive boiler compound on the market. Why buy high-priced compounds with fancy names?

STERNSON No. 30—A high temperature cement which ensures permanent joints in your furnace and protects your brick at the weakest spots—the edges. Withstands up to 3,000 deg. F. Comes ready for use.

STERNSON No. 40 MONOLITH—A plastic ceramic mixture which can be moulded by inexperienced workmen into a jointless, gas-tight furnace or fire-box lining. Not only solves all furnace troubles but is actually lower in cost to install than the old method of fire brick and mortar.

G. F. STERNE & SONS, LTD.—BRANTFORD, ONT.
Chemical Manufacturers—Consulting Chemical Engineers

HINTS TO BUYERS

Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and draft in last pass.

It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

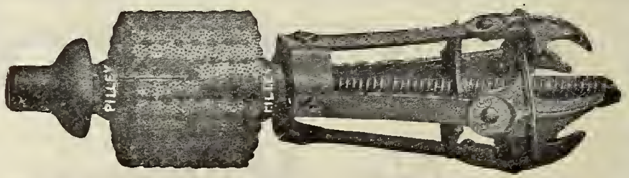
Write for Bulletin CF-131.

THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

FOXBORO
REG U.S. PAT. OFF.
THE COMPASS OF INDUSTRY

5323

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York

AMERICAN
STEAM ASH CONVEYORS

75% of all steam jet ash conveyors in Canada are **American.** Satisfactory and economical performance guaranteed. Ask for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Calgary, Edmonton, Vancouver.
WM. A. GOOLD, Winnipeg.

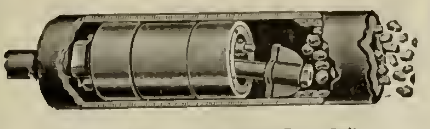
CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

FUEL OIL BURNING
for
HEATING and POWER PLANTS

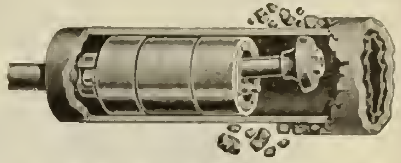
Correspondence Invited

ENGINEERING & CONTRACTING

The **T. J. CUNERTY** *Company*
9 Richmond St E. Toronto.



Dean



For removing scale from Water Tube Boilers.

Telephone : Adelaide 1135

For removing scale from Return Tubular Boilers.

You Are Paying for Coal You Don't Get Any Results From

Your boiler tubes may be more or less incrusted with scale. Let us handle your boiler scale problem. Every 100 lb. of scale wastes 200 lb. of coal every 10 hours of operation.

Get rid of the scale in a way that will not keep your boiler continually in a wasteful and unsafe condition.

This method of scaling boiler is recommended by the highest authorities on boilers in the province.

Let us either ship you a Dean Boiler Tube Cleaner on trial, give you a free demonstration in your own plant or Clean Your Boilers by Contract (distance no object).

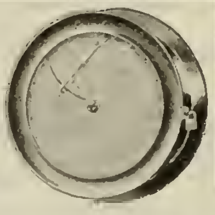
30 years' experience Scaling Boilers—Over 100 references in Toronto. NIGHT, SUNDAY and HOLIDAY SERVICE.

GEO. FARROW & SON, 17-19 Victoria Blvd., Mount Dennis, TORONTO

THE BROWN INSTRUMENT CO.
The Largest Pyrometer Manufacturers in the World
PHILADELPHIA - - PA.

Agents: LaChapelle Eng. Co., 414 St. James St., Montreal, P. Q.
Brown Instrument Co., 1421 Ford Bldg., Detroit, Mich.

Brown Pressure Gauge

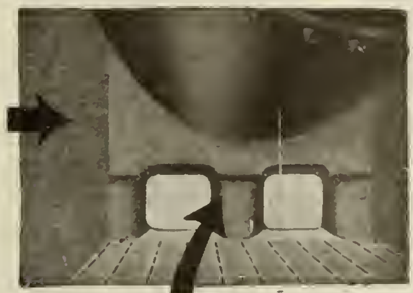


INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE
OF POWER HOUSE

Be Rid of Boiler Furnace Lining Troubles



Arches and Furnace Linings in one piece. No brick, no joints. Any handy man installs it without special forms or tools.

Betson Plastic Fire Brick kept on hand for emergency repairs and for use in building sloping baffles always proves profitable. **Write for instructive booklet.**

Betson Plastic Fire Brick Co., Inc. P. O. Box 386-6, ROME, N. Y.

CANADIAN DISTRIBUTORS: International Chemical Co., 26-6 Adelaide St. E., Toronto, Ontario, Canada

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial ?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.

GARLOCK

Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS

THE GARLOCK PACKING COMPANY

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd Hamilton
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

ASBESTOS SPECIALTIES
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited. Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited. Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited. Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto. Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H, Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING. MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION. FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

Power House

is a dominating factor in maintaining power plant efficiency in equipment and service

❧

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge. Every issue is full of real worth while ideas.

Two Issues per Month

24 Issues (one year) $2.00

Special Offer

48 Issues (two years) $3.00

Dunlop Belting and Hose

DUNLOP
BELTING

"Gibraltar RedSpecial"

—the High-Grade Belt for Transmission Service.

"Gibraltar"

Conveyor and Elevator Belts

—the Belts with the protective covering of Cord Tire Tread Stock that effectively resists abrasive action.

DUNLOP

Belting Hose Packing

And General Mechanical Rubber Products
For Every Purpose

Investigate the Advantages of the

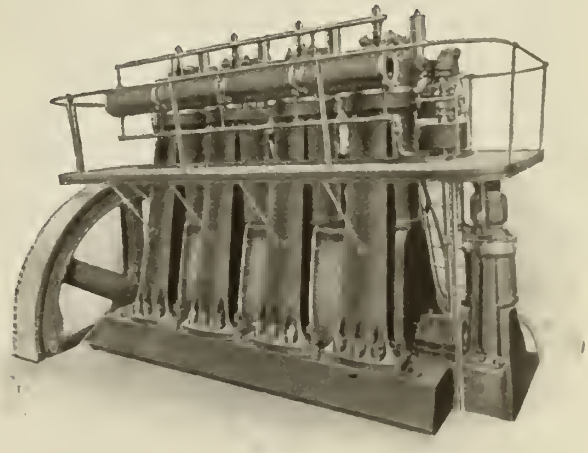
POLAR DIESEL ENGINE

Before Deciding on Your Power Plant

Lower operating cost than with any other system. Can be erected anywhere. No risk of fire, no smoke or smell, silent running.

Built for belt drive or direct coupling to Generators, Pumps or Air Compressors. Instantaneous starting. Cheapest crude oils may be used as fuel.

Types	Sizes	Fuel Consumption
BW	670 & 1000 B.H.P.	0.390 lbs. per B.H.P. hour
T	50 to 550 B.H.P.	0.396 to 0.418 lbs. B.H.P. hour
Z	12 to 75 B.H.P.	0.440 to 0.484 lbs. B.H.P. hour



Write us for particulars, we shall be pleased to submit proposals regarding power plants of any description.

LAMMERS & MAASE, LIMITED

170 McGill Street - - Montreal, P.Q.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Stephens Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schseffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE. PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Reading Steel Casting Co., Hartford, Conn.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Reading Steel Casting Co., Hartford, Conn.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS, STEAM, WATER)
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Ssnford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc,, New York. N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterhury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div-Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanka-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Moad-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jss. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johna-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

There is Science In Belt Lacing

ALLIGATOR teeth penetrate lengthwise of the belt, leaving the long burden-bearing fibers intact. Each tooth clinches down over its group of fibers, compressing them so firmly that there is no internal friction and wear at the belt end.

The sectional steel rocker hinge pin is the only metal pin that avoids wear to the joint.

Keep these vital features in mind when you buy belt lacing, for the cost of any lacing is nothing as compared to the cost of the belt on which it serves.

Just a Hammer to Apply It
"Never Lets Go"

Sold at Wholesale and Retail the World Over

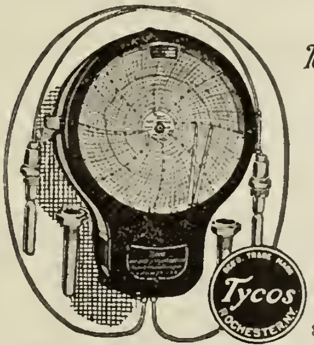
Flexible Steel Lacing Company
46 7 Lexington Street, Chicago
In England at 135 Finsbury Pavement, London, E.C. 2

Tycos and Condensers

Performance is determined by the difference in temperatures at the inlet and outlet, provided the condenser is of the closed type. The *Tycos* Bi-Record Recording Thermometer is best suited for this application. It furnishes the operator with a chart showing the temperature at both points on one chart.

Where a record of the absolute pressure or vacuum created by the condenser is desired *Tycos* Recording Pressure Gauges are recommended.

Let us send you full information of *Tycos* Indicating, Recording and Controlling Instruments in the steam power plant. Ask for Catalog Part One.



Taylor Instrument Companies
110-112 Church St.,
***Tycos* Bldg., Toronto**

There is a *Tycos* or *Taylor* Temperature Instrument for every purpose.

Indicating, Recording and Controlling.

878

What is Boiler Scale Costing You?

Do you realize that one-eighth of an inch of scale increases coal consumption 36%; that expensive repair bills, shut-downs and other cost-eating factors are due in the majority of cases to accumulation of boiler scale? And it's so unnecessary because STEPHEN'S FEEDWATER TREATMENT not only removes all old scale, but prevents new scale from forming.

Stephen's engineers are men of practical experience. They can discuss your boiler feedwater problems in a practical way. Consult them freely at any time.

Stephens Chemical Mfg. Co., Ltd.
2004 Dundas St. W. -:- Toronto, Canada.

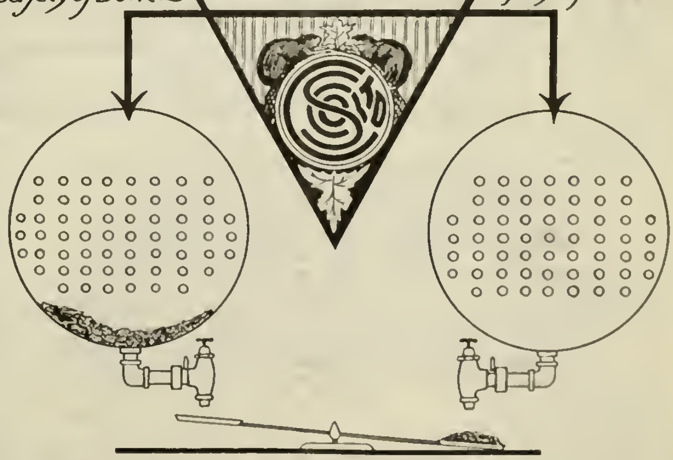
STEPHEN'S

Boiler Feedwater Treatment

Insures Safe Removal of Old Scale
Prevents Formation of New Scale
It Will Not Cause Foaming
It Does Not Vaporize Away
It Stays in the Boiler
Scale Stays Out

The Old Methods Expensive, Endangering Safety of Boilers

The New Method Economical, Re-assuring Safety of Boilers



PACKING, AMMONIA, STEAM AND WATER

Beveridge Suppy Co., Montrea.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Jenkins Bros., Limited, Montreal, Que.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Bolco Supply Ltd., Toronto.

PACKING, OIL

Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS

Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS

Shell Bar Bolco Supply Ltd., Toronto, Ont

PIPE COILS

Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER

Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED

Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS

Crane'a Limited, Montreal.

PIPING AND FITTINGS

Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd , St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS

Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS

Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Wateroua Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)

Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS

C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES

C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC

Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES

C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL

D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH

Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR

American Steam Pump Co., Battlo Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Mon'real.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID

Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX

The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass
The Garth Co., Montreal.
Northern Equipment Co , "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE

Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY

Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO

Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX

Pratt & Cady, Stratford, Conn.
Smart-Turner Mschine Co., Hamilton.

PUMPS, VACUUM (HEATING)

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING

Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL

Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS

Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS

Crane's, Limited, Montreal.

RADIATOR TRAPS

C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS

Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES

C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS

Shell Bar Bolco Supply Ltd., Toronto.

REBOILERS

Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS

Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2

Sarco Company, Inc., New York.

REFRACTORY MATERIALS

Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE

Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER

Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE

Crane's Limited, Montreal,
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg, Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS

The Superheater Co., Ltd., Montreal.

REGULATING VALVES

H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co, of Canada, Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS

Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING

Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES

Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER

Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)

Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY

Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS

Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM

V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS

W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE

C. A. Dunham, Co.,
Laurie & Lamb, Montreal,

SMOKE BOXES

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT CLEANERS

Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET

Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS

Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS

Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM TRAPS

Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS

Smart-Turner Machine Co., Hamilton.

STEEL DRUMS

Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL

Can. Fairbanks-Morse Co., Ltd., Montreal

STRAINERS

Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK

Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES

Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS

Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF

Waterous Engine Works. Co., Brantford.

TANKS, BRINE

Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE

Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., 'York, Pa.

TANKS, GASOLINE

Imperial Oil, Ltd., Toronto.

TANKS, OIL

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co. Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

TRANSFORMERS

Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES

Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING

Grant E, Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER

Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM

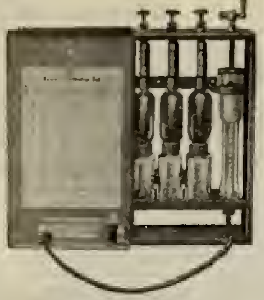
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Edward Valve & Mfg. Co., East Chicago, Ind.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio,
Lytle Engineering Co., Montreal, Que.
D'Esto Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont
Reading Steel Casting Co., Hartford, Conn.
Shell Bar Bolco Supply, Ld., Toronto.
Valve Engineering Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Underfeed Stoker Co., Toronto, Ont.

WALKWAYS, (Irving Subway)

Irving Iron Works Co., Long Island City, N. Y.



Hays Improved Gas Analyzer.

Are You Wasting Fuel?

Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO$_2$, O$_2$ and CO; 1-chamber Analyzer for CO$_2$ only. Stocked by Canadian Agents listed below.

HAYS DRAFT GAGES. "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts and Draft Regulation."

P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
Michigan City, Indiana

General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.

CURTIS ENGINEERING SPECIALTIES

Comprise a line of devices that have stood the test of years for the utmost in efficiency. They are built for dependable and enduring service. Scrupulous care in the selection of material and in construction, with adherence to the highest engineering standards, have won them a commanding position. The

CURTIS WATER-PRESSURE REGULATOR

will deliver water into service pipes at any desired pressure, regardless of any fluctuations of outside pressure.

Trouble with rust or clogging with sediment is prevented. Waste of water in domestic use by flying or spattering is avoided by the reduced pressure. This also prevents water hammer or concussion and prevents wear and tear on all packings and seats in valves and faucets, thus eliminating frequent plumbing bills. Adapted for use in pulp and paper mills, hotels, public buildings and dwelling houses. For ¾ in. to 2½ in. pipe, screwed. For 3 in. to 8 in. pipe flanged.

The Curtis Line of Steam Specialties contains many other notable devices. They are fully described in our No. 50 catalogue. Write for a copy.

JULIAN D'ESTE COMPANY
26 Canal Street, Boston, 14, Mass.

Emergencies Prove Its Superiority

It may not be often that the oil film fails in any of your bearings, but the possibility is always present. It is emergencies such as this that test the value of your bearing metals. Magnolia Anti-Friction Metal protects your shafts and bearings from damage in such temporary contingencies. With the lowest frictional coefficient of any known bearing metal—proven by U.S. and foreign government tests—it runs cool with less lubricant and is a safeguard against hot boxes and melting out where lubrication is neglected or may fail for any reason.

Try out a sample Magnolia-lined bearing and test its many advantages for yourself.

Magnolia Metal Company
113 Bank St., New York

CHICAGO Fisher Bldg.
SAN FRANCISCO Pacific Bldg.
MONTREAL 37 Shannon St.

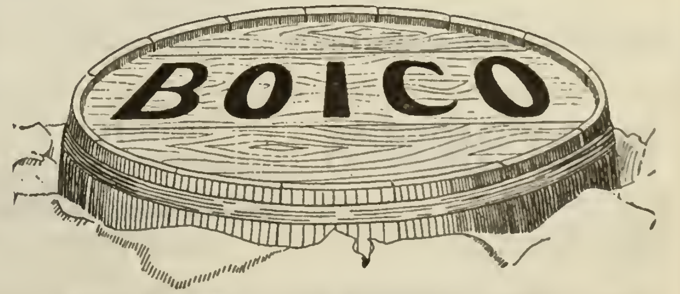
MAGNOLIA ANTI-FRICTION METAL
TRADE MARK

Makes Short Work of Boiler Scale

In hundreds of plants BOICO has been adopted as the one sure clean-boiler insurance. The speed with which it removes the most stubborn scale formations is surprising. Hurts nothing but boiler scale. It's economical, too.

TRY IT FREE—let us send you a sample to convince you. Write us to-day—you've nothing to lose.

SHELL-BAR BOICO SUPPLY LTD.
1-15 SAUNDERS AVE. - TORONTO



SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ontario.

Established 1907

POWER HOUSE

Member A.B.C.

B. G. NEWTON, Manager
S. S. MOORE, Advertising Manager

CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740. Montreal: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. Winnipeg: 810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—New York: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. Chicago: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. Boston: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—London: The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A
Audel, Theo. 61
Allen Feed Water Purifier Co.. 72
Albany Pump Co............... 19
American Steam Pump Co...... 24
B
Babcock & Wilcox, Ltd......... 55
Betson Plastic Fire Brick Co., Inc. 65
Brown Instrument Co. 65
Bristol Co. 16
Buyers' Directory........66, 68, 70
Bowden Machine Co., Ltd...... 18
C
Callard, Geo. 61
Canadian Fairbanks-Morse Co., Ltd 22
Conveyors Corp. of America.... 65
Cory & Sons, Inc., Chas........ 4
Combustion Engineering Co..... 15
Cunerty Co., T. J. 64
Can. Allis Chalmers Co........ 59
D
Dart Union Co................. 4
D'Este Co., Julian 71
De Laval Steam Turbine Co.... 18
Detroit Stoker Co. 5
Dominion Belting Co.......... 60
Dunham Co., C. A.............. 57
Durabla Mfg. Co............... 16
Dunlop Tire & Rubber Co., Ltd. 67
E
Engineering and Mach. Works of Canada 10
Edward Valve & Mfg. Co....... 10
F
Farrow & Son, Geo............ 65
Fisher Governor Co. 6
Foxboro Co., Inc.............. 64
Flexible Steel Lacing Co........ 69
Flexible Metallic Packing Co... 25
G
Garlock Packing Co........... 65
Garth Co., The 65
Goldie & McCulloch .....17 and 26
Gutta Percha & Rubber Co..... 2
H
Hays Corp., Jos. W........... 71
Hepburn Co., John T........... 21
I
Irving Iron Works............. 6
Inglis Co., John............... 22
J
Jamieson Cold Storage Door Co. 11
Jenkins Bros. 7
Jointless Fire Brick Co........ 62
K
Kirby & Co...... 63
Keighley Gas & Oil Engine Co.. 62
L
Laurie Engine Co.............. 61
Lunkenheimer Co. 14
Lammers & Maase, Ltd. 67
M
Magnolia Metal Co............ 71
McGowan Co., The John H..... 20
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncrieff, Ltd. 72
Mueller Mfg. Co. 13
McLean Underfeed Stoker Co... 57
N
Northern Equipment Co........ 63
P
Pilley Packing & Flue Brush Mfg. Co. 64
Q
Quaker City Rubber Co......... 62
R
Refinite Co. of Canada......... 64
S
Superheater Co., Ltd........... 65
Sterne & Sons, G. F............ 63
Sarco Co., Inc................. 12
Sanford Riley Stoker Co...... 8, 9
Shell Bar Boico Supply Co...... 71
Sterling Engine Co............ 12
Sturtevant Co. 61
Sexton Boiler Setting Co., W. R. Front Cover
Stephens Chemical & Mfg. Co., Limited 69
Smart-Turner Machine Co...... 23
T
Taylor Instrument Co., The..... 69
Thomson-Gordon, Ltd. 64
U
Underfeed Stoker Co. of Canada .. ..8 and 9
W
Wall, W. J. 72
Waterous Engine Works Co..... 1
Watson & McDaniel Co........ 65
Watson, M. Barry, M. E........ 61
Y
York Mfg. Co. 61
Young Pump Co. of Canada.... 24

Why Individual Boiler Feed Water Treatment

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)

Distributors: William C. Wilson & Co., 21 Camden Street, Toronto

Phone Adel. 1054 or write for full particulars.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

NO. 1 BOILER HOUSE, THE TEXAS COMPANY, WEST TULSA WORKS

CRANE REFINERY PIPING EQUIPMENT

For continuous and unfailing service in the power plants of oil refineries, Crane refinery piping equipment can be installed on the basis of dollar-efficiency as revealed in the quality and permanence of the service rendered.

CRANE

CRANE LIMITED, GENERAL OFFICES: 386 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., HEAD OFFICE: 45-51 LEMAN STREET, LONDON, ENG.

Branches and Sales Offices in 21 Cities in Canada and British Isles
Works: Montreal, Canada, and Ipswich, England

MORRISON

Steam Pump Governor

Constructed on the same principle as the well-known Morrison Reducing Valve, is sensitive and efficient in operation. The adjustment is extremely simple, being made by turning the hand wheel on top.

The Morrison Steam Pump Governor is the latest word in an efficient and compact machine for maintaining a steady discharge pressure on pumps.

The
James Morrison Brass Mfg. Co., Limited
extends a

Cordial Welcome

to all members attending the

C. A. S. E. CONVENTION

Don't Miss Our Booth

Get your name on our mailing list for
our Monthly Bulletin.

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Co., Limited
93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Fostering Economy in the Development of Power for All Industries

Vol. XVI—No. 13. Published Semi-Monthly by The MacLean Publishing Company, Limited, Toronto, Ont. July 5, 1923

Power House, Point du Bois - View from Tail Race

Harnessing the Waters of the Winnipeg River

CANADA CEMENT CONCRETE FOR PERMANENCE

THE development of water power within economic transportation distance of Winnipeg has reached a point where 70,000 horse power is available, and there is sufficient additional reserve power to develop 500,000 h. p. when required.

At the power house site, the Winnipeg River falls over a series of rapids with a natural fall of 33 to 28 feet within a ¼ mile. This fall is increased to a total head of 43 to 48 feet, by a concrete dam; giving a pondage area of 7 sq. miles. The power house, completed in 1920-21 is of concrete and steel. The power house foundations, consisting, besides the series of draft tubes, of a series of flat tail race arches upon supporting walls tapered in plan, were built in pairs of arches; the two adjacent spans, built as a unit with a mid-wall, are resting upon asphalt painted skewbacks formed upon alternate tail race walls. The contraction joints are thus 56 ft. apart. By this means the use of reinforcing steel in these arches was avoided.

In the other elevation of the building the foundations were separated in three portions—arrester bays, the transformer and generator room and the turbine and rack rooms. This was done by the use of two vertical expansion joints, running the entire length of the building. Above the tail race arches, parting planes, asphalted and keyed with wooden strips, were provided in the main walls, with considerable success in the effort to avoid unsightly cracks.

This great plan of hydro electric development at Point du Bois has given Winnipeg power at the lowest rate on the continent, less than a half cent per KWH.

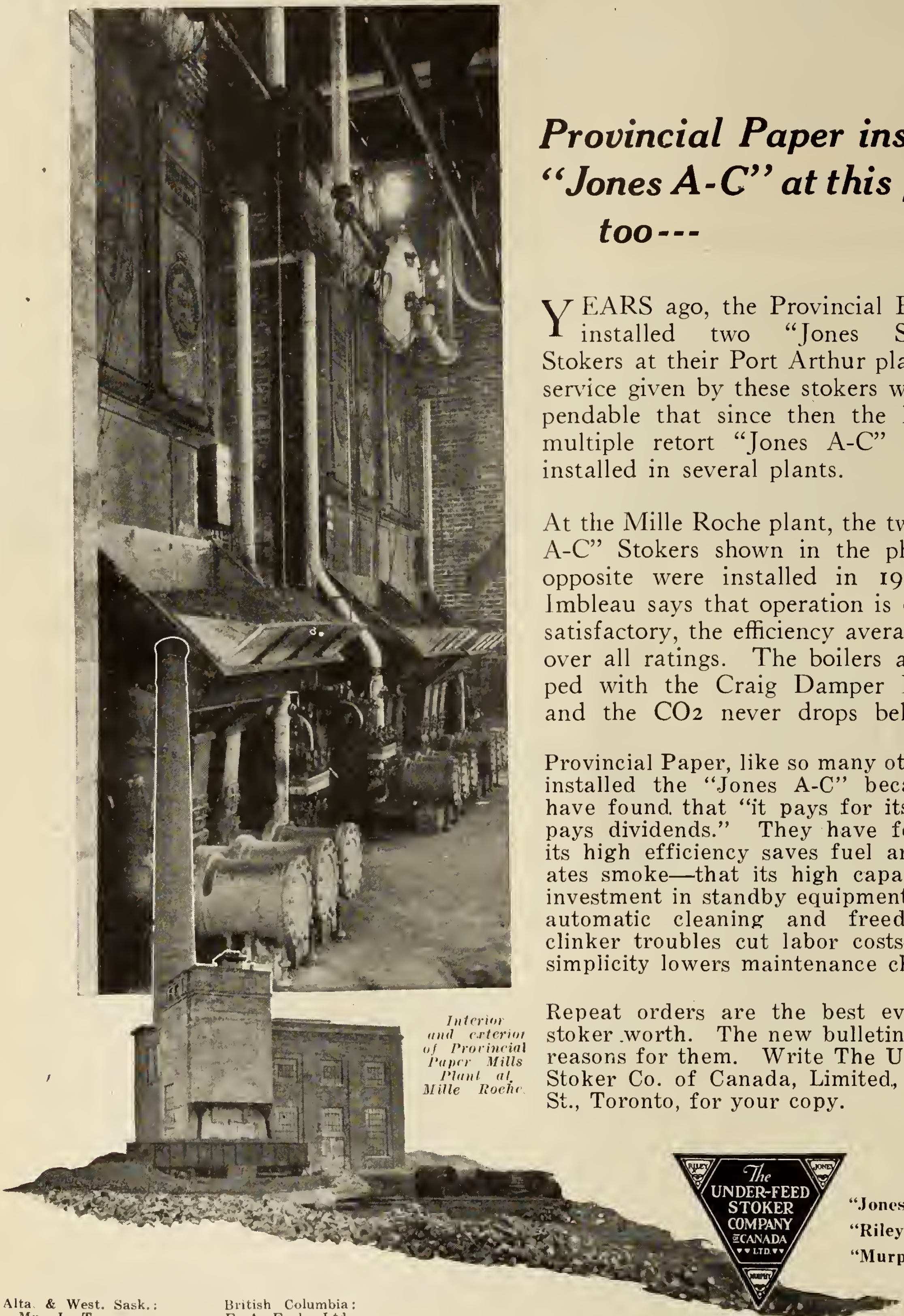
CANADA CEMENT COMPANY LIMITED

Canada Cement Company Building
Phillips Square Montreal

Sales Offices at

MONTREAL TORONTO WINNIPEG CALGARY

15 CENTS A COPY *$2.00 A YEAR*



Interior and exterior of Provincial Paper Mills Plant at Mille Roche.

Provincial Paper installed "Jones A-C" at this plant, too---

YEARS ago, the Provincial Paper Co. installed two "Jones Standard" Stokers at their Port Arthur plant. The service given by these stokers was so dependable that since then the high-duty multiple retort "Jones A-C" has been installed in several plants.

At the Mille Roche plant, the two "Jones A-C" Stokers shown in the photograph opposite were installed in 1922. Mr. Imbleau says that operation is extremely satisfactory, the efficiency averaging 72% over all ratings. The boilers are equipped with the Craig Damper Regulator and the CO_2 never drops below 12%.

Provincial Paper, like so many other firms, installed the "Jones A-C" because they have found that "it pays for itself—then pays dividends." They have found that its high efficiency saves fuel and eliminates smoke—that its high capacity saves investment in standby equipment—that its automatic cleaning and freedom from clinker troubles cut labor costs—that its simplicity lowers maintenance charges.

Repeat orders are the best evidence of stoker worth. The new bulletin gives the reasons for them. Write The Under-Feed Stoker Co. of Canada, Limited, 146 King St., Toronto, for your copy.

The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.

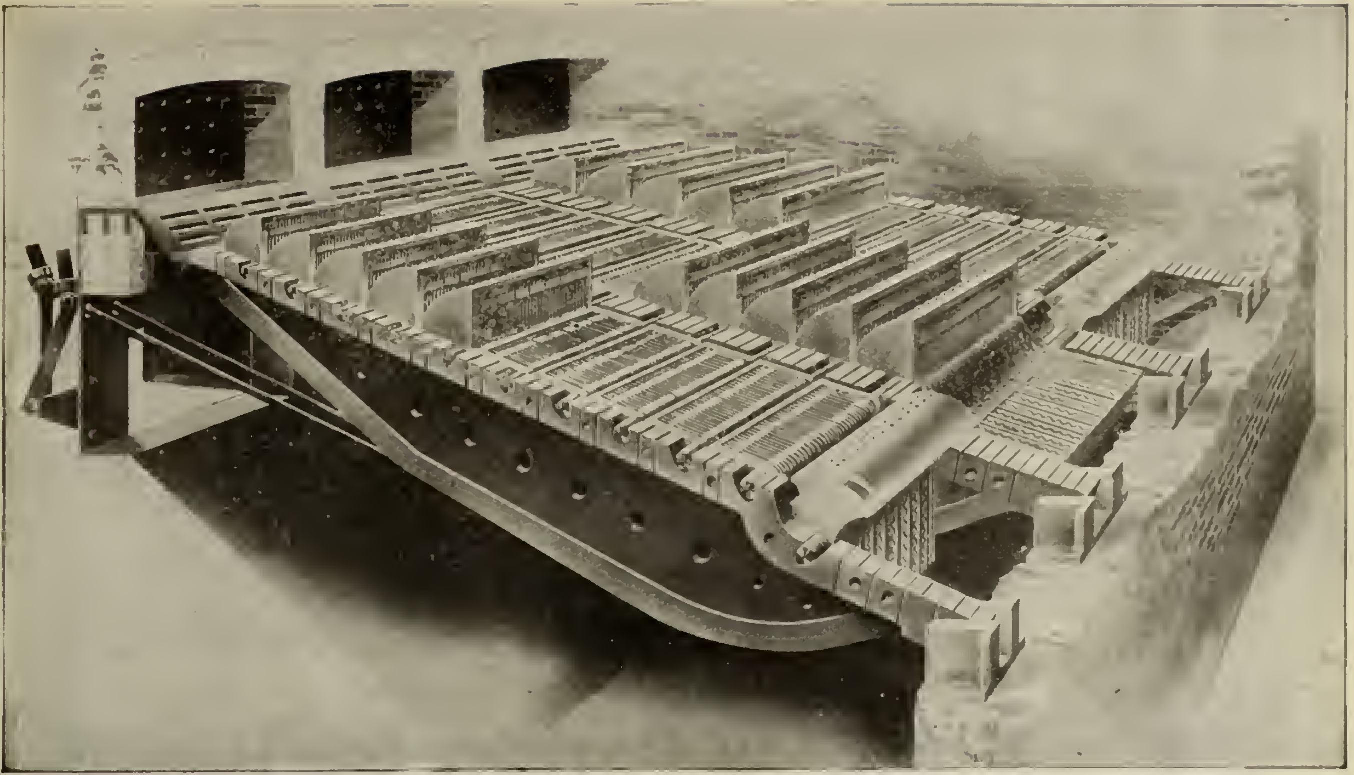
"Jones" Stokers
"Riley" Stokers
"Murphy" Furnaces

Alta. & West. Sask.:
Mr. J. Twomey,
Camrose, Alta.

Man. & East. Sask.:
W. W. Hicks & Co.,
Winnipeg.

British Columbia:
E. A. Earle, Ltd.,
Vancouver, B.C.

Quebec:
Cleaton Co. (Canada) Ltd.,
Montreal, Quebec.



Users Testify to the Saving Power of Files Stokers

ONE user of Files Stokers says a single installation (3,600 H.P.) saved enough coal to pay for the stoker investment in five months.

The average rating for this period was 223%.

Another user has written to say "While we have not made an actual test we would judge the saving in coal to be 10% to 15% as our load increased 25%. We are now able to obtain required steam without difficulty, which we could not do with down-draft furnaces."

Quoting from the letter of a third user the fuel-saving merits of Files Stokers is attested as follows: "Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel."

Files Stokers Achieve Results because:

1. They give correct distribution and proper proportion of air according to load carried.
2. The fuel bed is at all times kept clean and uniform.

You will be interested in the details of design of the Files Stoker. Write for complete information.

Waterous

BRANTFORD, ONTARIO, CANADA

The Peck Carrier for Handling Both Coal and Ashes

ONE sturdy reliable unit, instead of several inferior machines for accomplishing the same results.

Handles both coal and ashes with less upkeep than required for individual machines for coal and ashes.

Costs practically the same as elevators, conveyors, skip hoists and other equipment required to do same work—and is more dependable.

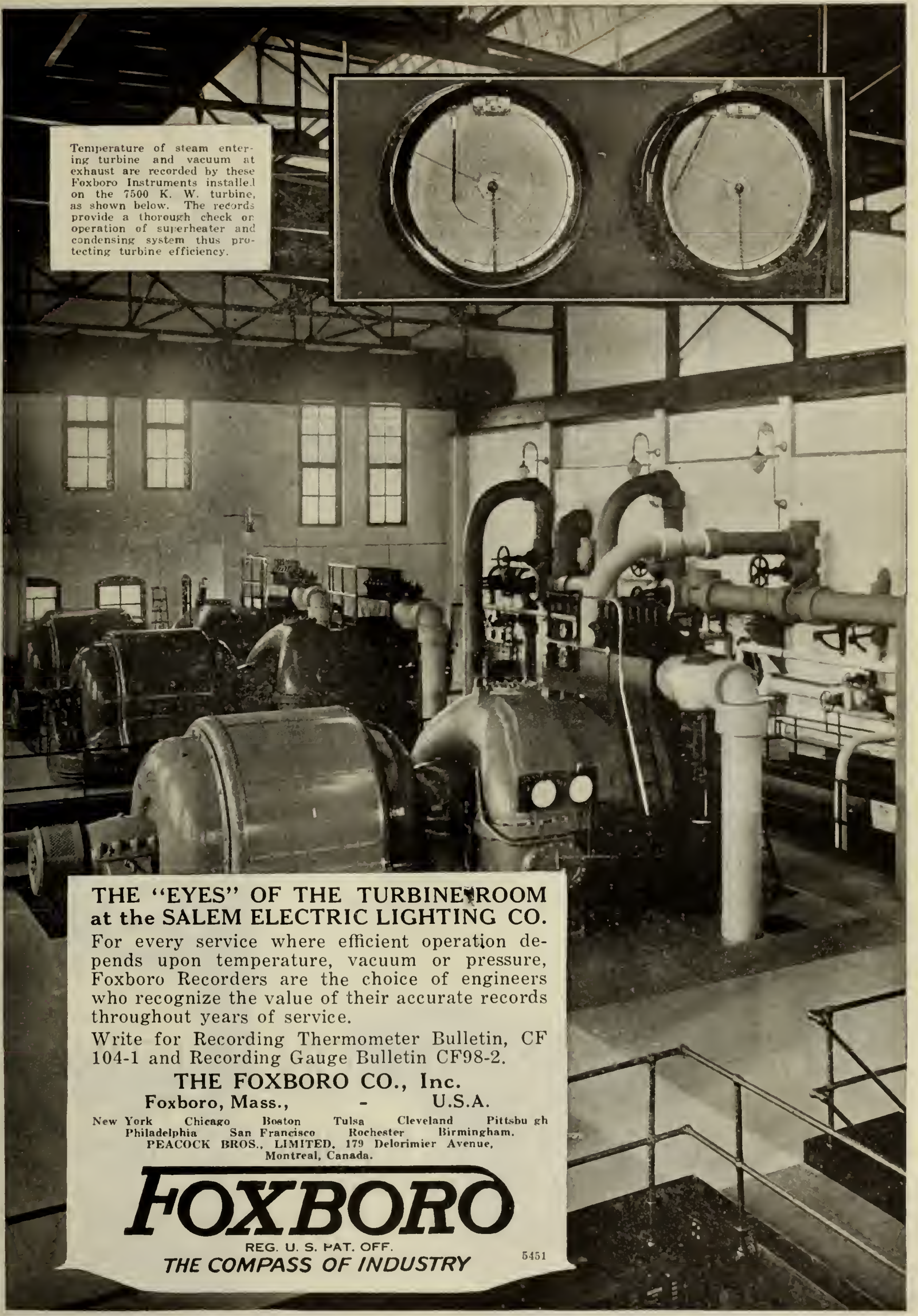
Operation and maintenance is less than for any other types of coal and ashes handling apparatus.

Minimum power required, the equipment runs slowly, is noiseless, and is always ready for service.

Back of the Peck Carrier stands the reputation of this Company—with hundreds of successful installations. Full particulars in Catalog 220.

CANADIAN LINK-BELT COMPANY LIMITED
TORONTO—Wellington and Peter Sts. MONTREAL—10 Gauvin Lane

LINK-BELT



Temperature of steam entering turbine and vacuum at exhaust are recorded by these Foxboro Instruments installed on the 7500 K. W. turbine, as shown below. The records provide a thorough check on operation of superheater and condensing system thus protecting turbine efficiency.

THE "EYES" OF THE TURBINE ROOM at the SALEM ELECTRIC LIGHTING CO.

For every service where efficient operation depends upon temperature, vacuum or pressure, Foxboro Recorders are the choice of engineers who recognize the value of their accurate records throughout years of service.

Write for Recording Thermometer Bulletin, CF 104-1 and Recording Gauge Bulletin CF98-2.

THE FOXBORO CO., Inc.
Foxboro, Mass., - U.S.A.

New York Chicago Boston Tulsa Cleveland Pittsburgh
Philadelphia San Francisco Rochester Birmingham.
PEACOCK BROS., LIMITED, 179 Delorimier Avenue,
Montreal, Canada.

FOXBORO
REG. U. S. PAT. OFF.
THE COMPASS OF INDUSTRY

5451

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Durable!

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

"PALMETTO"

REG. TRADE MARK

PACKING

There Is No Economy

in using a rod packing that does not meet the exacting conditions of present day engineering.

If the packing is not entirely heat resisting it will quickly char and fall apart—temperatures are high.

If the packing is made of heat resisting materials and does not contain sufficient lubricant it will quickly harden and become useless.

"Palmetto" meets the conditions, because it is absolutely heat resisting, and carries such quantities of lubricant that it does not harden.

If you do not know "Palmetto" let us send you working samples to test—no charge.

CANADIAN AGENTS:

The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver

GREENE, TWEED & CO.

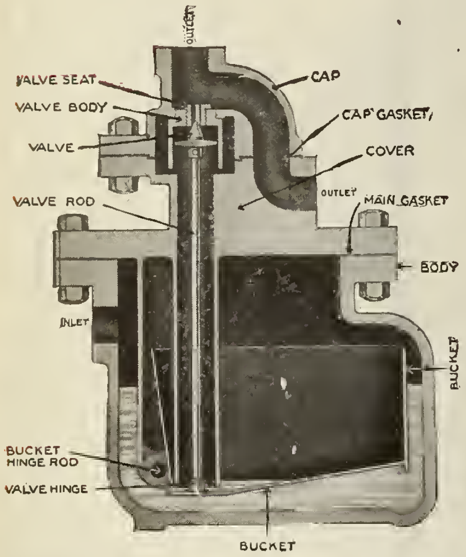
Sole Manufacturers

109 Duane St., New York

The Guardian

of the dwindling coal pile—

THE STRONG TRAP



Serious coal shortages—peak prices, and inferior quality are constant menaces to economical operation of your steam plant.

Don't allow waste of the steam that costs so much to produce nowadays.

Standardize on Strong Traps

These dependable rugged traps effect astonishing fuel savings, while their simple, perfect construction ensures years of satisfactory service.

Do not fail to get our Booklets which explain why Strong Traps are invaluable steam savers. Our nearest Branch will gladly mail them, and recommend the type suited to your needs.

Canadian Agents:

THE CANADIAN FAIRBANKS-MORSE CO.
Limited

St. John Quebec Montreal Ottawa Toronto
Windsor Winnipeg Regina Calgary Vancouver Victoria

29

Durabla Gaskets Make Tight Joints

Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.

Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

DURABLA
TRADE MARK REGISTERED

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in. long.

In thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Let us send you a trial order.

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

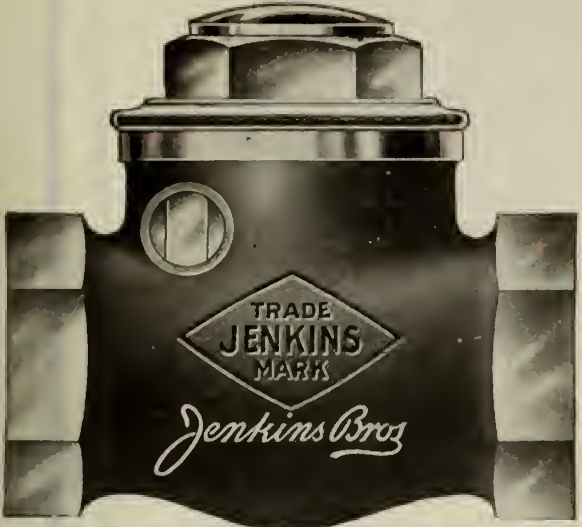


Fig. 475.
Standard Pattern
For 150 lbs. working pressure. Supplied with flanged ends, if desired. **Fig. 476.**

It fulfills the Jenkins Reputation

JENKINS
Bronze
Swing Check Valve

Equipped with Disc Holder and Composition Disc

This Valve conforms in every respect to the high standard guaranteed by the Jenkins name and the Jenkins "Diamond."

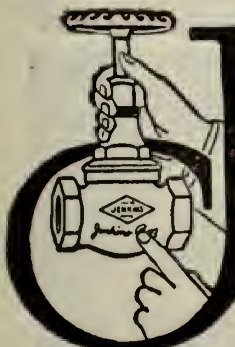
Like the other Bronze Valves in the Jenkins line it is cast from the virgin metal, a fact that assures strength and durability above the ordinary.

It has the Jenkins Renewable Disc feature. Disc lifts well out of passage. Hanger is heavy and has large bearing surface for carrying disc holder. Hanger pin is long and provides ample wearing surface. Angle of seat assures valve opening readily at low pressures.

Catalog No. 9 describes this Jenkins model fully. Write for free copy.

JENKINS BROS., LIMITED

Head Office and Works: 103 St. Remi Street, Montreal.
Sales Offices: Toronto, Vancouver.
European Branch: 6 Great Queen St., Kingsway, London W.C. 2, Eng.
Factories: Montreal, Bridgeport, Elizabeth.



Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

Pumping Sandy Water

Pumps handling sandy and gritty water are subjected to severe service even when operated under the best of conditions. It frequently happens that such pumps are installed in remote locations where they are required to give continuous service over long periods of time with little or no attention.

For pump rods and plungers exposed to the abrasive action of sandy water, for mine pumping and for medium pressure pumping service under abnormal conditions Garlock Hydraulic Duo Style No. 987 has been found effective.

GARLOCK
PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONTARIO

BRANCHES: Montreal, Que. Toronto, Ont. Winnipeg, Man. Calgary, Alta. St. John, N.B. Vancouver, B.C

More Power for Prosperity

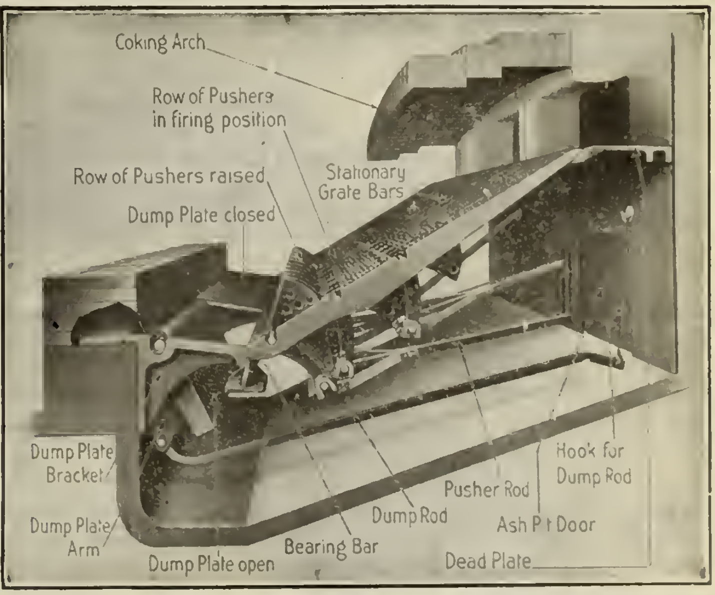
OF ALL the economies you can effect in your plant, the installation of modern, new, high grade Boilers will be the most far reaching. Boilers that leak steam, that leak heat, that require constant patching up and shutting down for repairs and have a regular "hog appetite" for coal are an intolerable expense, none the less dangerous because you probably don't see them often or hear much about them. Remember—the boiler is the heart of your power plant and every dollar wasted must come out of your profits. We make boilers of all types and sizes for either power or heating duties. Our 35 years of experience and our reputation for high class work at moderate prices are factors that warrant you corresponding with us at once on this important subject.

Big savings—

with the National Hand Fired Stoker

The special coking arch construction, possible only with the downward slope of our fire grates, is the most successful smoke consuming device you can use. Yet this arch is only one of several features that make the National Hand Fired Stoker a wonderful fuel and labor saver. The downward sloping banks of grates operated by convenient Pusher Rods from the front of the furnace enable even "green" help to get perfect stoking results with almost any grade of fuel.

The National can be installed with your present Boilers. Send for illustrated booklet.



Engineering & Machine Works of Canada, Limited

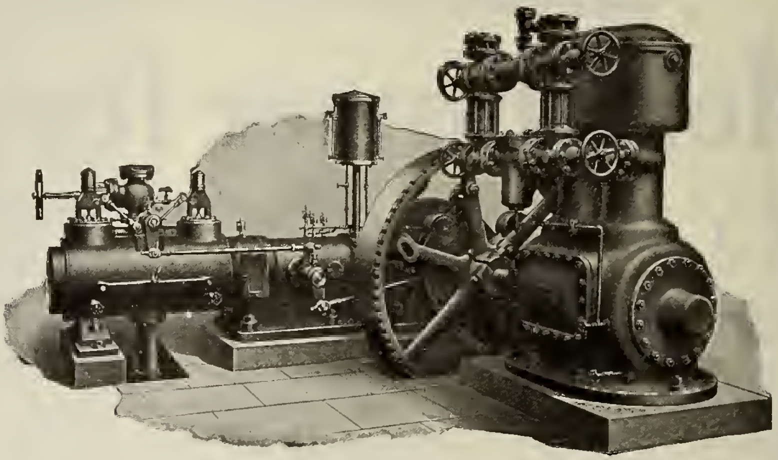
ST. CATHARINES, ONT.

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

FRICK COMPANY, INC. TRADE FRICK MARK WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical



Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

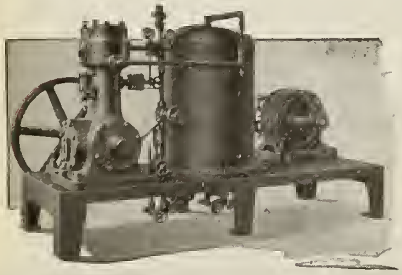
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

VILTER

ICE MAKING AND REFRIGERATING MACHINERY



A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada

LINDE

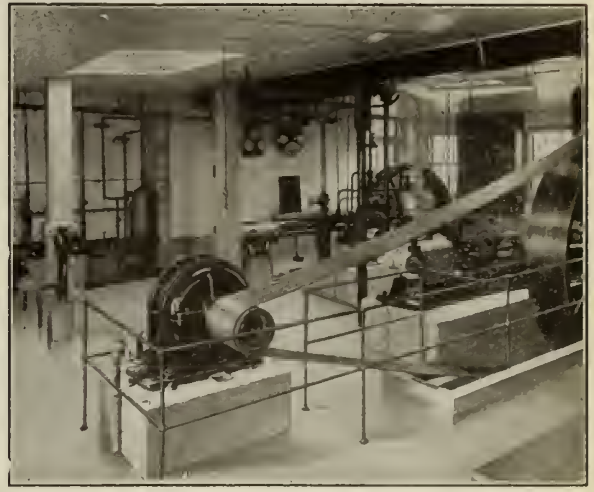
Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

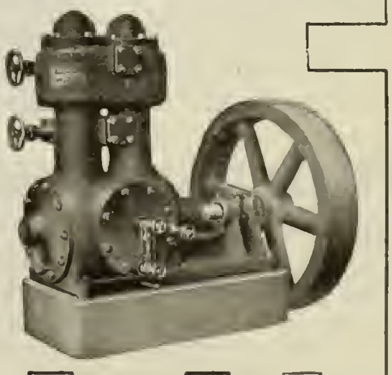
The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

YORK MECHANICAL REFRIGERATION

The Key That Unlocks the Door to INCREASED PROFITS

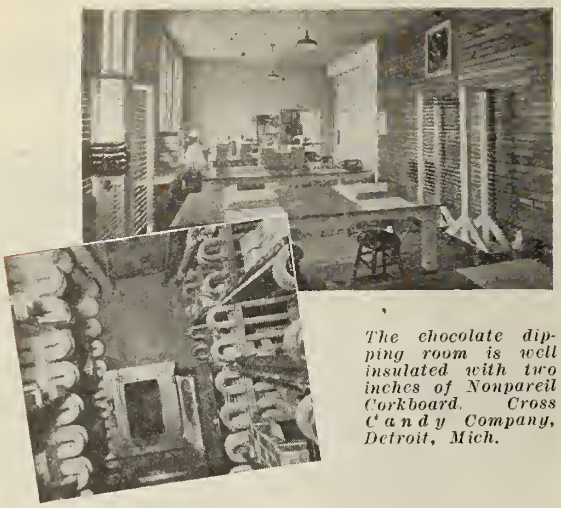


THOUSANDS of York Machines have paid for themselves, and are now earning substantial dividends for their owners. These machines are designed for service, built of the best materials for the purpose, thoroughly tested and rigidly inspected before shipment. They are self-contained, require very little attention and do not require a skilled operator. There is probably no other equipment you can buy that will be a greater help in increasing your profits than a York Refrigerating Machine.

CANADIAN ICE MACHINE CO., LTD.

TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals;
MONTREAL: 324 Craig St. West; WINNIPEG: 1415 Whyte Ave.;
VANCOUVER: 1158 Homer St.

YORK MANUFACTURING COMPANY
Ice Making and Refrigerating Machinery Exclusively.
YORK PENNA. U.S.A.



The chocolate dipping room is well insulated with two inches of Nonpareil Corkboard. Cross Candy Company, Detroit, Mich.

Eight inches of Nonpareil Corkboard is adequate insulation for this hardening room. Geo. Moore Ice Cream Company, Atlanta, Ga.

Both Are Well Insulated

EACH of these rooms is insulated correctly, though one has eight inches and the other only two inches of Nonpareil Corkboard.

Do you know the proper thickness for your rooms? Or where you can get dependable advice?

The sales engineers of this Company are at your service without charge or obligation. They are specialists in insulation who will help you determine your requirements and plan your construction for the most economical results. Nonpareil Corkboard designed and erected the Nonpareil way is insulation that is scientifically and economically correct.

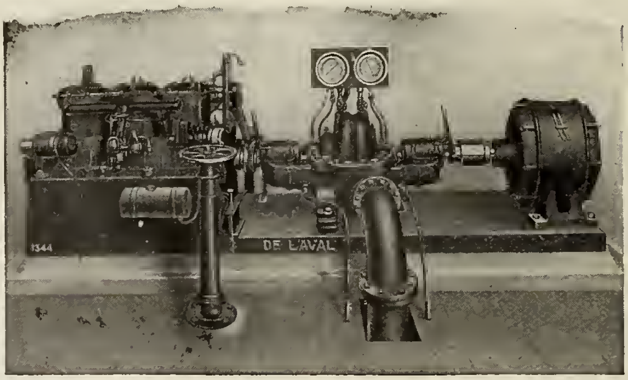
Are you planning new rooms or remodeling of old ones? Write for further information. There is absolutely no obligation or charge

Armstrong Cork & Insulation Company, Ltd., 902 McGill Building, Montreal, Que. 11 Brant St., Toronto, Ont. Can.

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines.

Nonpareil Corkboard Insulation

For All Cold Storage Rooms



Lindsay, Ont., sure of Water Supply

THE accompanying photograph shows a combined electric motor and gasoline engine drive for a De Laval two stage centrifugal pump installed by the City of Lindsay, Ont. This unit is guaranteed to deliver 1,325 gal. per min. against 290 ft. head.

The dual drive makes it possible to take advantage of the comparatively low cost of electric power, with a further saving in attendance charges, and at the same time to have absolute insurance of water supply in case the electric supply should fail. The pump can be connected to either source of power by means of the clutch couplings shown.

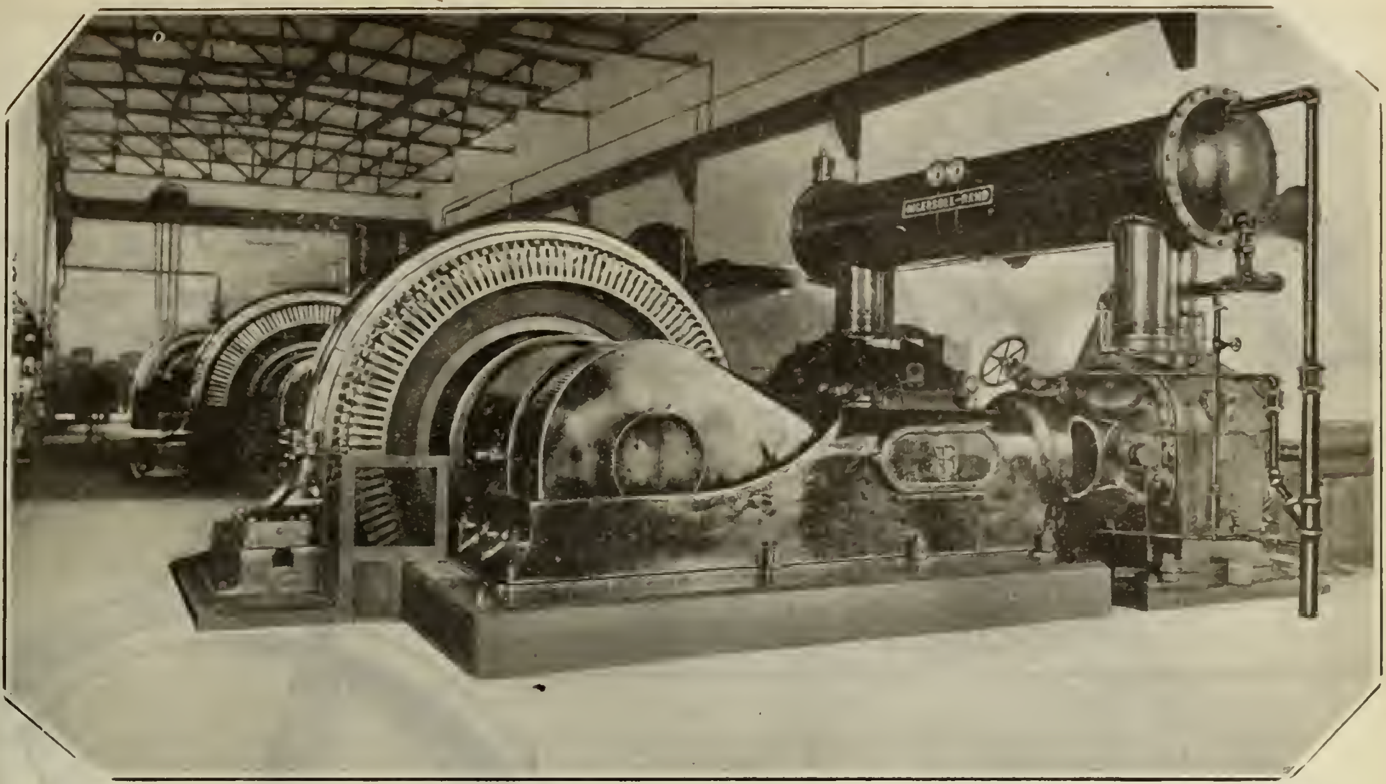
State your pumping requirements and ask for our special publication B100.

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

225



Ingersoll-Rand Class PRE-2 Compressors at the International Nickel Co.'s Creighton Mine.

Ingersoll-Rand Compressors

The Choice of Men Who Know

The mining Industry being the largest and oldest users of Air Compressors and the most dependent upon them are probably better qualified to judge compressor values than any other class of user.

Therefore, those requiring Compressors for construction work, pumping, gasoline extraction or industrial purposes of any kind can best be guided by selecting the types adopted by experienced mine operators.

In every recognized mining camp on the globe, "Ingersoll-Rand" Compressors predominate. Many of them have also found their way on mule back, or by other primitive modes of transportation into the heart of Africa, the ice-bound regions of the Far North, or over the mountain passes of Mexico, Columbia, Peru, Chili and other remote parts of the world.

"Ingersoll-Rand" Compressors are there because they have proven their worth—from a cold dollar and cents stand point. Workmanship, materials and design are up to the minute—the product of an organization with over 50 years experience in this field and who knowing the conditions under which this class of equipment operates build accordingly.

"Ingersoll-Rand" Compressors are built for all classes of service and for all drives in a complete range of sizes, from 6 to 10,000 cubic feet per minute. Standard and special units for gasoline extraction, handling ammonia gas and for high pressure service as well as a complete line of straight-line and duplex dry vacuum pumps are also available.

Detailed information concerning any or all sizes and types of "Ingersoll-Rand" Compressors or Vacuum Pumps forwarded on request.

Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

For the U.S., refer Ingersoll-Rand Co., 11 Broadway, New York.

Ingersoll-Rand

D. K. McLaren Limited

GENUINE OAK TANNED

Leather Belting

THERE are good reasons why D. K. McLaren's Leather Belting is so popular among Canadian power house engineers. They appreciate its stretchless quality that not only saves considerable of their time but helps them to keep transmission costs around where they should be.

The maintenance of these cost-cutting qualities is a first consideration with us. That's why we have a staff of experts to select the choicest hides; why we continue to use the more expensive **Genuine British Oak Tanning Process;** why every inch is subjected to the severest tests before the **Oak Leaf** is stamped upon it as a guarantee of the **utmost in belting efficiency.**

Be sure to look for the Oak Leaf—it's worth while

D·K·McLAREN
LIMITED

Head Office and Factory
351 St. James St., Montreal, P.Q.

Stock Depots:
VANCOUVER, B.C.
T. M. Grindley Co.,
1158 Homer St.

Branches:

ST. JOHN, N.B.
90 Germain Street

TORONTO
194 King Street, W.

CALGARY
Gormans, Ltd.

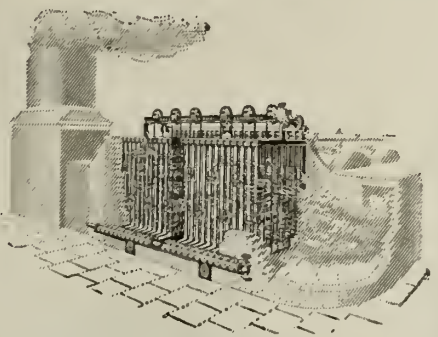
EDMONTON
Gormans, Ltd.

More Steam -- Less Coal

Up-to-date Boiler plants are saving thousands of tons of coal annually by the installation in the main flue between the boilers and the chimney stack of a

Green's Fuel Economiser

which by utilising high temperature flue gases



SAVES 15-20% OF COAL

Write for illustrated and descriptive Catalogue D.J. to—

E. GREEN & SON, Ltd., Wakefield, England

Codes: A.B.C., 5th Edition; Bentley's Phrase; A1; Lieber's; Engineering; Western Union.

MAINTAINED ACCURACY IN SERVICE

Even automatic control should be proved as accurate.

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

RECORDING PRESSURE GAUGES

Are successfully demonstrating their ability in checking up the accuracy of other controlling apparatus, in hundreds of the best operated power plants.

Bristol's Recorders are first aid for the speedy detection of the several sources of heat waste and other preventable operating losses.

The name BRISTOL'S is your protection against inferior quality. Bristol's Recording Instruments are the world's standard.

Our Catalog 1006-A deals with the subject in an interesting way. Write for a copy.

THE BRISTOL COMPANY
Waterbury, Conn.

Canadian Distributors :

Eastern Territory—Powerlite Devices, Toronto and Montreal.
Western Territory—Gorman's Ltd., Edmonton.

KERR

"Guaranteed" Satisfaction

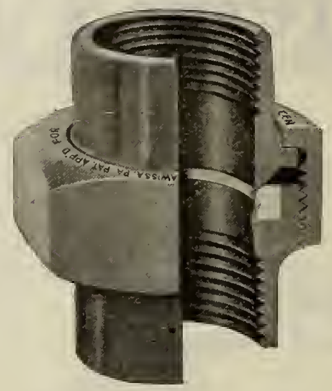
FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville Ontario

The "CATAWISSA" Forged Steel UNION



An Unusual Union

You lose no time tearing down lines on account of union troubles, when the "CATAWISSA" is on the job.

Forged from refined steel bars it has unusual strength and toughness and will stand any amount of abuse. Seats made from ordinary forged steel, brass or monel metal.

Monel Metal Seat

The toughness and durability of Monel Metal is a decided advantage when used as a seat for the "CATAWISSA." It makes it proof against the "wire-drawing" or cutting effect of the steam, is non-corrosive and is unaffected by small cutting particles that would otherwise cause leaks. It is especially suitable for high pressure temperature.

The high grade material used enables the "CATAWISSA" to withstand shock and vibration without the usual crystallization and breakage.

"CATAWISSA" Unions are thoroughly tested under water with compressed air—the best known method. You should investigate these "unusual" unions.

RAILWAY & POWER ENGINEERING CORPORATION
LIMITED
133 Eastern Avenue, Toronto, Ont.
Branches: Montreal, Que.; Winnipeg, Man.

5,000,000 Gallon
BAWDEN Centrifugal PUMP

Made in Canada

Write for Catalogue

AT THE
City of Toronto Waterworks

Day in and day out this Bawden Centrifugal at the Riverdale Pumping Station, Toronto, running at 730 r.p.m., pumps 3,500 gallons per minute against a pressure of 75 lbs.

In this, as in all Bawden Pumps, efficiency, accessibility, durability and ruggedness of construction are factors of its absolute dependability.

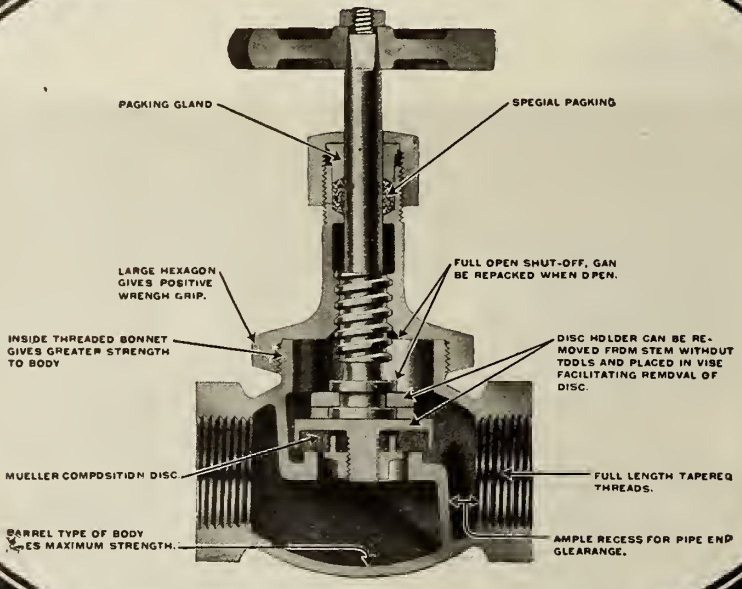
The BAWDEN line includes Steam, Centrifugal and Vacuum Pumps; Air Compressors; Rubber Mill Machinery and Tire Moulds; Special Automatic Machinery; Special Brass Work; Gear Cutters of all kinds; Brass, Bronze, Aluminum and Grey Iron Castings; etc.

Bawden Machine Co., Limited

Head Office: TORONTO, Canada

Agents: Montreal Winnipeg Calgary Vancouver

Make Canada Prosperous by Buying Canadian Products


PACKING GLAND
SPECIAL PACKING
LARGE HEXAGON GIVES POSITIVE WRENCH GRIP.
FULL OPEN SHUT-OFF, CAN BE REPACKED WHEN OPEN.
INSIDE THREADED BONNET GIVES GREATER STRENGTH TO BODY
DISC HOLDER CAN BE REMOVED FROM STEM WITHOUT TOOLS AND PLACED IN VISE FACILITATING REMOVAL OF DISC.
MUELLER COMPOSITION DISC.
FULL LENGTH TAPERED THREADS.
BARREL TYPE OF BODY GIVES MAXIMUM STRENGTH.
AMPLE RECESS FOR PIPE END CLEARANCE.

The Superior Steam Valve

The Mueller A-3006 Steam Valve has proven its superiority under high and super-heated steam pressures so that to-day repeat orders from customers satisfied with samples are the rule, rather than the exception.

If you have not acquainted yourself fully with this valve, there is no better time than right now. Made in a complete range of sizes, from 1/8" to 2". Send for sample and make your own test.

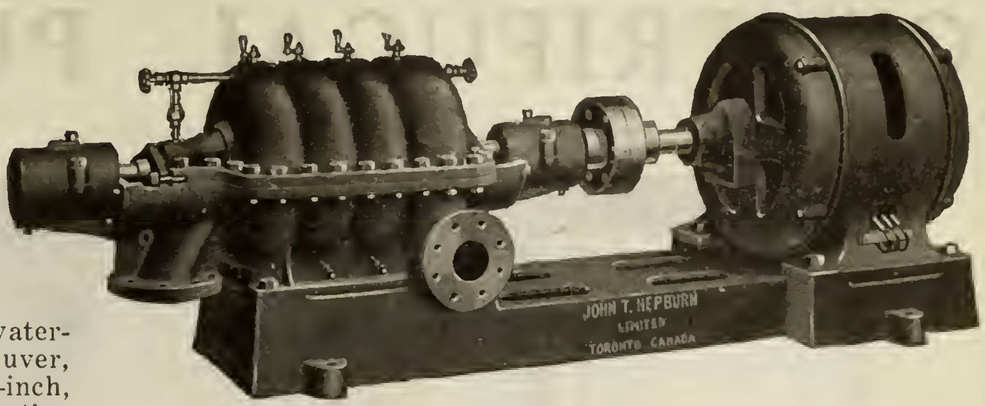
H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Ill., U. S. A. Branches, New York and San Francisco
Mueller Metals Co., Pt. Huron, Mich., makers of "Red Tip" Brass Rod, Brass and Copper Tubing, Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

© 1917 H MM Co

HEPBURN PUMPS

For Reliable Waterworks Service

In The City of Vancouver



In the Lynn Canyon waterworks, North Vancouver, there is installed a 3-inch, 4-stage pump, operating against a head of 600 feet. The pump is a HEPBURN and it was installed to safeguard the North Vancouver district water supply. The Hepburn pump was chosen for this important work because of its recognized dependability.

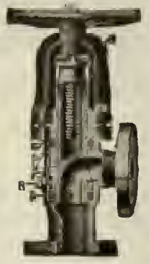
The Hepburn pumps are built on the most improved lines—Centrifugal, Simplex and Duplex. Write for complete information regarding Hepburn Pumps and Hepburn Hand and Electric Overhead Cranes, Vertical Engines, Castings and Forgings.

JOHN T. HEPBURN LIMITED

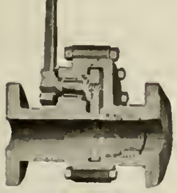
Engineers and Iron Founders **18-40 Van Horne St., Toronto**

The Yarway Tandem

Combination of slow-opening plunger type valve—the Yarway Seatless—and quick-opening swing-gate valve—the Yarway Double-Tightening. Complies with A.S.M.E. Code and Boiler laws of all States. Absolutely dependable for efficient blow-off service and long life.



Yarway Seatless Blow-Off Valve, (Formerly the Simplex).



Yarway Double-Tightening Valve.

Unconditionally Guaranteed For Two Years

The Yarway Tandem, consisting of the Yarway Seatless Blow-Off Valve and the Yarway Double-Tightening Valve, is unconditionally guaranteed for a period of two years from date of installation. Should any part of either valve fail within that time, it will be replaced or repaired without cost to the user.

Two years, however, by no means represent the maximum service that can be expected from the Yarway Tandem. We hear of Yarway Seatless Blow-Off Valves in service nine and ten years without repairs; and the first Yarway Double-Tightening Valves, installed several years ago, are on the job to-day.

The Yarway Tandem is fully described in Booklet B-410. May we send you a copy?

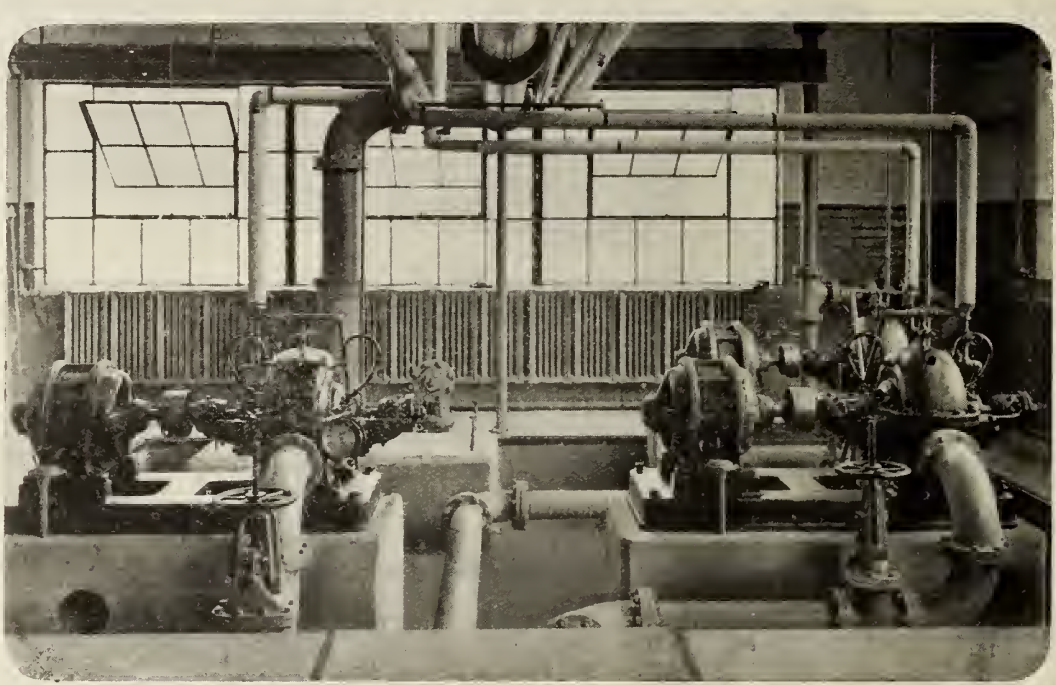
Yarnall-Waring Company
Mermaid Lane and Ardleigh Street
Philadelphia

207 St. James St., Montreal
400 Penobscott Bldg., Detroit

YARWAY

POWER PLANT DEVICES *to save fuel*

REES RoTURBo
CENTRIFUGAL PUMPS



3-Rees RoTURBo Circulating Pumps at the Plant of The Match Co., Limited, Berthierville, Que.

Freedom From Wear

The low velocity of the water through all passages of REES RoTURBo Pumps results in almost complete freedom from wear, even when gritty water is being pumped. Furthermore, the prime mover is insured against over-loading by its self-regulating feature. REES RoTURBo Pumps give permanently efficient service over a wide range of duties. Their many features are minutely explained in the REES RoTURBo bulletin. Shall we send you a copy?

Your enquiry promptly answered

The GOLDIE & McCULLOCH Co. Limited

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bldg.

OTTAWA OFFICE:
185 Sparks St.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig,
400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B. C.

POWER HOUSE

ESTABLISHED 1907 *Toronto, July 5th, 1923* A SEMI-MONTHLY NEWSPAPER

C.A.S.E. Convention in Toronto Best Ever!

J. J. Sullivan, of Ottawa, Chosen President for Ensuing Year—Montreal to be Scene of Next Gathering—Spirit of Goodwill Dominates Engineers and Exhibitors Alike

THE thirty-fourth annual convention of the Canadian Association of Stationary Engineers was, judging from the attendance, and the spirit evinced at the various meetings, one of the most successful ever held. The official registration was nearly 500, and many more attended the banquet, the concerts, and the power equipment exhibition.

The banquet Monday night, June 25, in the Hotel Carls-Rite, Toronto, at which members of the Exhibitors' Association were the hosts, was the best attended in the history of the organization, and the entertainment was of an unusually high order.

Robert McLaren, chief engineer, Massey-Harris, Ltd., and president of Toronto No. 1, who has been a member of the association for the past eighteen years, in welcoming the guests, declared that 1923 so far had been the best year in C. A. S. E. history, and urged all members to spread abroad the spirit of goodwill which is the fundamental essential of success. Alderman W. H. Shaw in voicing a plea for "Education—the Foundation of Good Citizenship," stated that more mathematics and science should be added to the curriculum of the public schools of Ontario.

After Duncan Cowan had left the audience applauding his solo effort for more than a full minute, a toast to the Department of Education was proposed by Geo. F. Galloway of London, Ont., secretary of the Grand Lodge.

Defends Boiler Law

The unusual spectacle was then witnessed of a government official, J. H. H. Ballantyne, deputy minister of labor. defending the boiler inspection law of the province, as the term of office of his chief in the U. F. O. government was being terminated by the voters of Ontario. Mr. Ballantyne stated that "it was not desirable to change the present law, until it had had a fair trial," as the complaints he had received to date, he claimed, were few. He, however. admitted, that if the Act was unsatisfactory it should be rectified. adding that as at present there is a strong tendency toward the use of electrical energy, any changes should cover future electrical development.

J. M. Brown, chairman of the Board of Examiners, explained briefly the grading of engineers and the issuance of certificates. To show how difficult the requirements have become, he pointed out that 70 per cent. of the applicants failed to pass last year. There are eighty first-class certificates held in Ontario.

J. T. Burke, chief inspector of factories, also spoke, his remarks being followed by a song by Earl Hetherington, which was well received.

MISS ARLENE JACKSON,
Power House Entertainer.

Jack Armour, of Power, then put everyone in good humour with a flood of oratory.

Miss Jackson Triumphs

Miss Arlene Jackson, in her initial appearance before members of the C. A. S. E. by arrangement with Power House, was the outstanding feature of the entertainment.

A winsome miss, whose billing in "big time" vaudeville, "syncopated songs at the piano," aptly describes her act, contributed four numbers to the program. Her first, "The Old Swimmin' Hole," struck a popular note with its echoes of boyhood days. The second, a parody on Gallagher and Shean, was improvised around the labors of Arthur Murphy, editor of Power House. Her third number was a careful characterization of Bert Williams, the famous star, in his Broadway success "Somebody Else," and her final offering, "Down in Indiana" won the favor of everyone.

It is hardly logical to expect an audience to applaud heartily when individually and collectively it is wiping its brow with one hand and more or less vigorously fanning itself with the other, but this snappy and entertaining turn brought down the house. It was a real vaudeville "spot holder."

T. H. Fenner, former editor of Power House, was the next "act," on the bill, his song offering winning favor.

The election results were announced during the evening.

Grand Lodge Opens

On Tuesday, June 26, at 9.30 a.m., the official opening of the Grand Lodge took place in the Central Technical School Library, being followed at 10.30 by a general meeting of engineers and exhibitors.

W. S. Kirkland, assistant principal of the night technical school, in a speech on behalf of Dr. A. C. McKay, who was out of the city, welcomed the delegates and outlined the educational value and history of the school, emphasizing the fact that the institution had its origin in the efforts of pioneer members of the C. A. S. E.

Short speeches in reply were made by Earl Hetherington, G. C. Keith, Geo. F. Galloway and Geo. J. Soucy, chairman of the convention committee.

Mr. McLaren in a tribute to the interest and enthusiasm of the exhibitors and delegates, said in part: "There could have been no better place selected for the purpose of this convention and exhibition than the Central Technical school. and I am sure we all appreciate the kindly interest and patronage of Dr. A. C. McKay, director of technical education for the City of Toronto.

"It was he who made it possible for us to have such fine and convenient quarters. I wish personally to extend a most hearty welcome to all our guests and patrons. We trust that your visit here will be both a source of pleasure and profit and should you leave us before the exhibition is concluded, Remember it, Boost it, and tell others to come to it."

Mr. McLaren then emphasized the value of the publicity Power House had given the C. A. S. E. in the past year, exhibiting many pages dealing with C. A. S. E. activities to the delegates from the platform. In concluding, Mr. McLaren asked Campbell Bradshaw, managing editor of Power House to address the delegates.

Urges Co-operation

Mr. Bradshaw in urging co-operation and unity warned the delegates of the dangers of one-man control and petty jealousies in any organization. He pledged his individual efforts toward the expansion of the organization in the coming year.

Before adjournment Mr. Soucy again spoke, saying in part: "Not many years ago nearly all practical engineers refused to have anything to do with theorists or professors of engineering; however, to-day the attitude of nearly all engineers is completely reversed, because to-day nearly all theorists have a practical working knowledge of their subjects, with the result that they can meet the practical or stationary engineer on his own ground. To-day the operating or stationary engineer is seeking to acquire more and more of the theoretical and technical knowledge required to fit him for a higher grade of certificate or a better position. The graded license has contributed very largely to this result; however, there is no doubt that technical newspapers and schools have made possible in many cases the results obtained.

"As chairman of the educational committee of the C. A. S. E. I wish to say that we cannot, nor do we ever hope, to displace technical education, but rather to supplement it by affording a sort of exchange or clearing house for practical problems. Our aim and purpose can best be accomplished by the establishment of operating engineers' clubs in all large centres where the engineer who is off duty or out of employment can go and see a permanent exhibit of power plant equipment and supplies, and attend lectures or classes of instruction in practical operation. I believe such a scheme is not only possible, but that it is the only one which will ever succeed in holding engineers together and in the end prove the most economical and effective from the supply men's stand point."

Tour Technical School

Tuesday afternoon was devoted to a tour through the mechanical departments of the technical school, conducted by M. Barry Watson, director of the engineering department of the school.

A concert was held in the main auditorium in the evening, which consisted of movie films, both technical and comic, a radio concert, directed by M Watson, and an organ recital by Geo. H. Graham, M. A.

Wednesday opened with a meeting of the Grand Lodge in the technical school library. At 12.30 all engineers and exhibitors assembled at the front entrance of the school on Lippincott St., for the official photograph. The Grand Lodge held a further meeting at 1.30 p.m. which was followed by a second tour of the school, again under the supervision of Mr. Watson. The evening concert was similar to that of Tuesday evening.

Elect New Officers

Thursday was featured by a meeting of the grand lodge for the election of officers for the ensuing year. The following engineers were elected:

Immediate Past President—Geo. F. Galloway, London, Ont.

President—J. J. Sullivan, Ottawa, Ont.

Vice-President—Robt. McLaren, Toronto, Ont.

Treasurer—E. J. Groome, Kingston, Ont.

Secretary—Geo. J. Soucy, Toronto, Ont.

At 11.30 a.m. the exhibitors held their annual meeting, and the following officers were elected:

President—Howard Fletcher, of Garlock Packing Co.

Vice-President—H. A. Hatfield, of Babcock & Wilcox.

Treasurer—L. M. Archibald, of Dart Union Co.

Assistant-Secretary—Geo. L. Wilkinson.

A vote of thanks was tendered C. B. Turner, who has acted as chairman of the exhibit committee for some years.

As the next convention city, Montreal was unanimously chosen.

Exhibits in Three Rooms

The three rooms in the central technical school devoted to the exhibits of machinery, appliances, asbestos, compounds, etc., were a veritable bee-hive, and engineers as well as visitors received much valuable information. The booths were well laid out and demonstrators and exhibitors were on hand with the desired information.

G. F. Sterne, of G. F. Sterne & Sons, consulting chemical engineers of Brantford, Ont., displayed silicate of soda for use in the prevention and removal of boiler scale, also their Monolith for making one-piece refractory boiler fire box and industrial furnace linings.

The Dearborn scientific treatment of boiler feed waters sold by the Dearborn Chemical Co. Ltd., of Toronto, to elimin-

Delegates and Exhibitors at 34th Annual Convention of the Canadian Association of Stationary Engineers.

ate scale formation and corrosion in boilers, was ably discussed by the company's representatives, G. Wilson and W. W. Jamieson.

The Crane Packing Co. Ltd., of Chicago, represented by F. R. Yeomans, exhibited engine packing goods and boiler roof supplies, laying particular stress on the "John Crane" flexible metallic packing.

Keasby & Mattison, of Ambler, Pa., with a branch office in Toronto, manufacturers of asbestos products of every description, were represented by B. Peltz, who demonstrated their asbestos pipe covering and asbestos tubing.

Howard G. Fletcher, of the Garlock Packing Co., of Hamilton, went into the subject of asbestos in all its stages from rock to the finished product, as well as the various stages in the manufacture of rubber, laying particular stress on the Garlock engine packings.

Dart Union Exhibit

The Dart Union Co. Ltd., of Toronto, had a special exhibit of the Dart union fitted with bronze rings. This was kept in water during the entire convention to show that the rings remained free from rust and corrosion. The ball joint of the Dart union was shown by a large ball standing on a raised union. L. M. Archibald was in attendance.

Walter H. Reid, of the Argus Manufacturing Co., Toronto, discussed various materials for the water-proofing and air-proofing of surfaces, also the Argus caulk and Argus boiler coat as coal-saving devices.

The operation of the Babcock & Wilcox boiler with B. & W. chain grate stokers were ably explained by H. A. Hatfield of the Toronto office of the company.

C. B. Turner, of C. B. Turner & Co., of Toronto, demonstrated an automatic boiler cleaner and the Hercules expanding boiler tube.

Plibrico, a jointless furnace lining, Boico boiler compound, and shell-bar grates, greeted the visitor to the second room, and were in charge of W. D. Wilson of Shell-Bar, Boico Supply Limited, Toronto.

The Celite Products Company, of Montreal, had representatives from the Montreal and Buffalo offices, L. Russel and W. D. Van Arnam respectively. They demonstrated the Sil-O-Cel insulating brick for heat insulating work with the aid of a blow-torch.

Arrived Too Late

Unfortunately, the exhibit of the Bird-Archer Co., of New York and Montreal, did not arrive in time for the convention. P. B. Bird of this company was in town from New York, though the booth was in charge of H. C. Harrigan, sales manager of the Montreal office.

The exhibit of the Waterous Engine Works, Co. Ltd., of Brantford, was in charge of Wm. Welsh and Earl Buckley, who had on display one of their Files hard stokers.

The various workings of this exhibit caused much interest.

The only solder exhibit was made by the Magnolia Metal Co. Ltd. of Canada, Montreal. C H. Bechtel looked after everyone interested.

H. H. Gee, of Jenkins Bros. Ltd., Montreal, was particularly anxious that visitors should learn everything about the Jenkins valve and Beaver non-return valve. He had one of the largest displays, and also explained an air reducing valve capable of standing 200 lbs. pressure.

A new company just incorporated in Toronto, The Reliable Washerless Valves, Ltd., displayed the McIsaac valve which they are manufacturing. A. H. McIsaac, of this company, and inventor of the valve, was in attendance.

Darling Bros. Ltd., 120 Prince St., Montreal, represented by S. A. Jennings and D. Eggett, the latter of London, Ont., exhibited the Dexter valve reseating machines and Webster steam appliances.

Fire brick and Bours refractory furnace cement were explained by N. B. Jackes, of the Toronto Pottery Co. Ltd. The cement is a dry preparation and is claimed to resist flame.

The Jas. Morrison Brass Manufacturing Co., Toronto, Ont., had a large display in charge of A. Betton. Their chief exhibits were engine room set gauges and locomotive injectors. Beaver globe, angle and cross non-return stop and equalizing valves were all in paramount positions.

All Canada Product

A special feature in the Bull Dog lacing pointed out by E. Gordon of the Bull Dog Lacer Co. of Canada, Hamilton, is the fact that the wire used in it is entirely a Canadian product. It is a machine closed wire lacing that takes a staggered hold on the belt, by using a long and short hook alternately.

Thos. H. Fenner, A. M. E. I. C., former editor of Power House, is instructor in special courses for stationary engineers at the Shaw Correspondence Schools. He outlined courses to prepare for first, second and third-class examinations.

One of the largest exhibits was a Copes boiler feed regulator in charge of E. Dean Wilkes, of the Allen General supplies, Limited, sales engineers of Toronto. This machine was in operation fifty per cent. of the time, and had many interested observers.

A. W. Cash & Co., of Toronto, represented by W. T. Brickenden, displayed their damper regulator and reducing and regulating valves. An added feature of this booth was a lady's handsome hand bag, and a gentleman's set of Wahl pen and pencil. Visitors were given tickets,

Photographed for Power House at Toronto Central Technical School, June 27.

and on Wednesday evening they were drawn for, being won by Miss Holmes, 630 Lonsdale Ave., Toronto, and H. Marshall, engineer of Bingham's Limited, 84 Yonge St., Toronto.

W. W. Shears, of C. A. Dunham & Co. Ltd., Toronto, demonstrated the Dunham expanded outlet reducing valve and reducing pressure valve, also high pressure bucket traps and Dunham radiator traps.

Discussed Lubrication

W. W. Horsey, of the Imperial Oil, Limited, discussed oil and various lubricants for use in machinery and power plants. Pictures of their various refineries interested visitors.

W. Russell Sexton, of the W. R. Sexton Boiler Setting Co., Toronto, explained Sexton's Nonpareil shaking and dumping grate bars. He also gave information of fire-brick work and the retubing of boilers.

The Zeolite process, for the softening of water, used chiefly in laundries, hospitals, steam power plants, and textile mills, was thoroughly discussed by Robt. S. Hambleton, of the Refinite Co. of Canada, Toronto.

Wm. McKay ably represented the Goldie & McCulloch Co. Ltd., of Galt, manufacturers of boilers, pumps and engines.

Geo. Farrow & Son had an interesting exhibit explaining the coal wasted when boiler tubes become incrusted with scale.

Crane's Limited had a prominent booth at which the many types of valves this firm manufactures were explained.

Power House was also in evidence, the booth being under the direction of Miss M. Riopel and Walter Hudson.

Power was represented by Mr. Armour.

Other Booths Noticed

Ernie Wilkinson looked after the interests of the Lunkenheimer Company, and other booths noticed were Ontario Lime Co. Ltd., of Toronto, F. J. Downes, 23 River St., Toronto, manufacturers of feed water treatment, and dealers in Cole tilting return traps, and Canadian International Filter Co. Ltd., specializing in appliances for water softening and filtration plants; Quaker City Rubber Co., and Refinite Company of Canada.

The exhibition was open every day and evening during the convention.

Thursday, the last of the convention, which was to close with a picnic for exhibitors, engineers and their families and friends, dawned with rather a threatening appearance, and worst fears were realized, for about 10 a.m. it commenced to rain, and until evening kept up a fairly steady downpour.

Nothing daunted, however, it was decided to hold the picnic at the Horticulturad building at the Exhibition grounds, and to this meeting place those with cars very kindly conveyed those without, and by 3.30 p.m. everyone was on hand and the sports and races scheduled were in full swing. About two hundred were present, and practically all took active part in the proceedings.

There seemed to be a great deal of competition between engineers and exhibitors, but it is to their credit that they broke even in nearly every case. In the one hundred yard dash there was nearly a bad accident, when, having worked up steam to such an extent that he could not get under control, the "first in" had to spring right over the supper table, and all that was thereon. We are glad to say he cleared the top! The one foot hop race, also competed for by engineers and exhibitors, went to the engineers.

The ladies' candle race and the clothes pin race called for some patience, which was not at first realized by the participants, but all put up a good attempt to get to goal first. The potato race for engineers' wives and daughters only proved the "survival of the fittest," and it is quite safe to say that they never worked harder for a few ordinary "spuds."

Man's dominion over nature comes through the utilization of power. Upon this our present civilization rests. Therefore the generation of power is our most fundamental industry in Canada, and energy our most essential commodity. To-day we face a rapidly growing demand for power, a diminution of its sources of supply and increasing expenses of generation and distribution. In this situation the engineer must seek for vastly improved means of power production and more effective and economical means of distribution.

The kiddies had their races, and that none of them tumbled is certainly a credit to their sturdy little limbs, for, with so many, all excited, accidentally bumping and hitting each other with energetic arms, it seemed a miracle. All were happy, and as children will be, excited at the realization of days of anticipation, and perhaps it helped in making the day nicer for them, when each and everyone of them was presented with candy in some shape or form.

W. R. Sexton and J. Thompson, exhibitors, were among the most prominent in arranging the children for all their races, and for the general order which prevailed while all ages and sizes took their places and made ready for all the other tests of prowess. Geo. J. Soucy attended to the distribution of prizes.

Hungry for Supper

Supper was served, and it was a hungry crowd that sat themselves around the tables for the good supper that had been arranged by various members of the C. A. S. E.

The following were the lucky winners in the different contests:

1. One hundred yard dash, engineers and exhibitors—First, J. Fossey, large Union Jack; second, J. Thompson, Canadian flag; six consolations, small Union Jacks.

2. Balloon race, engineers' wives—First, Mrs. E. Bruce, pillow cover; second, Mrs. B. Scott, pillow cover; two consolations, handkerchiefs.

3. One foot hop race, engineers and exhibitors—First, J. W. Fossey, tape line, 100 ft.; second, B. Burgess, tape line, 75 ft.; first consolation, nickel-plated tape line, 3 ft.; second consolation, rule, 2 ft.; third consolation, rule, 1 ft.

4. Ladies' candle race—First, Gladys Bly, 1 pr. candle sticks; second, Mrs. J. B. Scharfe, 1 candle stick; consolations, candles and handkerchiefs.

5. Backward running race, engineers only—First, B. Burgess, two-year subscription to Power House; second, F. G. Galloway, one-year subscription to Power House.

6. Ladies' clothes pin race—First, Muriel Harvey, patent clothes reel; second, H. W. Vallis, patent clothes reel; consolations, handkerchiefs.

7. Men's smoking race, 75 yards and return, engineers only—First G. F. Galloway, pipe; second, I. V. Huber, pipe; consolations, corncob pipes.

8. Potato race, engineers' wives and daughters only—First, Hazel Scharfe, patent peeler; second, Mrs. J. Miller, patent peeler; six consolations, peelers.

9. Wheelbarrow race, team to consist of engineer and exhibitor—First, J. Thompson and H. Marshall, pipes.

10-a. Little boys' race—First, Albert Potter; second, E. H. Perkins.

10-b. Little boys' race—First, Geo. Harvey; second, Frank Miller.

11-a. Little girls' race—First, Nora Faulkes; second, Hazel Scharfe.

11-b. Little girls' race—First, Violet Harvey; second, Flo Harvey.

There had been only one race billed for the boys and girls, but it was found that there were so many they divided them up according to size, the larger ones in each party running together, thereby giving the smaller tots a better chance. Owing to weather conditions, the softball game scheduled between engineers and exhibitors to take place in the evening had to be cancelled.

Trade Catalogs

The Combustion Engineering Corporation Ltd., Bank of Hamilton Building, Toronto, have published a 32-page treatise on the subject of oil burning, outlining the advantages of the Quinn Fuel Oil Burning Equipment and emphasizing the absurdity of rumors circulated from time to time to the effect that the oil supply of the world is nearing exhaustion. The equipment described in the book is designed specifically for the purpose of getting the greatest number of heat units out of the oil it burns and is installed to-day, it is claimed, in numerous plants where the decision to buy is based upon the everyday operating results assured by the equipment selected.

The book is ready for distribution to any Canadian engineer who cares to write for it.

The Value of Slide Rule in the Power House

By ARTHUR MURPHY*

A Brief Outline of the Principles Involved, Showing Simple Methods of Calculating—Easy Ways to Read the Scale and Illustrations of Its Value to the Engineer

THE slide rule is one of the most useful pieces of apparatus that can be used around the modern power plant. Unfortunately, in the past it has been used almost solely by designing engineers to make calculations without waste of time or energy. Operating engineers and non-technical men have come to regard it as being too complicated for their use, disregarding the fact that if they would take certain mathematical laws, which they do not need to understand, for granted, and spend about fifteen minutes a day practising with the rule, in a very short time they would be able to solve any ordinary mathematical problem of the power house.

Once a person has learned the use of the slide rule, he will find it such a saving in time that he will wonder why he did not learn all about it years ago.

Though the principles governing the operation of the slide rule may be learned in a few minutes, it requires patience and practice before the engineer can become an expert in its use. It is unwise to spend several hours in striving to master the intricacies of the rule, as such concentration results in fatigue and the mind becomes so confused that more harm than good is done. Whenever an engineer has a few minutes to spare, however, he should pick up the rule and practise with it.

It will be found helpful to work out simple multiplication with the rule, later checking the result by longhand, in this way one can soon find how close it is possible to work with the rule as well as find out where and when care must be taken in the setting.

Market Many Styles

There are many styles of slide rules on the market from the simple type designed for the merchant to the log for the mathematical gymnast. Though special rules are made for special work such as the Allan Friction head slide rule for piping and hydraulic problems, the power computing slide rule for steam, gas and oil engines; the chemist's rule, and others, the Mannheim or polyphase slide rule for general work will be found to be most suitable, containing a sufficient number of scales for the power house.

A good slide rule can be obtained at reasonable cost but if the beginner so desires he can purchase for a small amount a plain boxwood or bamboo rule.

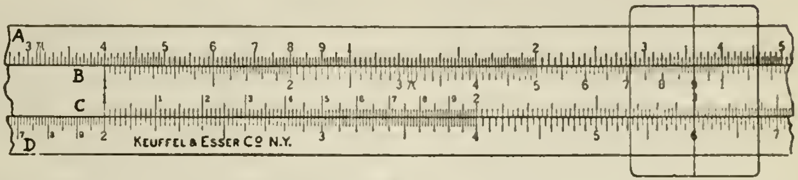


Fig. 1.

Suppose we take two yard sticks and place them side by side with the zero of one corresponding in line with the 14 inch graduation of the other; now if we look under the 20 inch mark on the first we find the mark on the second is 34. In other words by adding spaces that represent a number of units, we accomplish the same result as if we added the numbers.

Ability to use a slide rule and knowledge of its application to the power house has been a subject of much inquiry in Canada in the past month or two. This article, which shows how to read the scales, will be followed in the July 20 issue by typical problems of the engineer and their solution by the use of the rule. The electros were made by the Keuffel & Esser Co. to illustrate the value of the rule to the engineer.

The distance on the yard stick between 1 and 2, 4 and 5, 9 and 1 is the same, or in other words, the yard stick is a scale of equal parts.

The Use of Logarithms

It is not the intention of this article to explain the use of logarithms and how they are obtained. If the logarithm of a number is obtained and to that be added the logarithm of any other number, the sum obtained will be the logarithm of the product of the two numbers.

In a similar manner the subtraction of the logarithm of one of the numbers from the logarithm of the other gives the difference as the quotient of the two numbers.

Thus by the addition of the logarithm of numbers we accomplish the same as by the multiplication of the numbers.

If on our sticks we mark off the spaces to represent the logarithms of the numbers from 1 to 10 and place the two scales together, we have in effect the simple slide rule.

In adding the spaces on the slide rule we in effect multiply the numbers indicated on the scale on the rule.

Suppose we start with the simple slide rule containing only scales A, B, C, and D on its face as in Fig. 1. The two bottom scales C and D will be found very convenient for multiplication and division, consisting of 9 major divisions of unequal length, designated by the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9 and 1, reading from left to right. The numbers at the extreme right and left are called the right index and the left index respectively. The space 1—2 is the longest in the rule, gradually decreasing in length to the shorter space 9—10. Each of the nine major divisions are divided into 10 minor divisions but it will be noticed that the major division 1—2 is divided into 10 minor divisions all of which are numbered. In no other major division are any sub-divisions numbered. All the minor divisions in the major space 1—2 are sub-divided into 10 unnumbered spaces.

Divided Into Five Parts

In the other major divisions 2—3 to 9—1 each sub-division is unnumbered and is only divided into five parts, which are not numbered.

Each minor division in the major divisions 2—3 and 3—4 is divided into five parts, in the major divisions 4—5 to 9—1 each minor division is divided into two parts only.

The left hand index 1 was arbitrarily designated as 100 then the other divisions assigned numbers to correspond.

It must not be forgotten that a number such as 4 in the major division may

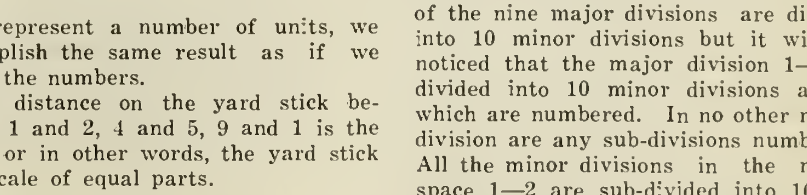


Fig. 2.

---

*Editor, Power House.

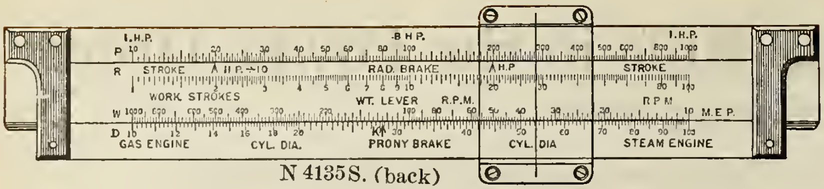


Fig. 3.

represent .0004, .04 or 4,000 or any other simple multiple of ten, depending on the placing of the decimal point. If the value of 3 in the major division is 300 then in the minor division 1—2 the value of the smallest division is 1. In the 2—3 or 3—4 each small division has a value of 2. In the major division 4—5 and all the remaining divisions a value of 5.

From the foregoing it would appear difficult to read the scale; a little practice, however, will do more good than a page of instructions.

Read Scales Quickly

Before any calculations can be made on the slide rule one must be able to read the scales quickly and accurately. In referring to Fig. 9, C and D scales, assuming that the left hand index has a value of 100, the value of each space is indicated by the numbers opposite. In the actual slide rule the numbers 101 and 102, etc., are omitted, the numbers representing 110, 120, 130, etc., only being marked.

This is on account of the fact that the figures would be so small as to be scarcely discernible, and their presence would only lead to confusion.

In reading a number always take the first figure to the left of the prime line, the second figure of the number on the secondary line to the right, then the third figure on the subdivision, thus 315 read three—one—five, not three hundred and fifteen.

Study carefully the numbering in Fig. 9 and when in doubt as to the correct reading in working problems, consult it.

The first figure of a number locates the major division. Under no circumstances are any numbers whose first figures commence with 1 found in any but the major division 1—2; similarly the numbers that represent any graduation in the major division 1—2 must always begin with 1. This may appear simple but more mistakes are made by beginners not realizing this, than by any other cause. The major division gives the first figure of the number and similarly the first figure fixes the major division.

Minor Division Fixed

Having located the major division of the number, the minor division is fixed by the second figure from the left of the number.

Thus 345, 380 and 310 are all in the third major division; in 324, 126 and 925 the graduation representing these numbers is found in the third minor division of their respective major divisions, similarly in 106, 203 and 709, these numbers are located in the first minor division of their major divisions.

The location of the third figure in each number is equally as easy if the line happens to fall on a graduation but presents a little trouble if it comes between the lines, so will be discussed later when the reader has grasped the fundamentals.

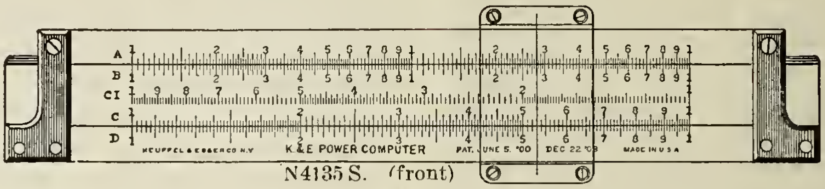


Fig. 5.

Try reading the graduations on the two lower scales in Fig. 7.

On the C scale the number in the major division nearest to the left of the hair line is 6, it may be 6, 600 or 6,000, the fixing of the decimal is performed later.

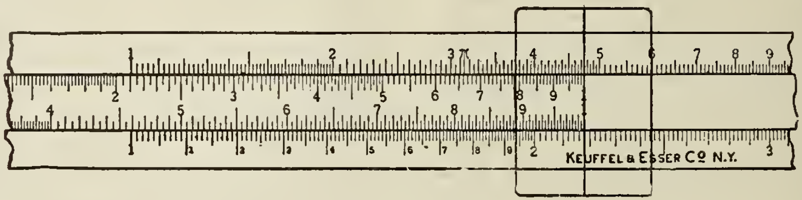


Fig. 6.

The hair line falls on the 2 graduation mark in the 6—7 major division. The number then must start with 62. Referring to the lower or the D scale, the hair line is in the first major division 1—2, the first figure on the left of the number must be 1, the figure to the left of the hair line in the minor division is 3 and the hair line being half way between 3 and 4, the number must be 135.

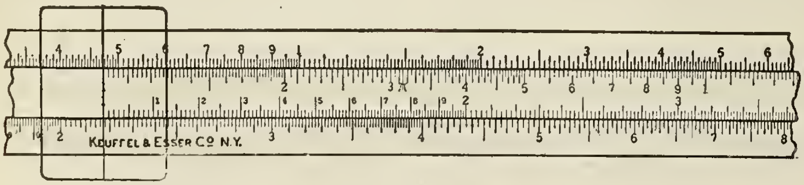


Fig. 4.

Try reading other numbers such as 230, 420 and 236.

Doubt Its Accuracy

Persons who are none too familiar with the slide rule will frequently state that it is not accurate enough for their work. With ordinary precautions and a little care in setting the scales and in reading the graduations, it will in many cases be found to be as accurate as necessary for ordinary engineering problems, certainly in some cases quite as close as the observed readings of pressure gauges or of thermometers.

With the 10 inch slide rule three significant figures can be read, the fourth is doubtful. In reading at the left of the rule four figures can be read, as in the number 1235, the 123 are certain, the 5 might be 4 or 6, giving an error less than 1 in 1,000, or correct to one tenth of one per cent.

In general it may be said that readings closer than 1 per cent. may be secured on any portion of the rule and in many cases at the left of the rule to one tenth of one per cent.

Simple Calculations

Multiplication:—Find the value of 2 × 3, see Fig. 1.

Opposite 2 on scale D set 1 on scale C. Then move the indicator or glass runner so that the hair line is over 3 on scale C. Directly below this you will find 6, the answer.

Division:—Suppose we wish to divide 6 by 3. See Fig. 1. Opposite 6 on scale D set 3 on scale C. Then move the indicator to 1 on scale C. On D will be found 2, the answer.

Combined multiplication and division:

Example:—

$$\frac{1.35 \times 3.16}{6.2}$$

See Fig. 7.

Opposite 1.35 on D set 6.2 on C. If we try to move the indicator to 316 on C, it is impossible because 316 lies beyond the extremity of D. In such a case proceed as follows:—

Move the indicator to the right hand index of C. See Fig. 6.

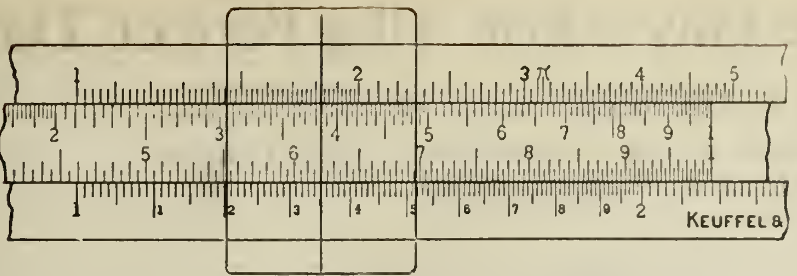


Fig. 7.

Then move the slide, setting the left hand index of C to the indicator. See Fig. 4.

Now we can move the indicator to 316 on C. See Fig. 2, and under 316 on C read the answer 688 on D.

A rough calculation for the decimal point gives us 1 × 3 ÷ 6 or 3 ÷ 6 = .5 and stretching our imagination so that .5 looks like .688 we have .688.

Squares and square roots:—To square a number means to multiply by itself, that is, $3^2 = 3 \times 3 = 9$. On the slide rule this is done as follows:—

Referring to Fig. 8, set the indicator to 3 on scale D. Above on scale A, using the face of the rule under the indicator we find 9 the answer.

In the same manner in Fig. 8 find the square of 2. Finding the square root is just the reverse. To find the square root of 9 we find the number which multiplied by itself will give 9; the square root of 9 is indicated thus $\sqrt{9}$.

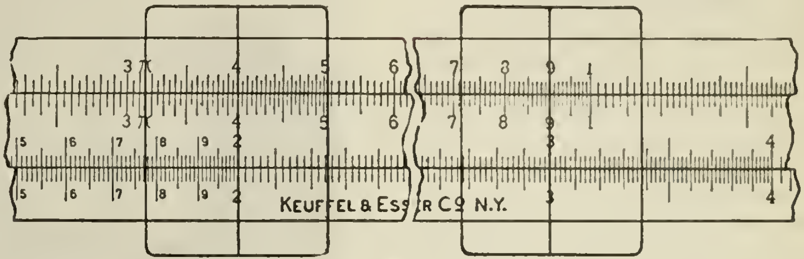


Fig. 8.

More care is required to find square roots than in finding squares.

Set the indicator to 9 on scale A being careful to use 9 on the left hand half of the scale; the 9 on the right hand is really 90. Below 9 on scale A read the answer 3 on scale D.

Find in Fig. 8 the square root of 2.

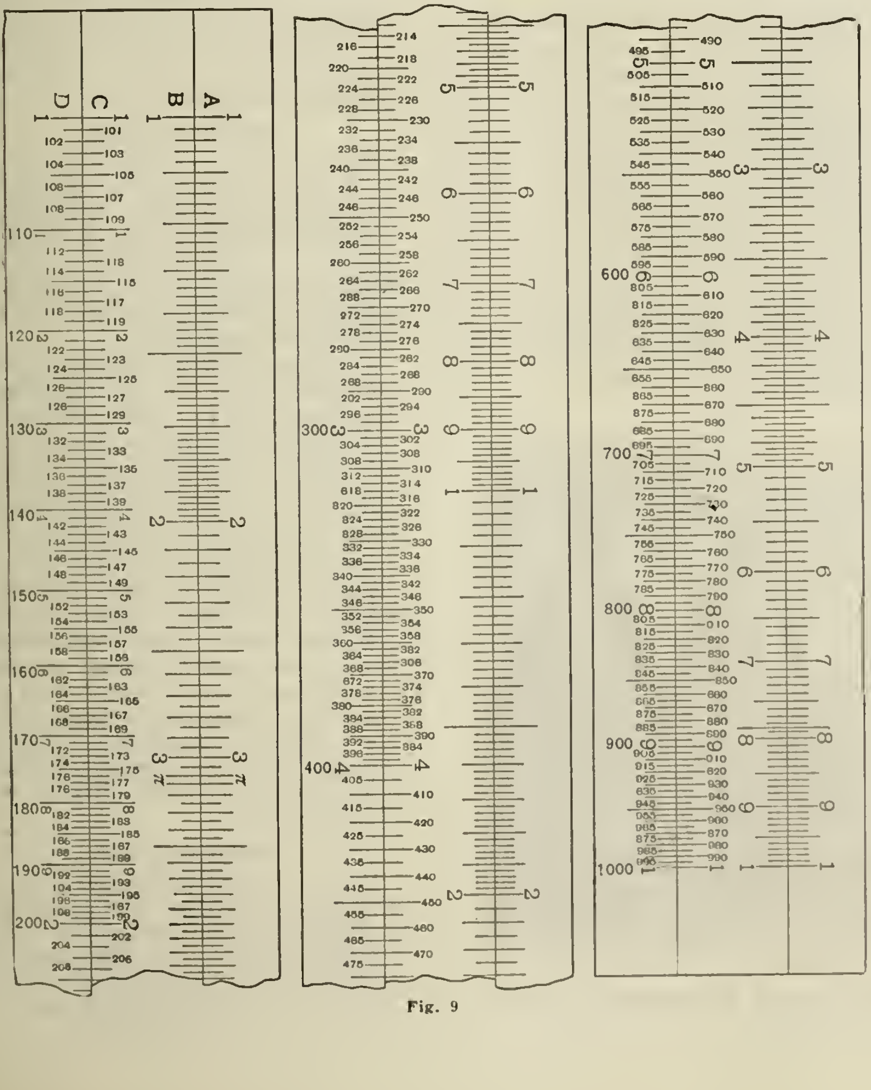


Fig. 9

Oliver Machinery Co., Grand Rapids, Mich., manufacturers of machine tools and woodworking machinery, who specialize on pattern maker's machinery of every description, have entered into an arrangement with the Canadian Fairbanks-Morse Co., Montreal and Toronto, to represent them exclusively in the sale of their machinery in Canada, thus giving their Canadian customers the advantage of buying without the annoyance of entering through the customs.

Power Notes

H. C. Harragan, McGill Building, Montreal, has been appointed Canadian representative for the Bird Archer Chemical Co.

C. B. Smith, chief engineer of the Union Bank of Canada Building, corner King and Bay Sts., Toronto, has resigned his post after 14 years service.

Ernest Norgate, formerly of the Coleman Lamp Co., has been appointed chief engineer of the Union Bank of Canada Building, Toronto.

The Canadian Electrical Association elected the following officers at their annual meeting held in Montreal: President, P. R. Davies; vice-presidents, R. J. Beaumont, W. P. Axton Little, and J. B. Goodyatt. Executive committee: A. P. Dodridge, M. A. Pooler, J. E. Tanguay, N. S. Baden, W. A. Bucke, A. B. Cooper, A. A. Dion, and A. Munro Grier, K. C.

The Mohawk Electrical Co., Brantford, Ont., have been granted the contract for the electrical work in the new addition to the Brantford Collegate Institute.

Sealed tenders will be received by C. J. Brown, chairman, Committee on Public Utilities, City Clerk's Office, Winnipeg, Man., up to July 23, 1923, for the manufacture of three Integral Type Super Heaters complete delivered to the site of the Steam Stand-by Plant, Winnipeg. Specifications may be obtained at the office of the City of Winnipeg Hydro-Electric System.

U.C.C. of E. Picnic Gay—For All a Perfect Day!

Queen City Council No. 27 Stages Annual Frolic at Ward's Island, June 23—Bumper Crowd in Attendance, Sports Program Enjoyed by Young and Old

IT IS EVIDENT that when the ladies of Queen City Council No. 27, Universal Craftsmen Council of Engineers, undertake to do anything, it is done thoroughly and goes over with a bang! This at least, is the opinion of those who attended the picnic at Ward's Island on Saturday, June 23.

The afternoon was ideal, and Old Sol in all his glory was a welcome guest. Engineers of the U. C. C. of E. with their wives and kiddies began to arrive by the 2 p.m. boat, and by 4 p.m. practically 200 were in attendance, and the contests scheduled began.

It seemed as though the different participants in the various races had been in training for some time, or else they are naturally very agile, for there was no cause for anyone to be ashamed of the place they reached at the finishing line.

Officers Queen City Council No. 27, U.C.C. of E. Left to Right—Mrs. C. L. Holmes, Mrs. John Grimshaw, Mrs. Fred Lewis, Mrs. L. Westwood, Mrs. T. C. McAree, Mrs. A. M. Auchterlonie, Mrs. J. L. Cuthbird, Mrs. William Bruce, Mrs. A H Stannah

All Races Enjoyed

All the races were thoroughly enjoyed by the contestants and audience. Beside the usual running races for all ages, there were a few contests of a rather novel type, for instance the ladies' balloon race, wherein the winner was the one who could blow a balloon to the bursting point in the shortest time.

The men's measuring race afforded amusement too, and it would be interesting to know how many of the men measured their shoes on their return home! The ladies' nail driving contest was a winner, and almost every lady had a "shot" at it, but all agreed that anyone who could drive a spike into the wood in four efforts, certainly deserved first prize.

And the kiddies! You certainly should have seen them! A picnic may be enjoyed by grown-ups, but the ones who really make it "go" are the children. After hearing about it for so long,, there is no doubt that realization brought more happiness to their little hearts than the anticipation. When a little boy in blue and white who couldn't possibly have been more than six years of age can say "Gee, I'm havin' even a better time than I thought I would," you know there was no drag to the party. And the supper—well, when it comes to that I don't know just where to begin. No wonder engineers are such strong, able looking men, for when their wives can place such delectable viands before them, they have absolutely no choice but to consume to capacity——no mortal man could withstand the temptation!

Six Past Worthy Chiefs, Canada Council No. 27, U.C.C. of E. Left to Right—T. C. McAree, W. Wolfenden, J. L. Cudbird, H. E. Terry, W. J. Hudson, and H. Potter.

Rain Ended Game

One thing that one and all regret is the fact that owing to a shower just after supper which later turned into a good sized electrical storm, the ball game had to be struck off the sports list. However, the interval gave people an opportunity to tell one another how they had enjoyed themselves.

A special feature, which was carried out regardless of the sprinkling, was a three-legged race, termed during this afternoon as the "Sexton Race," as Mr. and Mrs. W. Russell Sexton were responsible for it and presented the prizes. Power House was responsible for a Spoon and Egg Race for the ladies, and an obstacle race for the men. The ladies should certainly be congratulated on handling an awkward situation gracefully, for it takes no small effort to balance an egg on a tea spoon and guide yourself and it around a good sized tree! The men in the party certainly showed what stuff they were made of, in the obstacle race, for though shackled it was evident they were determined to reach the goal.

End Perfect Day

Everyone voted it a perfect day, and while of course, the storm caused a bit of disappointment, the spirits of the crowd were not visibly dampened. Particular mention must be made of J. L. Cudbird, A. M. Auchterlonie and G. H.

Jenkins, and their attention to business during the sporting events. Thanks and congratulations are most certainly in order to the Ladies' Picnic Committee, the following being members:—Mrs. W. Russell Sexton, Mrs. Darbyshire, Mrs. S. A. Longmore, Mrs. L. J. Cudbird, Mrs. C. L. Holmes, Mrs. A. M. Auchterlonie and Mrs. Albert Stannah.

The following is a list of races and winners:—

1.—Tot's Race.
Muriel Davis, Naomi Stannah, Trevor Cudbird, Elwyn Cudbird, Erma Morse and Aubrey Potter. Prizes, ball to each.
2.—Girl's Race, 8—12 yrs.
1: Elsie Jenkins, box of paints.
2: Doris Jenkins, string of beads.
3: Evelyn Norgate, handkerchiefs.
3.—Boy's Race, 8—12 yrs.
1: Albert Stannah, baseball.
2: Clarence Hunter, bat.
3: George Burridge, set of tools.
4.—Girl's Race, 12—15 yrs.
1: Agnes Stevens, Sol-rite pencil.
2: Gladys Wilson, manicure set.
5.—Boy's Race 12—15 yrs.
1: Alex. Auchterlonie, tie.
2: Wilber Hunter, pen-knife.
6.—Single Ladies' Race.
1: Violet Woodiman, lunch set.
2: Helen Westwood, ivory bud vase.
7.—Single Men's Race.
1: J. Auchterlonie, handkerchiefs.
2: Thomas Smith, tie.
8.—Married Ladies' Race.
1: Mrs. A. M. Auchterlonie ½ doz. sherbert glasses.
2: Mrs. Albert Stannah, aluminum collander.
9.—Married Men's Race.
1: Mr. A. M. Auchterlonie, two pairs socks.
2: Mr. L. J. Cudbird, handerchiefs.
10.—Ladies' Blowing Balloons.
1: Mrs. J. Miller, pr. embroidered pillow cases.
2: Mrs. J. Stephen, cup and saucer.
11.—Men's Measuring Race.
1: Mr. J. O'Brien, thermos bottle.
2: Mr. W. Russell Sexton, handkerchiefs.
12.—Queen City Officers. (Past and Present.)
1: Mrs. H. E. Potter, ½ doz. sherbert glasses.
2: Mrs. A. Baker, cup and saucer.
13.—Ladies' Nail Driving Contest.
1: Mrs. Fred Lewis, Royal Doulton plate.
2: Mrs. W. Russell Sexton, cut-glass butter tub.
14.—Ladies' Egg and Spoon Race.
1: Miss V. Woodiman, pr. silk hose.
2: Mrs. J. Miller, box of bon-bons.
15.—Men's Obstacle Race.
1: Mr. G. H. Jenkins, box cigars.
2: Mr. L. Westwood, speed indicator.
16.—Married Couples 3-legged Race.
1: Mr. & Mrs. A. M. Auchterlonie, electric iron.

Build 1,200 lb. Pressure Boiler

Babcock & Wilcox Co. See Early Solution of Water Level Indicator Difficulties

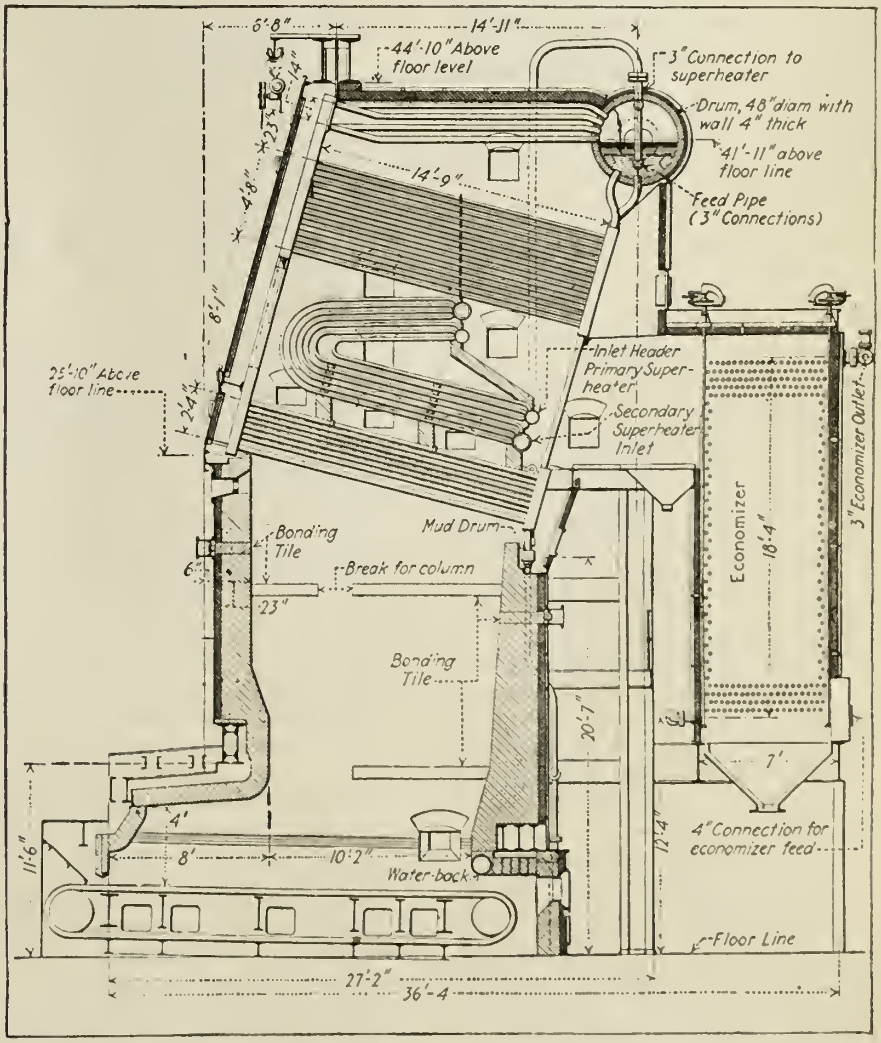
A. G. PRATT, vice-president of the Babcock & Wilcox Co., manufacturers of water tube steam boilers, in a letter to Power House this week, reported satisfactory progress in the experiments with water level indicators his company has been making for the last three months, in connection with a boiler being built in one of their shops, designed for an operating pressure of 1,200 lb. per sq. in. for use at the Calumet station of the Commonwealth Edison Company.

It is proposed to put in with this boiler a small "extra-high-pressure" turbine taking steam from the boiler at 1,200 lb. pressure and exhausting at 300 lb. pressure into the steam mains which supply the large turbines at the station.

In discussing super-pressure boilers of the future, H. A. Hatfield, when seen at the Toronto office of Babcock & Wilcox Limited, in the Bank of Hamilton Building, declared little trouble would be experienced by his company in constructing such boilers, the only difficulty being found in obtaining fittings which would stand up under the pressure contemplated.

New Setting Height

The unit at present under construction in New York is of the inclined-header, cross-drum type, and comprises a lower deck of eight-high sections of 2-in. tubes having a setting height of 25 feet. 9¾ ins., a primary and a secondary superheater in an interdeck space 8 ft. 1¼ in. between decks, an upper deck of seventeen-high sections of 2-in. tubes, horizontal 3¼-in. circulating tubes entering a 48-in. cross-drum, and a steel contraflow economizer. The lower deck is not baffled; the upper deck has a vertical baffle, causing the gases to make two passes. The complete unit is about 28 ft. wide, 36½ ft. deep, including the economizer, and 45



SECTION THROUGH BOILER, SHOWING SECONDARY SUPERHEATER AND FOUR-INCH THICK DRUM ft. high above the floor. The heating surfaces have not yet been definitely fixed, but they will be approximately as follows: Boiler, 15,750 sq. ft.; primary superheater, 2,120 sq. ft.; secondary superheater, 3,300 sq. ft.; economizer, 9,230 sq. ft.

The headers have 1¼-in. thickness front and back and ⅝-in. sides and are designed to give the tubes a stagger of nearly 4 in. The eight tubes in each section of the lower deck are expanded into nine-high headers, the tube space not filled being that next to the bottom. The mud drum is 7¼ in. square, 1 in. thick and extends through each side of the setting, with a flange for blow-off valves at each end.

The cross-drum is a forged steel cylinder 48 in. in diameter and 4 in. thick, with integral drum heads, each with a manhole closed by a 12 x 16-in. manhole fitting.

Unusual Arrangement

In order that the holes for connecting the circulating tubes to the drum may leave the largest practicable ligaments between circumferential rows of holes, an unusual arrangement of connections has been adopted. At the top of each uptake header two horizontal circulators are connected but the circulators from each alternate header are bent downward and sidewise so that they are connected to the drum in the same circumferential row as the circulators without such bends. This makes the distance between these circumferential rows about 16 in.

In the same way, the downtake nipples are not straight, but bent so that two downtake headers are connected to each of these circumferential rows. The drum has four 3-in. nozzles for safety valves, a 3-in. nozzle for the saturated-steam connection to the primary superheater, and two 3-in. feedwater connections.

The primary superheater has 8-in. headers drilled for three staggered rows of tube holes, with 72 tubes in each row. It is designed to raise the temperature of the steam under 1,200 lb. pressure to 750 deg. The secondary superheater has 11¾-in. headers drilled for four staggered rows of 72 tubes each. This secondary superheater incloses the primary superheater and is intended to raise the temperature of the exhaust from the extra-high-pressure turbine to 750 degrees.

The economizer has 44 rows of tubes with twenty 2-in. tubes 20 ft. long in each row.

In a parallel-connected armature there are as many paths through the windings as there are poles, which requires a set of brushes (positive and negative) for each pair of poles. In the series-connected winding there are only two paths through the armature, irrespective of the number of poles; hence only one set of brushes is necessary, although in large machines more brushes are usually fitted.

Industrial Classes in Ontario

Splendid Opportunity Open to All Engineers in Province Who Seek Higher Certificates

THE Industrial Education Act of 1911 made provision for the teaching of industrial and technical education in the schools of Ontario. Since that time great progress has been made in establishing both day and evening schools and the arrangement of courses of study to meet the needs of those persons already working in industry or those intending to enter upon industrial pursuits as a means of livelihood.

The Technical Education Act of the Federal Government of 1919 set aside $10,000,000.00 to cover a period of ten years for the assistance of the Provinces in establishing and maintaining schools and courses for the study of technical and vocational work.

These two Acts co-ordinate in such a way that any Secondary School Board may establish courses in vocational subjects and by complying with certain regulations regarding teachers, equipment, accommodation, etc., will receive assistance approximating 50 per cent. of the cost of operating. This assistance covers both expenditures on approved day and evening schools.

35,000 Enrolled

The number of schools has increased from one day school and eight evening schools, with an enrolled attendance of less than 4,000 in 1912, to thirteen day schools and fifty-six evening schools, with an enrolled attendance of approximately 35,000. There are over 1,000 teachers now engaged in teaching in these schools.

The evening schools are of special interest to employed persons who wish to obtain further knowledge and training in any trade or calling. Where day technical schools are established, it is possible to offer a wide range of work for evening classes. The courses are more limited where no special accommodation is provided. The subjects offered in the schools depend largely upon the demand. It has been the custom in many municipalities to provide a teacher and accommodation for any group of students who may desire instruction in any particular subject providing the number of students is large enough and the equipment is available.

Have Wide Variation

The classes in evening schools have a very wide variation, depending upon the needs of the community. In Technical and Industrial courses the subjects taught are usually:—Electricity, Mechanical Drawing, and Machine Design, Stationary Steam Engineering, Shop Mathematics, Woodworking and Carpentry, and Automobile Mechanics.

The classes for stationary steam engineers have grown considerably since it became necessary for engineers to obtain certificates to qualify them for positions in power plants. During the past season one hundred and twenty-six engineers have been enrolled in six classes as follows:—

Toronto	56
St. Catharines	20
Hamilton	18
Fort William	11
London	11
Timmins	10
	126

The Vocational Branch of the Department of Education co-operating with the Board of Examiners of Stationary and Hoisting Engineering have now in course of preparation a bulletin covering the work in arithmetic and engineering required for fourth class, third class, and Hoisting Engineers' Certificates.

Will Issue Bulletin

This bulletin is arranged in the form of lesson units to aid the teachers and students in preparing for these examinations. This bulletin will be published and issued for use in vocational evening classes this year.

The teacher is usually a practical man employed in a power plant in the locality and is selected because of his advanced knowledge of the subject and its practical application. The charge for enrolment is only large enough to insure that the student is sincere in his application.

This opportunity is open to all men working as steam or hoisting engineers who wish to prepare themselves for a higher certificate or to take special instruction along some branch of steam engineering. The Technical Branch of the Department of Education is anxious to promote this work, as the benefit of having efficient engineers in the industries of Ontario is evident to all.

Book Reviews

The Dynamo, Its Theory, Design, and Manufacture,—sixth edition, by C. C. Hawkins, is an authoritative work covering the present-day principles and practice involved in the production of all types of D.C. generators. Typical designs are fully discussed and every part of the generator, and the methods of construction, are illustrated by photographs of modern equipment. This book is of interest to the designer, and also to the operating engineer who should know in every detail the "Why" and "How" of the apparatus in his charge. The new edition is in two volumes. Vol. 1, with 610 pages, priced at $6.25, and Vol. 2, with 322 pages, priced at $4.50. Messrs. Pitmans Ltd., of 70 Bond Street, Toronto, are the publishers

Generating Power at Canada's Pacific Gateway

By GEO. R. ARCHDEACON, A.M.I.E.E.

Empress Hotel, Victoria, B.C., Equipped With Modern and Efficient Steam, Electrical, Heating and Ventilation Systems for Those Departing in Search of Adventure in the Orient

FACING the Pacific Ocean, within a few miles of the extreme western edge of Canada, stands the Empress Hotel, Victoria, B. C.

It is the first thing to catch the eye of all travellers approaching the Dominion on the Pacific Ocean, and it is the last link with home to those departing in search of adventure in the Orient.

And as the adornment of this hotel may be considered the last word in good taste and refinement, so may the power plant and power house be accepted as modern, efficient and complete.

J. B. Benty is the chief engineer. He was born in Bristol, England, and to fit him for his profession his parents apprenticed him early in life to the century old established firm of Peckett & Sons, Atlas Locomotive Works, Bristol.

Mr. Benty served a five years apprenticeship, finally spending two years in the drawing office, to fit himself for future responsibilities. In addition to this he filled in his spare time with special studies at the Technical Institute.

Was Junior on "Tramp"

With this training and experience as his capital, he secured a position as a junior engineer on one of the "tramp" steamers which appear at regular intervals in the port of Bristol.

After amassing considerable experience on such ships, Mr. Benty sat for his 2nd class Board of Trade certificate, and was successful. Although his scientific training and experience fitted him in every way to compete for a higher grade of certificate, the law demanded that he return to the sea, to occupy the position of 2nd engineer for a period of not less than twelve months before he could offer himself for examination for the higher grade certificate.

Subsequently he occupied the position of chief engineer with the Elder Dempster Steamship Co., and later with the C. P. R. Ocean Services, being chief engineer of the *R. M. S. Monteagle*, which rendered valuable services to the British Government during the World War.

The steam, electrical, heating and ventilation system of the Empress Hotel were installed under the supervision of Mr. Benty, and upon its completion the C. P. R. retained his services as chief engineer.

In passing it may be mentioned that Mr. Benty is a regular reader of "Power House," holds it in high esteem and encourages all members of his staff to read it regularly.

Houses Steam Laundry

The power house is situated behind the hotel a distance of 100 yards. It is a solid brick building about 100x100 feet and in addition to the steam plant, houses the steam laundry.

The engine room is a well lighted and well ventilated room 75 ft. long and 36 ft. wide.

The electrical power plant consists of three Allis Chalmers compound wound dynamos, each 75 K.W. 115-120 volts, 625 amperes at a speed of 275 revolutions per min. These are six pole machines, with six brush arms on the brush rocker, direct connected to 100 h.p. Robb-Armstrong horizontal engines, totally enclosed, with sensitive fly-wheel governors.

The switchboard is made of grey marble and is 22 feet long and 8 feet 6 inches high. As it is for controlling a two wire system, a middle wire panel is not required.

Two Linde Compressors

At the far end of the engine room there is a railed off space about three feet below the level of the engine room. Within this space are the distillers and the refrigerating plant, consisting of the following:—

> Two ten ton Linde ammonia compressors, each driven by a steam engine, the suction pressure being thirty pounds, discharge pressure 100-150 pounds. All the gauges for this plant are mounted high up on the wall and are about 15 inches in diameter, being easily visible from all parts of the room.
>
> Two sets of condenser coils, each pipe being eighteen feet long by two inches diameter, each of these banks of coils is fifteen pipes high.

The distilled water plant is operated by the exhaust steam from the main engines. There are two distillers with a capacity of about ten tons of distilled water per day. In addition, the water passes through a filter bed consisting of layers of charcoal and fels-spar.

Passing down a flight of about twelve steps we come to the pump room. The various pumps are well arranged, care having been taken to give plenty of working space behind each pump, so that repair operations may be conducted from either side. The pumps are as follows:

1 Weir Feed Pump (Vertical)	8"x5½"x12"
1 Weir Feed Pump (Horizontal)	8"x6"x12"
1 Darling Feed Pump (Horizontal)	8½"x5½"x10"
1 Burnham Vacuum Pump	8"x10"x12"
1 Blake Vacuum Pump	8"x14"x12"
1 Underwriters Fire Pump	14"x8"x10"

inlet 75 lbs. and discharge at 160 lbs. This is a displacement type and has a capacity of 500 gallons per minute when working at 70 revs. per min.

Oil fuel was used in this plant for a period of seven years, from 1913-1920, the oil utilized being Californian crude oil with a calorific value of 18,000 B.t.u.

40 Barrels Per Day

The average consumption was forty barrels per day, each barrel having a capacity of thirty-six Imperial gallons with an approximate weight of 350 lbs. of oil per barrel, or a total of 14,000 lbs. of oil fuel per day.

The oil was atomized under pressure and blown through a special ejector where it picked up the necessary amount of air. The quantity of air could readily be adjusted by movable ports in the side of the ejector. This rendered very satisfactory service, unfortunately however the market for oil fuel was so unstable and prices were subject to such wide fluctuations, that the problem ceased to be an economical one and consequently was discarded.

In this particular case the price fluctuation was as follows:—original price, ninety-six cents per barrel. Maximum price reached $3.45 per barrel. Price prevailing during January, 1923, $1.50 per barrel.

In view of such wide fluctuations Mr. Benty decided to return to a fuel with a lower calorific value but a more stable price.

Boiler House Lofty

The boiler house is a fine lofty room about 50 feet by 40 feet with an inclined runway down to the coal bunkers. Steel roller shutters close off the outer sides of the bunkers, permitting the boiler room to be kept snug and dry during rain storms and bad weather, whilst during the heat of the summer they are left open to admit plenty of fresh air and keep the place cool and comfortable for the staff.

The plant consists of the following:

> Three horizontal return tubular boilers, cross connected duplex header system of tubes. Each boiler is 157 h.p. working pressure 125 lbs.
>
> 1 Babcock & Wilcox water tube boiler with 70 tubes 16 feet long by four in diameter, Working pressure 125 lbs.

All the firing is done by mechanical stokers, each boiler being equipped with Jones Underfeed Stokers.

There is a balanced forced draught system fitted to each boiler by the B. F. Sturtevant Co. This is operated by a vertical steam engine and also a 10 h.p. D.C. motor with a belt drive is maintained in readiness in case of a breakdown.

This system appears to be giving very satisfactory results judging from the average of the CO_2 Recorder.

Average Results Good

There is a Uehling CO_2 Recorder and the average results appear to be 12 per cent. CO_2.

Mr. Benty has introduced a system of paying a bonus to his firemen, based upon the percentage of CO_2, thereby encouraging them to so regulate their firing as to obtain a higher degree of combustion. A special bonus acount is kept and totalled up each month; each fireman must show a record of not less than 10 per cent. CO_2 and not more than 12 per cent. to qualify for a bonus.

The fuel used is washed pea Ladysmith Coal with an ash content of about 15 per cent. and a calorific value of about 11,500 B.t.u. The fuel consumption is 300 tons per month.

The boiler feed water is all measured by a Venturi Water meter, and complete records are made. There is a daily log showing all possible details of operation and maintenance costs. From these it was observed that the monthly total of feed water for the boilers was 5,000,000 lbs. per month.

Seeing that the monthly coal consumption was 300 tons, this would be a total of 600,000 lbs. of coal. In other words 600,000 lbs. of coal evaporated 5,000,000 lbs. of water, or 1 lb. of coal is evaporating 8.35 lbs. of water.

The ashes are handled by an American Steam Ash Conveyor, being discharged into a concrete tank with a capacity of 12 tons and mounted on an iron frame work. The open body is then placed on the five ton truck and it is run under this ash tank, a sliding door in the base of the tank is opened and the ashes caught in the body of the truck and carted away as required.

The steam jet discharge on this conveyor is 2½" pipe terminating in a nozzle of ⅝".

Stack 120 Feet High

The chimney stack is of brick construction and is 120 ft. high, the dampers are all hand regulated and there are numerous draught gauges connected to the flues to permit the firemen to keep a constant check on their condition.

The feed water is obtained from Sooke Lake, about forty miles distance, and is of excellent quality for evaporation purposes. This is heated by a Webster feed water heater, which treats all the feed water and delivers it at a temperature of 175 degrees.

A special main supplies steam to the laundry at 100 lbs. pressure, and this operates the washing machines, ironing machines, and dryers.

There are four electric elevators, 1 hydraulic elevator, and 3,500 electric lights in the hotel, and the average energy consumed by each lamp is 40 watts. Supposing, therefore, that all these lights were burning at one time there would be a demand on the power house for electrical energy of 140,000 watts for the electric light service only, or a total of 182 h.p. of energy.

The power house is connected to the hotel by means of a tunnel. This is 7 ft. 6 ins. wide and 8 ft. high, and is made of concrete well drained. The electric mains are run down one side of the tunnel, supported in iron troughs laid on angle iron bearers. On the opposite side are the steam heating mains, compressed air, and vacuum pipe lines for the various hotel services.

In conclusion it may be of interest to readers of *Power House* to know that the C.P.R. has been granted a further exemption from local taxes by the municipality of Victoria, upon the understanding that they inaugurate a tea garden, cafe, and amusement park on a vacant piece of land within half a mile of the hotel.

In view of this undertaking it will be necessary to increase the size of their present electrical plant, and Mr. Benty estimates that he will require an additional boiler, steam engine and dynamo, some time within the next eighteen months as well as the other accessories that go toward the efficient operation and completion of such an extension.

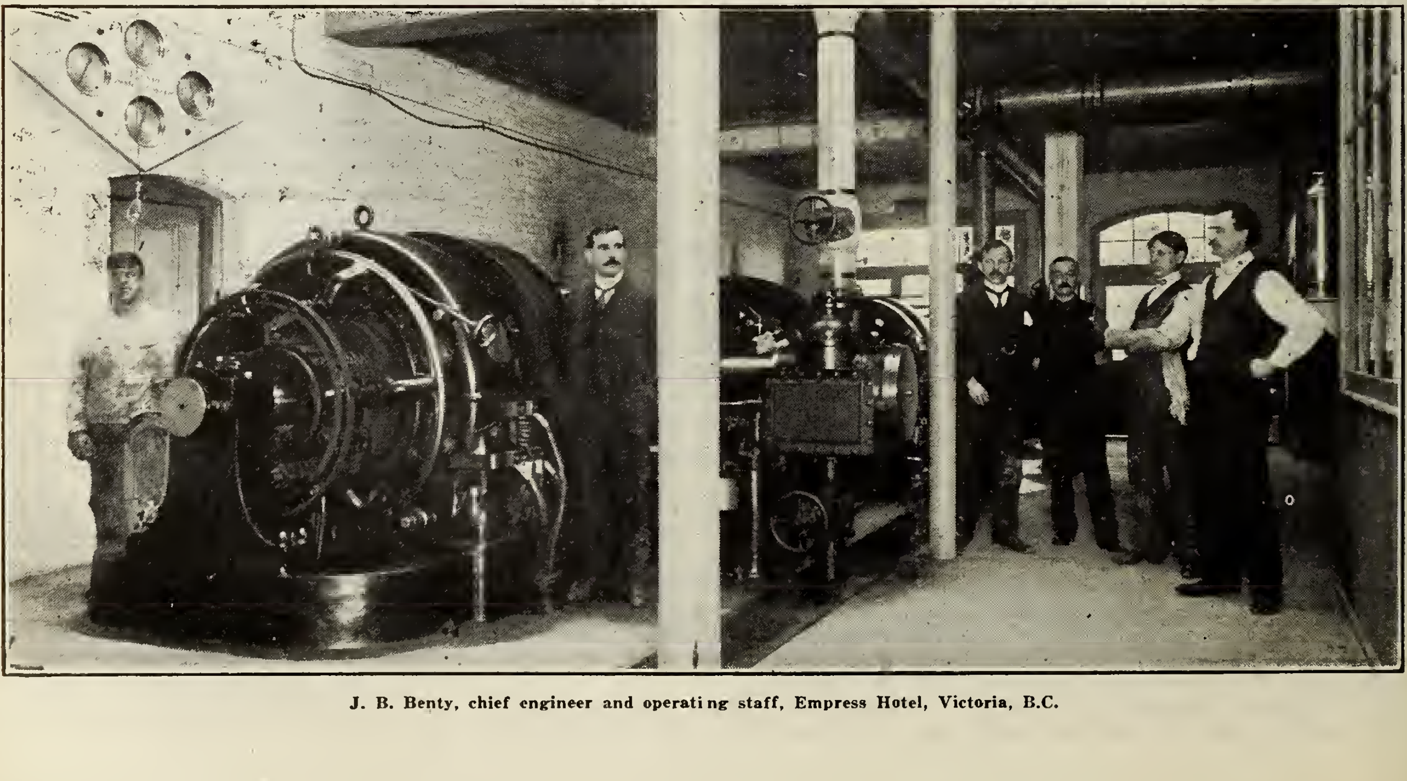
Water jackets around bearings furnish means of carrying away the heat generated by friction in proportion to the pounds of water multiplied by the temperature increase in deg. F., the specific heat of water being unity.

Self-oiling bearings have the merit of using the same oil continuously without waste other than by slight vaporization and creepings, but proximity to a heated bearing keeps the oil at a higher temperature than it is at its best for lubricating.

The current is that in any lead and the voltage that of any phase except in the case of a two-phase, three-wire system, where the current is that in either outside wire and the voltage that between either outside wire and the common wire.

To operate a compound-wound dynamo as a motor it is necessary to reverse the series-field connections, otherwise the series and shunt fields will oppose one another, resulting in a small starting torque and poor speed characteristics.

The law of fluid motion is that the force required to shear a layer of fluid, of a given area of the element in plane of shear, and thickness, normal to the plane of shear, is directly proportional to the relative velocity (surface speed of journal) of the two surfaces and to the area, and inversely to the thickness of the fluid.



J. B. Benty, chief engineer and operating staff, Empress Hotel, Victoria, B.C.

Remote Control of High Pressure Steam Lines

By PETER PAYNE DEAN,* A.S.M.E.

An Explanation of the Construction of Various Protective Devices, Values and Motor-Control Systems That May be Obtained in the Open Market To-day

THIS article is intended to bring out need of protection other than that of hand-operated valves for high-pressure steam lines in case of failure of pipe or fittings, and deals with the remote operation of various types of valves by electric motor or steam piston in order to quickly and safely stop escaping steam.

It is based on a very careful study of valve construction and methods of power operation during the last few years, and on experience gained with more than a thousand electrically operated valve installations which the author has designed and placed in large power generating stations.

Steam pressure as high as 350 lbs. per sq. in. with 700 deg. Fahr. total heat are now frequently encountered, and no doubt 500 lb. will soon be standard practice. Under such pressures every piece of valve, piping, and fitting metal will be subjected to an excessive strain, which, when coupled with high temperature. may produce a result akin to metal fatigue, about which we have little knowledge and even less experience. Further, no safe standard has been universally adopted for 500-lb. steam fittings, bolts, flanges, expansion loops, etc., but this will very probably come after more exhaustive time tests.

Gives Protection

The protection of human life, however, should be the first consideration, and after that, continuity of plant operation and protection of property; and surely all will agree that protection beyond that found in the average plant is necessary.

We never think of asking an operator to manually trip an oil switch, which is done from the central switchboard; therefore, why ask him to mount a boiler or scramble through dark galleries to shut off a steam break when it may be done from a safe point by merely turning a switch?

We can only make every attempt to prevent failure by careful design, and then provide, as a matter of precaution, the best possible safeguard if it does happen.

The master valves should be those nearest the boiler, and either the automatic stop checks or gate valves in the boiler lead. Valves at this point protect the complete piping system and would not be affected by mechanical movement of a broken line, which would possibly throw excessive strain on a gate valve, causing it to jam.

Automatic stop-check and boiler-lead gate valves are seldom above 10in. in diameter and without doubt can be closed in from fifteen to thirty seconds, so that any or all of the boilers may be cut out at will.

Unless all the boilers are isolated there would be a reverse flow from the header back through the break, so that a maste valve is also necessary in the boiler lead at the header, which in any event is usually included. Closing both the boiler-lead valve and this last-mentioned valve completely isolates one boiler.

Valves are Needed

Boiler-lead valves are suggested for three very good reasons:

They protect the whole system of piping from the superheater and are well located for power operation.

Peter Payne Dean was born in Staffordshire, England, and his early education was received at the English public schools. Later he attended the Birmingham Technical School and the City and Guilds of London Institute.

In 1909 he went to the United States and became connected with the Diehl Manufacturing Company, of Elizabeth, N. J., acting as sales engineer until 1913. During this time he was responsible for the electric equipment of many large industrial plants, and he completely developed an electrical dynamometer which was extensively used in the scientific testing of internal-combustion engines.

In 1913 he was engaged by the Ingersoll-Rand Company, and in 1914 by the Cutler-Hammer Manufacturing Company, which latter concern took over his patents on valve control. From that time to the present his whole work has been devoted to the design and manufacture of valve-control systems and remote-control devices for central-station use.

If a bad fracture should occur, it would be almost useless to endeavor to locate it and sectionalize the header to stop the flow, on account of the tremendous volume of condensed steam and consequent confusion.

There is no certainty whatever that header valves above 12 or 14 in. in diameter will close under open-end conditions on account of their construction to withstand such strain.

The principal argument against emergency closing off of the boilers is that the plant would be completely shut down. In the author's opinion, if a bad break occurs its location cannot be determined until almost the entire steam supply is stopped. As soon as the break is located, the sectionalizing valves may be brought into play and the boilers quickly brought back on the line.

Even though large header valves can be closed from a distance, the author nevertheless believes that the quick and safe way is to shut off the boilers in sections until the break is stopped. Incidentally, with any remote-closing scheme the boiler safety valves should be piped to a header and blown to atmosphere, as in the event of a boiler shutdown they would all blow together.

Some arrangement also of an auxiliary header should be worked out to supply the boiler-feed pumps, as well as a scheme for shutting down the draft fans.

Power-operated header valves of large diameter may be depended upon to stop a very bad fitting blow or gasket leak, so for this reason and also for convenience of operation they should be provided with remote control.

To close an 18-in. high-pressure gate valve requires two men for a period of at least fifteen minutes, including transit to and from the valve, not to mention the physical effort-necessary and the danger of penetrating a steam-laden alley with very uncertain conditions under foot. For years engineers have applied power operation to sash monitors, ash gates, dampers, and other auxiliaries, but seem to have entirely overlooked the poor old steel sentinel that stands guard over the main artery.

Great care is taken to see that main-line valves are tested for tightness and that they are strong and rugged, presumably for assurance that they will not fail during operation or when an emergency arises. Who knows, however, whether they can be even reached in case of trouble? Therefore, why not turn them into real protective devices by providing remote control? It should not take much of an argument to convince those in charge of expenditures that it is worth the money.

Fig. 1 shows a typical existing boiler and piping layout in which electrically operated valves are employed. Complete isolation of one boiler from the line may be made by closing any pair of valves A, B, either singly or from one switch, but this of course leaves the boiler-lead lines unprotected. Further protection may be accomplished by electrically operating the non-return valves shown and closing them together with valves A, B, in order to prevent reverse flow from the header.

Locate Switchboard

Since any remote-control system must of necessity be electrical, the design and placing of a central switchboard must be carefully thought out. The location should be as near the main means of exit as possible, as plant operators in case of trouble will move toward this point. With the open air in view, a man is more apt to regain his composure and presence of mind than when called upon to act hurriedly and then bolt for his life.

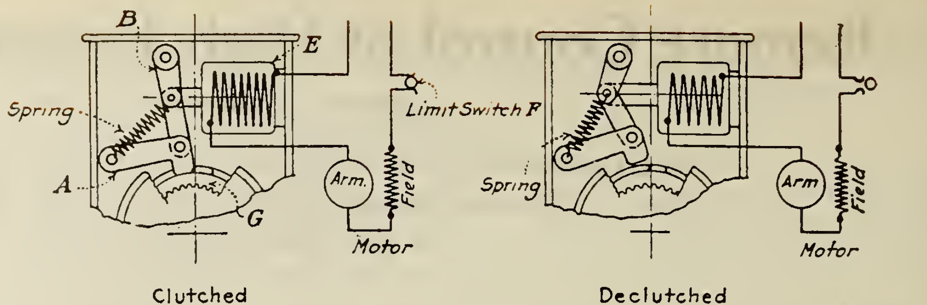
---

*Extracts from a paper presented at the Spring Meeting, Montreal, Canada of the A.S.M.E.

Such stations should never be placed in steamprof vaults adjacent to the boiler room and without means of safe exit. They will be useless in emergencies, as the opertors will not travel in that direction.

The operation of switches to shut the valves should be as simple as possible, preferably by breaking a protective glass window and pushing a button.

Under no consideration is it safe to open master valves from a remote point which may be opened locally, eitner by hand or electrically.



SKETCH SHOWING PRINCIPLE OF OPERATION OF A SECOND TYPE OF VALVE-CONTROL UNIT

Two Types

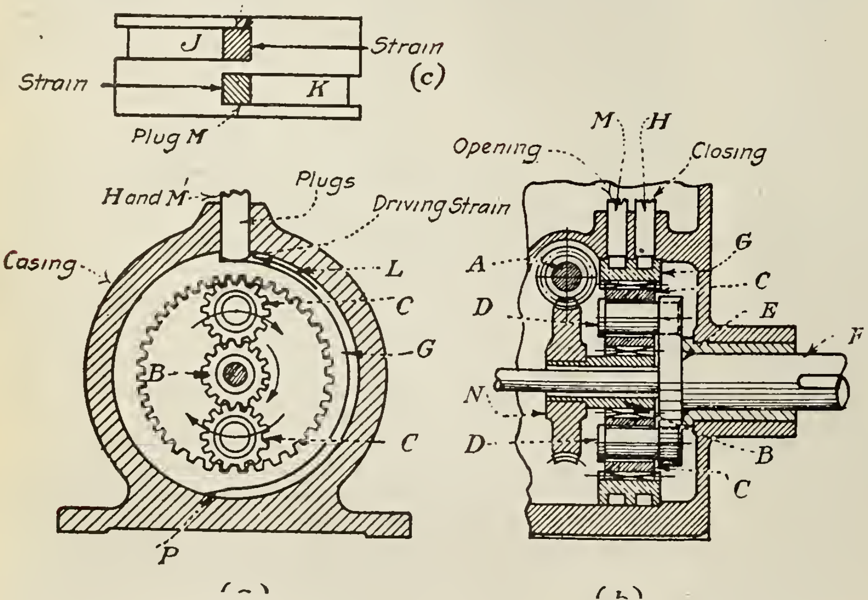
There are two types of quick-acting valves, the straight triple-duty, and the piston-operated trip valve, both of which are of the globe type. The former is a combination of non-return, stop, and "automatic closing on drop of line pressure," performing therefore the three duties. Engineers have not taken kindly to line protection upon drop of pressure; therefore the third duty is operated by an electrically controlled pilot valve admitting steam on top of the closing cylinder. This valve depends upon the excess-area piston forcing the disc to its seat against the pressure. The straight trip valve closes with the pressure and is remotely operated by a olenoid magnetic latch.

This valve is used mostly as an additional emergency turbine stop upon overspeeding, being placed in the turbine lead between the header and throttle trip valve. On account of its somewhat complicated construction, it is hardly suitable for line protection. The triple-duty remotely controlled valve would seem to be the logical type for quick closing, provided that it can be made to close against the extreme velocity which would result with an open-end line blowing to atmosphere and would possibly reach 50,000 ft. per min., depending upon the friction loss in the pipe between the header and the boiler. The action in this case would not be that of a non-return automatic check valve which actually closes due to the reverse flow, but the disk would be forced on to its seat against an extreme velocity in the opposite direction and the action would be somewhat akin to that of stopping a high-pressure nozzle with one's finger. Valves of this description are generally closed by pressure being admitted to the top of the excess-area piston, but test data on closing under extreme velocity conditions do not seem to be available, and until they are, much cannot be said.

A high steam discharge is very apt to carry over slugs of water, and there may be some doubt as to the advisability of instantly closing a valve under this condition. It would seem that a closing time of ten to fifteen seconds would be safer.

Motors Close Valves

Electrical operation of non-return valves was first suggested by the author and has been adopted by many leading engineers. The operation is the same as that required on the triple-duty design, with the exception that the valve stem is driven by a motor provided with reduction gearing. Their action under most extreme conditions is positive, provided that the motor control is of the proper design and application. The valves are ideally located with respect to line protection, being directly at the superheat outlet and where vibration due to the whip of a broken boiler lead would not be excessive on account of the valve being securely anchored. They close easily under normal conditions, and for emergency closing should be provided with ball thrust bearings to eliminate the closing friction as much as possible. The control unit should be bolted directly to the yoke and geared to the stem through the yoke nut which is of the rising-stem type. The travel of the disk is not more than one-quarter of its diameter, so that quick closing is possible. Although ruggedly built, this valve will not stand much jamming, and therefore calls for a special type of motor control to prevent it.



MECHANISM OF ONE TYPE OF THE AUTHOR'S VALVE-CONTROL UNIT

Disks Must Be in Contact

There is only one safe point of closing, and that is when the disks and seats are in perfect contact; to effect this the motor drive should have an automatically operated mechanical clutch completely disconnecting the high-speed armature and gears from the motor at the moment of closing, thus eliminating its momentum and allowing the motor armature to come freely to rest. Without this clutch the limit switch must be set to stop the motor before the valve reaches its seat, and a certain amount of drift due to the momentum of the armature and gears must be depended upon to seat the valve.

This drift depends upon the resistance to closing, which distinctly varies with line conditions; for instance, when the valve is closed with balanced pressure and there is no flow in the boiler-lead line, there is no resistance to the disk and the electrical limit must be set to trip just at the point of closing so that the disk can drift into its seat.

Assume, then, an open-end pipe condition with steam blowing to atmosphere, during which the disk encounters excessive resistance. The moment the electrical limit opens, the velocity will overcome the momentum and act as a brake, thus causing the motor to stop instantly and before the valve is actually seated.

The non-return or globe valve must seat tightly and has no leeway to travel as has a gate valve. Therefore it should be made to seat tightly under all conditions and without jamming or strain.

Motors Get Little Care

There is hardly a piece of machinery in the power plant that is subjected to such extreme operating conditions as the motor-controlled valve:

a It is usually located in an out-of-the-way gallery and covered with coal dust, and in a temperature ranging between 150 and 165 deg. fahr. which necessitates special heatproof motor-coil insulation.

b It is thrown directly across the line without the aid of starting resistance so that the full voltage is impressed upon the windings, and at the same moment the motor may be called upon to exert its maximum mechanical effort in unseating a tightly seated valve

c It must be small and compact, automatically lubricated, and entirely steamproof and waterproof.

d Periods of inoperation range from the minimum of one week to, say, three months, during which time plant conditions may be such as to prevent its operation; and it is expected to function perfectly, even though it has not been tested over this extended period.

e Steam from a leaky gland may be allowed to blow freely on the control unit for an indefinite period, and to withstand this it must be impregnated.

In case of piping rupture it is more than likely to be enveloped in condensed steam, and just at this time it will be called upon to exert its maximum mechanical effort to close the valve.

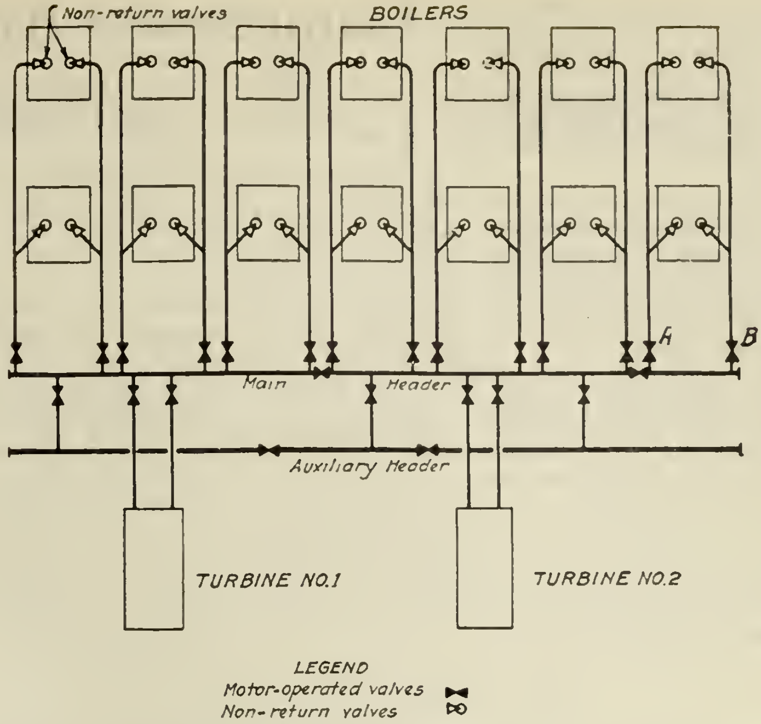
The duty on such equipment is extremely severe and without doubt necessitates much special construction. The motor must be of the totally enclosed type and provided with ball bearings of excessive diameter. It should be bolted directly to the reduction-gear casing, leaving no coupling or high-speed shafts and bearings exposed. It should be series wound with such characteristics that it will automatically slow down upon the application of load caused by the valve disk passing into the seat. This is the surest means of protection against cutting of the disk and seat rings.

The reduction gears should be of heat-treated steel on account of their compactness and the excessive strain that may be applied, and should be continually immersed in oil. Any oilless or self-lubricating type of bearing for either the motor or slow-speed shaft should be avoided on account of its inability to withstand excessive heat, long periods of rest, and the accumulation of dust in the bearing.

On account of the excessive drift of the motor armature and gears after tripping, a declutching device should be provided to enable the valve stem to be stopped automatically at a pre-determined point without jamming. In the same casing should be provided a self-contained electrical limit which is capable of breaking the main motor current without arcing and so geared that operation of the valve by hand will not throw it out of adjustment.

The casing should be provided with one conduit opening arranged for making a steamproof joint between the internal connections and the line, and all internal connections should be of asbestos-covered heatproof cable.

Control of the valves may be effected from either one point or from multiple points by the aid of a totally enclosed dust-proof reversible drum switch capable of reversing the armature connections.



Boiler and Piping Layout of a Power Station in Which Electrically Operated Valves Are Employed

The stations should be provided with lamp indication showing the full open and closed positions of the valve at all times. Such a control switch should be provided with a lock, an emergency glass window, and a hammer.

Operator Has Full Control

For multi-point control an interlocking system should be provided so that the first operator to reach a valve will have full control, even though other control stations are operated at the same time and in reverse directions. The best way of accomplishing this is to provide an interlocking relay panel so that only one switch may be closed at a time, and further protection by an electrical interlock consisting of a magnetic system whereby each control-station drum will be retained in its proper operating position and will automatically return to the "off" position at the opening or closing point of the valve.

In every case both poles of the electrical circuit should be interrupted when the switches are in the "off" position. Single pole break is dangerous, as a ground may cause the valve to either open or close and produce very serious inconvenience.

Current Must Not Fail

A valve-control system should be connected to the most reliable source of current in the station, which is either the direct current exciter or switch-control battery circuit, as it is equal in importance to any piece of auxiliary machinery. The voltage should not exceed 250, firstly, because direct-current battery circuits of this voltage are standard, and secondly, because higher voltages would cause an unnecessary strain on the very closely packed windings. Valve motors are thrown directly across the line without resistance and encounter at the same moment their full mechanical strain due to a tightly seated valve.

Each valve should be provided with a local control station, mounted at some point from which opening and closing the valve may be observed. Preferably there should be two points of control for each valve, one in the boiler room close to the door leading into the turbine room, and the other at a safe point unlikely to be affected by steam flow. Where a centralized control board is adopted, the second point of control may be mounted in the turbine room, and for the closing of turbine-lead valves the control may be mounted on the turbine gage board.

Protect Cables

All conductors should be suitably protected by fuses having a capacity equal to the full-load starting current of the motor, and fuses rather than switches should be provided for disconnection. The cable should be chosen according to the location, and for the operation of high-pressure superheated-steam equipment, should have an asbestos heatproof covering.

It is a good plan to end the rigid conduit within 3 ft. or so of the control unit, and from that point use a flexible loop of Greenfield or similar duct. This will allow considerable vibration in the pipe line without affecting the cables, and will further enable the control unit to be freely moved.

Hand Control Essential

Handwheels should be provided in case of failure of current supply.

No declutching device should be installed between the motor and valve which destroys the relative position of valve and motor mechanism. A properly designed and cared-for valve-operating system, especially in a power plant, need never fail, and in case of possible failure at a critical moment the valve may be closed by the handwheel, through the gears and motor, in almost as short a time as when the parts are disconnected.

The great danger of a declutching device is that it is very apt to be left disconnected with no means of showing its position at the control station, and that it introduces a non-foolproof feature by providing a piece of mechanism that can be tampered with by any unauthorized person.

If such a device is insisted upon, it should be a self-contained part of the mechanism and operated externally by the aid of a wrench. Further, it must be so arranged that positive indication of its position must be noted on the indicating lights at the control station.

Every electrically operated valve should be opened and closed at least once a week, preferably under load conditions if possible, and an examination of the internal parts should be made at least once a month and all records of such tests and examinations kept on file.

When transformers are to be operated in parallel, care should be taken to see that they have the same polarity and that they have the same characteristics. To determine whether the polarity of two transformers is the same, connect the corresponding secondary terminals through small pieces of fuse wire and close the primary circuit. If the fuse blows the connections must be reversed; if not, the transformers are of the same polarity.

Announcements

Geo. J. Soucy, of Toronto, has been elected general secretary of Dominion executive, Canadian Association of Stationary Engineers. Mr. Soucy is now engaged in special work in connection with the betterment of power plants and the supervision of operating conditions. He has had twenty-five years' experience in the design, construction and operation of all kinds of plants. His method of procedure is believed to be unique in that he always insists on a personal inspection of the boilers to determine the actual working conditions.

Mr. Soucy, it is claimed, effected a saving of $250.00 per day in one plant of 4,000 h.p. capacity by simply regulating the drafts and dampers for a given thickness of fire. He has twice been the Canadian representative to the convention of the National District Steam Heating Association, which formulated rates during the war and standardized the methods of underground construction.

Compressed Air Main Leakage

Leaks in Air Lines Hard to Detect—Flanges Superior to Screw Joints—Use Proper Packing

AS FAR as leakage is concerned, compressed air is very different from steam or water. Both the latter substances are easily seen, and any escape is therefore immediately apparent. In the case of steam the pipes are always accessible and the remedy is soon applied. A water leak is easily found on account of the inconvenience caused by the appearance of any considerable body of water in one locality. If the pipe is underground, the earth gets very sodden and accumulations of water appear on the surface; in this case also the remedy is simply applied. With compressed air, however, the problem is more difficult, since the medium employed cannot be seen, and in places where a great deal of noise is an everyday occurrence it cannot be heard escaping, so that undetected leakage is very possible.

When pneumatic pipes are laid underground any small leakage may go undetected; but if any considerable volume of air escapes, the first heavy rain causes a furious bubbling on the surface of the ground just above the leak. During dry weather it is a good plan—that is, if the surface is not covered by cement—to pour periodically several pails of water over the ground above those pipe flanges where leakage is most likely to occur. Such places are at sharp bends in the pipe-line, and where the pressure on the earth due to foundations and buildings changes suddenly. This method can be made infinitely more sensitive if, when the pipes are being laid, the space above each flange is filled in with ashes instead of earth. In this way the smallest amount of truant air quickly rises to the top and is detected.

In the case of pipes which are above ground other methods have to be adopted. Where the pipes pass through buildings an excellent method is to pass a lighted match or candle round the flanges, when even the slightest leak will be betrayed. In the open, where a light is impracticable, a very good method is to wet one's hands, and, moving from flange to flange, to pass them round each at about half an inch distance so that any leak must blow directly upon them. In this way the presence of the smallest issue of air causes a slight evaporation on the hand, and a consequent coldness which is very readily felt.

For testing large air receivers for leaks an excellent method is to have the seams periodically brushed over with a soap solution. It is wonderful the number of small leaks which come to light in this way. These only require a tap from a caulking tool to be rectified. In a large system, if all these small escapes are allowed to accumulate, the leakage soon assumes great proportions—that in a large shipyard having been known to reach 25 per cent. of the total output from the power-house.

Having enumerated some of the leaks which may be expected in a large or small system, attention had better be turned to their remedy, or, better still, their prevention. First, then, as to joints in the pipe-line. Flanges are much superior to screwed couplings, on account of the greater ease with which they can be adjusted.

Then, again, when dismantling for repairs, small bolts are easier to unscrew than a large-diameter ferrule, which is apt to get out of shape and jam. Last, but not least, flange joints will allow of slight curves being made in the pipe lines, whilst screwed couplings will not. For jointing material leather has been tried, but the great variations in temperature and moisture soon cause shrinking and endless trouble. Most kinds of patent steam and water jointing will stand a first tightening up, but not a second; and all these joints are fairly expensive. A very successful method which has been in use for some time now is to face the flanges in ridges and use a medium grade of oily millboard. The ridges are easily machined with a quick self-act and a tool of the type shown in the figure. By this means the millboard, which should be "doped" with a thin oil if not greasy enough, is forced into a series of small rings, which act like miniature hydraulic leathers. This type of joint can be tightened up time after time, is cheap, and above all very reliable. Results show that if these joints are initially quite tight and followed up with a half-turn or two for a day or so until quite set, no trouble need be expected from repeated heating and cooling, or from moisture or vibration.

Oil containing paraffine will emulsify, in warm water, more readily than if without, and on being allowed to stand in a glass vessel, will show a whitish film between the oil and water when cooled.

Selecting oils may be best done by trial, like the proverbial pudding, and when a satisfactory mixture is found, have it analyzed and require the same ingredients in the same proportions in future purchases.

Flashpoint determinations have no definite connection with lubricating power. None of the lubricating oils on the market have a dangerously low flashpoint. For gas-engine cylinder lubrication a reasonably high flashpoint is necessary.

Editorial Comment

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

N. C. SHATFORD
News Editor

The Value Of Convention

THE annual convention of the Canadian Association of Stationary Engineers, with its accompanying exhibition of power plant equipment, has established itself as an occasion for presenting to the engineering fraternity new and better methods of combustion. The gathering last week in the Central Technical School at Toronto surpassed those of the past in the numbers attending, in the excellence of the entertainment program and in the diversity of the exhibits presented.

Apparently there has been a rejuvenescence of interest in modern combustion methods, which can be attributed, doubtless, to the fact that the problems now facing engineers of the Dominion call for advanced knowledge to bring about their correct and economical solution.

Conventions such as this, which serve to interpret and to apply economies in the art of combustion as well as to disseminate the spirit of goodwill, are valuable to the power plant industry in an even greater degree than those which exist merely to discuss commercial practices.

All who attended the C. A. S. E. convention must necessarily have returned to the boiler room stimulated and keyed to a higher pitch through hearing the experts in charge of the various exhibits explain the developments in their particular fields.

* * * *

Easy Engineering Lessons

TO THE publishers of Power House comes unusual opportunity for service in being able to begin with this issue the first of an extensive series of articles on power plant operation by Captain M. B. Watson, director of the Department of Engineering in the Central Technical School, Toronto.

Mr. Watson's experience and qualifications are such that these articles should be of immense benefit to stationary and other engineers of all grades.

Commencing his stationary engineering experience at the age of fifteen years by taking charge of a night shift in a steam-driven power plant, while he continued to attend high school in the day time, Mr. Watson proceeded to the University of Toronto, where he graduated in mechanical and electrical engineering in 1910.

He has received from the above institution the degrees of Bachelor of Applied Science and Mechanical Engineer. From the above early age to the present, Mr. Watson has kept more or less closely in touch with the stationary engineer and his work. Even during the war he was employed as an officer of the Royal Engineers (Imperial) in charge of the installation and operation of pumping plants for the supply of water to the trenches in France, until he was sent back to England due to physical disability, when he was attached to the Royal Air Force as an instructional officer on internal combustion engine work.

At present, Captain Watson is chief engineer, holding a first class Ontario stationary engineer's certificate, and is in charge of the instructional work in engineering in Toronto's Central Technical School. As a registered professional engineer of the province of Ontario, he is carrying on a consulting practice along the lines of power plant design and efficiency, also on heating, ventilation and illumination. Mr. Watson is an associate member of the Engineering Institute of Canada, a member of the American Society of Mechanical Engineers, also an honorary life member of the Canadian Association of Stationary Engineers.

Men having such a combination of theoretical training, actual stationary operating experience, as well as experience in instructional work, are few and far between, and we feel fortunate in securing Mr. Watson to take charge of this section of Power House.

* * * *

Careful Reading Vital

IT IS to be feared that many Canadan engineers, immersed in the busy job of power plant operation, do not fully appreciate how much science, and it may be justly added, the technical press, have done and are daily doing to lighten the burden of their labors.

The combustion field is so vast that it is difficult for the individual to realize more than a small fraction of what is being done, whether it be in regard to the study of boilers and their behavior under the exacting conditions which apply to modern practice, or in regard to such matters as the practicability of super pressure, or the economies of various types of fuel.

What is more common than to hear an engineer say, "I have not had time to read so and so; there is so much to be read"—which means generally that he reads nothing at all.

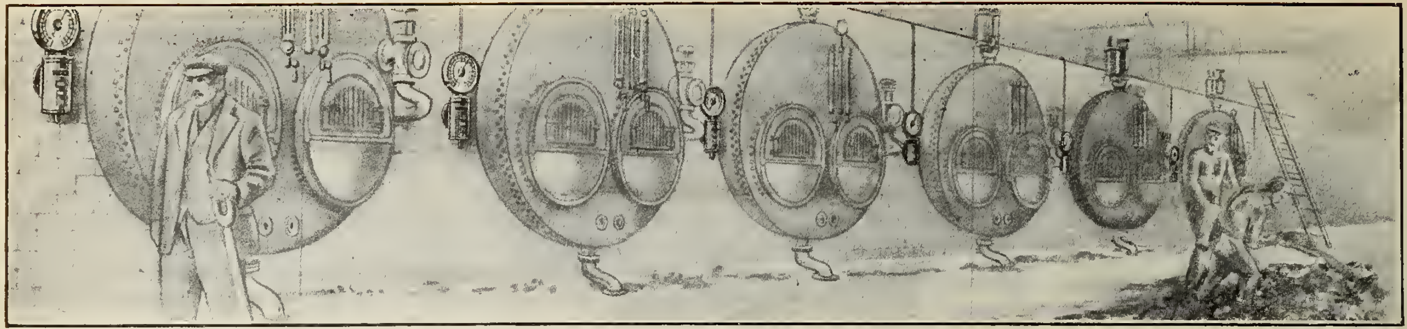
"Proceedings" are collected and filed, books are bought but only glanced at, technical newspapers are skimmed; indeed, experts do not hesitate to say that amongst the general body of engineers there is far less careful reading to-day than there was thirty years ago, although it is universally admitted that never before was it so essential for engineers to keep posted on developments in power plant operation.

* * * *

Using The Slide Rule

THE number of Canadian engineers who make daily use of the slide rule increases daily but some of the old prejudice that it is not "accurate" remains. For most purposes, however, its degree of accuracy is entirely sufficient.

It must, of course, be remembered that when using the rule for multiplication or division one cannot expect to read closer than about one part in a thousand, but on the other hand it should be remembered that the majority of the original measurements in power plant problems are out more than one part in a thousand and so the engineer who is skilled in the use of the slide rule and aware of its limitations can save a lot of time without sacrificing any necessary accuracy.



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.,
Director of Engineering, Central Technical School, Toronto.

The Proper Use of the Shovel a Vital Factor in Increasing the Efficiency of a Plant With a Corresponding Decrease in the Physical Exertion Necessary

IN ALL but the largest steam power or heating plants, where the handling of all coal and ashes is done mechanically, by far the greatest part of real physical labor is expended in the shoveling of coal and ashes. Anything that will tend to decrease the amount of physical exertion or the time spent in shoveling will therefore be of value to all engineers.

The engineer who is alone in the one-man plant will be less tired at the end of his day, because of the saving of muscular exertion, and in the time saved he will be able to give better attention to the minor things which increase the efficiency and improve the appearance of his plant.

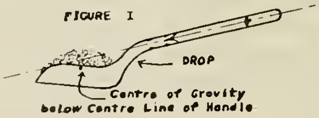
The chief engineer of a large plant who understands this work can train his firemen to carry it out in the easiest and most efficient manner, giving them more time to attend to other work which benefits the firm in saving coal, the chief engineer in getting more help on other work, and the firemen in having less coal and ashes to shovel, as well as giving them a chance to learn the more advanced part of operating work.

Objection Groundless

The writer has heard the objection put forward by some firemen that if they shovel more efficiently than the other fellow they will be given more boilers to fire, etc. This type of objection is on the face of it quite groundless, because, in the first place, it is no more exertion to fire three boilers properly than to fire two improperly; besides the chief engineer or the manager will before long single out the man who works most efficiently and will remember him when a chance for promotion comes.

Some firemen have even gone so far as to think that the most efficient firemen will be kept on the job firing while those less efficient will be given other work, possibly with promotion, when the opportunity opens. This is, of course, a mistaken idea. A reasonable chief or manager will at once realize that the best man should be promoted, and thus be given authority to instruct the poorer men in the efficient methods which he himself used, thus increasing the efficiency of the staff and the plant as a whole.

FIGURE I

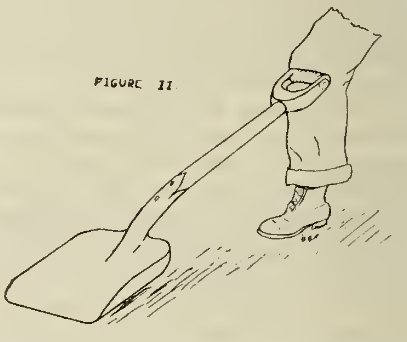


Choice of Shovel

The most important point in the efficient use of a shovel is the selection of the best shovel for the work and for the man who is to use it. There is a large variety of shovels on the market and not all are suitable for different jobs or different men. The scoop of the shovel should be large enough to hold from eighteen to twenty-one pounds of the material to be handled when the shovel is new. The shovel should be discarded when it has worn down so much that it will not hold more than fifteen pounds of material, or it might be used for shovelling some more dense material. For instance, a shovel which was worn so far that it would not hold sufficient coal might be used with economy for shoveling ore. It has been found from the results of a long series of experiments that a shovel of the above size will handle a greater amount of material in less time and with less exertion than any other size.

The lessons which will be published in this department of Power House are not a consecutive series of lessons leading up to any one Class of Stationary Engineer's Certificate, but will alternate between lessons suitable for the various classes of engineers. At the same time they will be in such form and will bring out points which will make each of them of value to all classes. For example the following article on the Use of the Shovel, while apparently a subject on which most engineers feel they are thoroughly posted, brings out some points which most engineers have never thought of. Correspondingly the more advanced lessons, while probably of greatest value to the higher class engineers, will bring out minor points which will be intelligible to and of use to engineers in even the humblest positions. Throughout these lessons the author does not propose to be didactic, but will welcome criticisms, discussions or suggestions, also requests for lessons on any particular subject. These may be sent to the author, care of the Editor of Power House, 143-153 University Avenue, Toronto.

FIGURE II



A larger shovel than this is too tiring for any but the biggest men, while a shovel which is too small takes longer to do the work, which is especially important in firing a boiler when the fire doors should be open as short a time as possible; and it is no less tiring, because, although it is slightly easier to lift a shovelful, there must be more shovelfuls moved, which means the work required to move the shovel around more times besides the energy required to move the same amount of material.

The scoop of the shovel should be "dropped" from the handle sufficiently to insure that the centre of gravity of the loaded shovel is below the line passing up the centre of the handle, as illustrated in figure 1. This prevents any tendency of the shovel to upset in the hand as well as allowing the scoop to swing slightly with the movements of the shovel which prevents part of the load falling off the shovel. This saves a lot of muscular strain on the wrists, which, though it might be corrected unconsciously while shoveling, is nevertheless tiring to the muscles and nerves.

The best shovels are those in which the metal of the scoop is fashioned into quite a long ferrule, or into long top and bottom straps extending at least a third way up and riveted securely to the wooden part of the handle.

The handle of the shovel should be as long as can be conveniently used by the fireman. A short-handled shovel makes it hard to give the coal enough force to carry it to the bridge wall, especially in a long furnace. It also necessitates the fireman standing too close to the furnace door for comfort, and makes him bend his back farther for each shovelful he picks up.

Angle is Important

The angle at which the scoop is attached to the handle is quite important. If the angle is too flat material will roll off the tip of the shovel when it is being swung. On the other hand the material will roll off over the back edge of the scoop if the angle is too great. Also in sliding the shovel along the floor at the edge of a pile, the end of the handle will be too low for comfort or for applying the necessary force easily if the angle is too flat, and the handle will be too high if too large an angle.

Naturally all firemen cannot use the same sized shovel with equal facility. The shovel should "fit" the fireman. A tall, long-armed man will prefer a longer handled shovel than a short man, and vice-versa.

To "fit" a fireman, the angle of the scoop, the drop and the length of the handle should be such that the end of the handle comes just below the fireman's knee cap, as shown in figure II, when the scoop is lying flat on the floor.

Care of Shovel

About half the exertion in shoveling is in the filling of the shovel. In order to make this part of the work as easy and speedy as possible the shovel must be kept in proper condition. The edge must not be allowed to become burred or split. When a small burr forms on the edge of the shovel, it should be hammered flat, or better still, ground off and the edge trimmed to its original shape. In case the edge becomes split, it should be trimmed or ground off to the bottom of the crack. The bottom of the shovel should be perfectly flat across the edge to the points where it turns up to form the sides.

Naturally the shovel will hold less and less material as it becomes worn away or trimmed and should be discarded when it gets too small to be efficient.

Cheap shovels often come loose at the ferrule or handle straps, and if this condition cannot be successfully remedied by tightening up the rivets the shovel should be discarded, as good work cannot be done with a wobbly shovel.

Filling the Shovel

In picking up a shovelful of coal or other material the shovel should, whenever possible, be placed on the floor at the edge of the pile and pushed under the material. Of course this is not possible when it is necessary to stand on the coal and dig into the top of it, such as starting to unload a car. If the floor is smooth the shovel will slide under the edge of the pile easily, this is because the edge of the shovel always strikes the edges of the pieces of coal, and has to raise them only the thickness of the blade of the shovel, whereas when digging into the top of a pile the edge of the shovel strikes all parts of the various lumps of coal, etc., and has to either push these ahead of it or push them aside. If necessary, in pushing the shovel into the pile, the leg can be made use of by throwing the weight of the body against the back of the hand holding the end of the handle.

M. BARRY WATSON, B.A.Sc., M.E.

To insure easy shoveling off a floor the floor must be as smooth as possible. A good concrete floor is usually the best for this purpose because the feet will not slip easily on it, while the shovel slides along quite readily. A poor quality of concrete soon wears into holes, making the shoveling just as hard as digging into the top of a pile. A good quality of paving brick makes a good floor off which to shovel if it is laid with good hard mortar and thin joints. A piece of steel plate on the floor is about the easiest thing to shovel off, but it makes a very slippery floor to walk or stand on. If steel plate is used for the coal in front of a boiler, it should not extend so far toward the boiler that the fireman has to stand on it.

While considering floors on which to shovel, it should be kept in mind that a clean space should be kept on which the shoveller is to stand, for if he has to stand on lumps of coal, etc., he may lose his balance, or he will at least have to exert extra energy to steady himself. Far less energy would really be used in sweeping up the floor occasionally.

Convention Notes

At a luncheon of the Canadian Electrical Association, during their convention held in Montreal, the members were pledged to promote international security between Canada and the United States, and to use the agencies of electricity and electrical research for the mutual benefit and protection of the people of the two countries.

The Summer Convention of the Association of Municipal Electrical Utilities opened at Orchard Point, Orillia, on June 13. The following are the officers of the association: president, A. T. Hicks; vice-president, J. E. B. Phelps; secretary, S. R. A. Clement; treasurer, G. J. Mickler.

At the Ninth National Exposition of Chemical Industries which will be held at the Grand Central Palace, New York, from Sept. 17 to 22, the progressive tendency in the chemical equipment field will be demonstrated.

At the convention of the Electrical Co-operative Association held in Montreal, the following officers were elected: hon. president, Geo. Templeman; president, P. A. McFarlane; vice-president, D. H. Ross; secretary and treasurer, T. H. Chennell.

Martin D. Brayman, an old and trusted employee of the James Smart Mfg. Co., up to the time of its absorption by the Canada Foundries and Forgings, and who continued on with the latter, has been pensioned off by the company after fifty-two years of continuous service. Mr. Brayman is seventy-two years of age.

Electricity in the Power House

MODERN CASCADE MOTORS

WITH the ever-increasing use of alternating current, especially in conjunction with cheap power supplied from hydro-electric plants, the motor user is always ready to welcome any new type or system showing improved operating results.

While the modern alternating current motor leaves little to be desired, the single field cascade type has recently come to the front as a machine specially suitable to certain applications, and is being regarded with favor by many electrical engineers.

The principal feature is, that with the single speed machine there are no slip rings, the motor is capable of exerting twice the full load torque even down to creeping speed without trouble, and any particular machine will stand a momentary overload of 150 per cent.

Comparison of Types

In the old system of cascade operation two distinct machines were used. The stator of the first being connected to the mains and its rotor connected to the stator of the second. When running at cascade speed the second rotor would be short circuited. Alternatively the two rotors were connected and one of the stators short circuited.

While with two separate motors there are two entirely separate magnetic fields, in the single field type having but one core, the two fields, although existing as components, merge into a single resultant field, likewise the two individual stator and rotor windings are replaced by a single winding, that of the rotor being so connected that the currents induced in it produce two magnetic fields in that of the stator so that "main" and "slip frequency" currents can circulate independently.

At the same time the windings are quite simple. Both electrically and magnetically, the single field motor is identical in action wtih a cascade combination of two machines, the combination only affecting the cost, efficiency and power factor, in other words, there is a stator winding connected to a supply which induces in turn currents in the rotor winding.

The production of these two distinct fields is brought about by the manner in which the two coils are arranged. An eight pole element corresponds to the main stator field and a four pole field rotating in the opposite direction induces voltages in the stator winding which is so connected that induced currents can flow independently of the currents supplied from the mains, these currents producing a field corresponding to the four pole rotor field.

The Single Speed Motor

This type of machine is practically a squirrel cage motor, the rotor winding being completely short circuited.

The starting torque and speed are under complete control by regulating resistances connected to the stator tappings. A back E.M.F. is induced in the rotor conductors by the auxiliary rotor field permitting only sufficient current to flow to produce the required torque. This, at starting, can be varied at will by means of the stator tapping resistances. While behaving like a slip ring motor and taking about full load current for full load torque, unlike the slip ring motor, the rotor voltage at standstill is very small and being quite stable at rest, starting is effected without a jerk. This is due to equality of turning moment for different positions of the rotor so that these machines will run steadily when 100 per cent. overloaded and, at only 2 per cent. of normal speed.

In consequence, the single speed cascade motor is entirely suitable for haulage purposes in mines and quarries, for driving rams, pumps and compressors, paper mills, and other machinery in steel works, flour milling machinery, etc., and for several other uses especially in dusty situations.

Resistances Connected

When it is not required to regulate the starting torque, resistances are connected permanently to the stator tappings to give the required starting torque, these being short circuited by a switch when the motor has reached full speed.

By using two separate windings for the stator, the motor may be controlled by a standard three phase controller.

Multi-Speed Motors

In this case slip rings are necessary and these being short circuited in the case of two-speed motors, the currents in each section of the winding are in phase with the corresponding voltages and no secondary field is produced. Thus the motors when so connected run as normal motors at speeds corresponding to the number of poles in the main winding, the second speed being usually two thirds the full speed, with the number of main poles being half that of the auxiliary ones, a ratio of 3 : 1 is obtainable.

The full speed can be arranged to correspond to any number of poles greater than 2.

They may be hand controlled or the speeds changed automatically by means of a contractor gear. The field of application of these multi-speed motors is greater than that of the single-speed, and they are suitable for air compressor work, especially for units installed for a greater capacity than immediate requirements demand, the second speed being brought into use at a later date to meet the increased demand.

Winding Engine Work

Two-speed control with alternating current is analogous to series-parallel control with direct current, but has the added advantage of the main circuit not being open when the connections are changed. A winder is accelerated in two stages which dovetail into one another; at starting the slip ring circuit is open and the controlling resistances are connected to the induction circuit of the stator. The cascade coupling and the winder will accelerate to two-third speed. During the second stage the resistances are connected to the rotor, the second stator winding is opened, and by gradually short circuiting the resistances, the winder runs up to full speed. Preferably the control should be automatic, hand control may suffice for a small machine. For a given kilowatt input, the motor connected in cascade develops approximately 50 per cent. more torque than it does when connected to resistances through the slip rings.

For minimum kilowatt peak, the input is kept constant during both stages of acceleration and as the torque during the first stage is 50 per cent. greater than during the second stage the acceleration is also greater. This is of advantage as it gives a smoother effect.

This increase in the torque per k.w. greatly reduces the input during acceleration and for winders of moderate depths, the peak is 25 to 30 per cent. less than for similar winders driven by straight induction motors. The power consumed per wind is reduced. Generally the cascade connection is only required during accelerating or retarding and in consequence the SR losses in the stator secondary circuit are of little account as they merely form part of the controlling resistance losses. For this reason it is good practice to use two entirely separate windings for the stator, one the main winding of the usual type for connecting to the line; the other similar winding connected for half the number of poles of the main winding with three phase connections for coupling to the controller.

—JOHNSTONE TAYLOR.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

PIPE LAYOUT

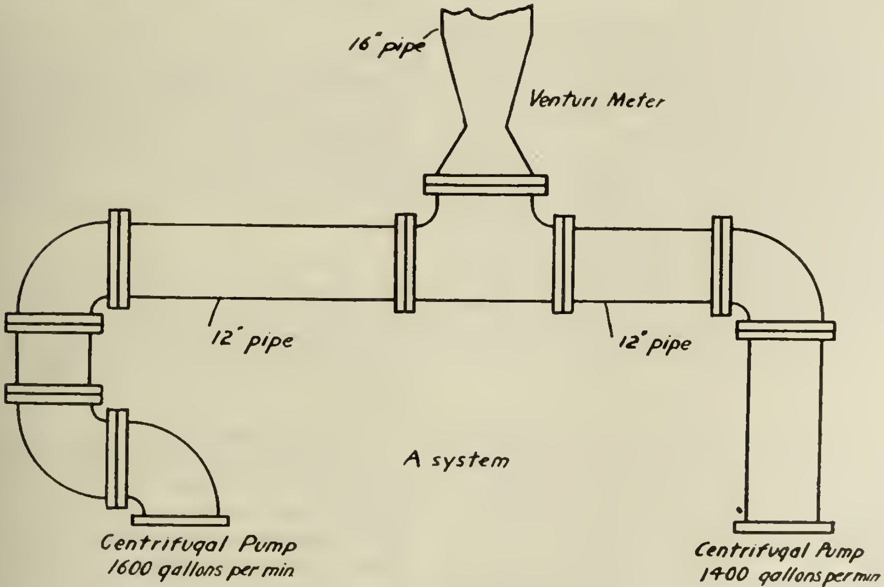
The accompanying sketch (scheme A) shows our present piping system, which has been condemned by several as a serious detriment to maintaining a pressure in the city mains. What would be the actual gain in lbs. per sq. in. by substituting the system shown in scheme B?

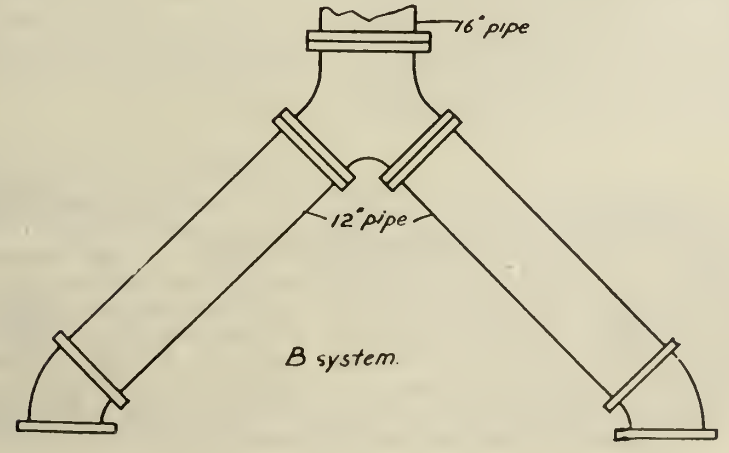
E. MAYHEW

Answer:—It is not possible to give any accurate information as to the actual gain, no lengths of pipe are given, and the condition of piping and elbows is not known. Hydraulically, scheme A is bad, there are too many 90 deg. elbows; and a sharp turn at the T.

With a good Venturi meter the loss in head is scarcely noticeable, but if the meter is located, as in your sketch, it will not give any accurate readings, due to eddies caused by the T. It should be at least 10 pipe diameters from any sharp turns.

With scheme B there certainly would be a gain in head, but it would be small on account of the fairly low velocities in the pipe line (about 4 ft. per sec.). The gain in head using system B might be about one lb. per sq. in.





ALTERNATOR SPEEDS

We have in our plant a Corliss engine driving an alternator. The engine is now running at 150 r.p.m., develops 200 k.v.a., 240 volts, 481 amperes per terminal, three-phase, 60-cycle current. With the engine running at 150 r.p.m. the exciter speed is 1,200 r.p.m.

The engine is capable of running 160 r.p.m. with its present gravity gear.

Would the exciter have any effect on the alternations of the current with quick changes of load?

The exciter should run only 1,100 r.p.m. instead of 1,200 r.p.m. Has this any effect on the alternations?—R. L. BOOTH. Windsor.

Answer:—The cycles in alternating current are dependent on the number of poles and the speed of the machine. As no change in the construction of the machine is to be made, the frequency is directly proportional to speed.

If your machine gives 60-cycle current at 150 r.p.m., with a speed of 160

$$\text{frequency is} \frac{160}{150} \times 60 = 64$$

You cannot change the speed of the engine without a change in the cycles.

The changing of the speed in the exciter would have but small effect on the unit. An increase of speed would give a higher voltage tending to cause over-excitation of the alternator field. Simply put more resistance between the exciter and the alternator.

WARM COOLING WATER

We have a carbon dioxide refrigerating system, but in order to get its rating, must run the compressor at twice its normal speed. The condenser pressure is 1,100 lb. per sq. in., the coil pressure 300 lb. and the cooling-water temperature from 77 to 87 deg. F. on and 110 deg. off. What is wrong?

Answer:—It is necessary to have a temperature drop between the carbon dioxide in the condenser and the cooling water in order to cause the heat to flow from the hot gas to the water. This temperature difference would probably be in the neighborhood of 10 deg. F.—the temperature in the condenser would then be 97 deg. F. This is above the critical temperature for carbon dioxide. By critical temperature is meant the temperature at which carbon dioxide gas will not liquefy into liquid carbon dioxide, no matter how high the pressure is that is placed on the condenser. This critical temperature is in the neighborhood of 86 to 87 deg. F., and if your carbon dioxide gas is at a higher temperature, you will not be able to condense it. Under these circumstances the only thing that goes through the receiver and expansion valve into the evaporating coil is carbon dioxide gas. The cooling effect that you do obtain is due to the temperature drop caused by the expansion of this gas from 1,140 lb. to 300 lb. Incidentally, this is a small percentage of the refrigerating effect that you would be able to obtain if liquid carbon dioxide were passing through the expansion valve and boiling in the evaporating coil.

It is quite possible that you have some liquid carbon dioxide going to the receiver and through the expansion valve to the evaporating coil, for the reason that the gas drops below the critical temperature, and the temperature drop causes some of the gas to condense, say 20 per cent.

The result of the high cooling-water temperature is that your plant capacity is reduced, and to offset this, the compressor speed must be increased to handle a larger volume of gas. The solution is to find a cooler condenser-water supply. You should have it at least below 75 deg.

EFFECT OF ASH

What effect has the presence of different proportions of ash and slate on the value of steaming coal?

Answer:—The efficiency of combustion ordinarily decreases with increase of ash or slate and incombustibles mixed with the coal and there is also the additional expense for storing, handling, firing and ash disposal. High-ash coals require higher draft because the ash forms an insulating layer around the coal, which hinders the oxygen from coming in contact with the combustible material and the ash may clinker and clog the fuel bed so the higher draft required results in more leakage of air through the walls of the setting. Hence, the higher the percentage of incombustible the greater the loss from excess air and the lower the efficiency obtainable for the combustible element in the coal.

The relative value of coals according to the percentage of ash content varies with different boiler plants. Under average plant conditions the relative values are about as follows:

Taking 0 per cent. ash as 100, 10 per cent. ash in dry coal would have a value of 92; 20 per cent. ash a value of 80; 30 per cent. ash a value of 60; 35 per cent. ash a value of 40; and 40 per cent. ash a value of 0.

STARTING A. C. GENERATORS

In synchronizing motors and generators to the station bus, the power factor meters usually indicate a low-lagging power factor. Is this due to improper synchronizing or improper adjustment of the field current? Do the machines keep the phase relations they had at the instant the switch is closed, or is there a slight change afterward?

Answer:—When starting a synchronous motor, it takes a lagging current from the line due to the machine being started as an induction motor, and therefore its magnetization must be supplied from the alternating-current circuit. After the machine has been brought up to speed and the field coils are connected to the direct-current excitation source, the magnetization can be adjusted to bring the power factor to unity, at which value all the excitation is supplied from the direct-current line.

In connecting an alternating-current generator in parallel with other machines, there are a number of combinations of voltage and speed that can be made to exist when the switch is closed on the incoming machine. If the voltage is high on the incoming machine, it will supply a lagging current to the other machines on the system when connected to the busbars.

On the other hand, if the voltage of the incoming machine is low, the other machines will supply a lagging current to it. A little experimenting should show the best voltage at which to connect the machines to the bus. It is generally best to close the switch with the incoming machine running a little fast and the voltage a little high. Then the machine will pick up some load from the system when the switch is closed and tend to relieve any disturbance that might be caused in the paralleling operation. After the switch is closed, all machines must take the same phase relation and continue to retain this condition. If they all have the same number of poles, they will run at the same speed. The only difference will be in the angular position of the rotors corresponding to the proportion of the load each machine may be carrying.

GETTING UP STEAM

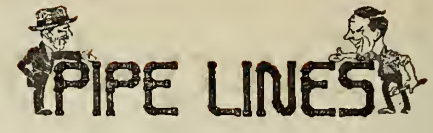
Having the manhole and handhole plate removed, how would you proceed to get up steam?

Answer:—After thoroughly cleaning and examining all parts of the boiler, stays, fusible plug, seams, etc., and finding them in good condition, replace the lower plates with good gaskets, then close the blowoff valves, and fill the boiler with water, comparing the water level with the gauge cocks or glass. Being satisfied, replace the top plate using a new gasket if necessary, and after examining the feed appliances and finding them in good working condition, proceed to light the fire, allowing the steam pressure to build up very slowly. It may be necessary to open a vent.

To reverse the direction of rotation of a series motor either reverse the series field connection, reverse the armature leads, or shift the brushes backward, as explained for the shunt motor.

Heating is manifest soonest, with the same expenditure of energy, in small bodies because they are not capable of absorbing the heat generated, therefore feel hot to the touch, while the same energy expended on large masses will produce only a slight rise in their temperature.

If a 60-cycle transformer is to be operated on a 25-cycle circuit, the voltage should be reduced to about one-half that rated and the capacity will be correspondingly reduced; otherwise excessive heating will result with continuous operation. Conversely, a 25-cycle transformer may be operated on a 60-cycle system with double the voltage at which it is rated for 25 cycles, providing the insulation will safely withstand the current.



UNCOVERED IN ANY OLD SPOT

A fireman from Woodstock was so ignorant he thought that stick candy was made from kindling wood.

* * * *

Terminal pressure is the pressure that would be in the cylinder at the end of the stroke of the piston if the exhaust valve did not open until the stroke was completed. On a steam-engine-indicator diagram the terminal pressure may be found by extending the expansion curve to the end of the diagram. The theoretical terminal pressure is found by dividing the pressure at cut-off by the ratio of expansion.

* * * *

1923 is proving a great year for any engineer who doesn't sit on the mourners' bench.

* * * *

Power factor is the ratio of the wattmeter reading with alternating current to the product of volts, amperes, read simultaneously.

* * * *

Elbow grease is a wonderful window cleaner.

* * * *

Never leave the secondary of a series transformer (instrument transformer) open. Excessive voltage will be induced in the secondary and may damage the instrument which the transformer serves. Short-circuit the secondary with a jumper before disconnecting the leads.

* * * *

An engineer who lived in Montreal,
Fell into a spring last Fall.
Had he fell in this Spring,
'Twould have been a sad thing,
But he didn't, he fell in the Fall.

* * * *

To distinguish between a parallel and a series-connected armature winding first note the center of the coils at the back of the armature. If the leads to the commutator are in the same direction as the back ends of the coil, that is, if they swing in toward the center, the winding is parallel connected. If the leads swing around the armature, away from the center of the coil, the winding is series-connected.

* * * *

If nothing appears in this column in the next issue of Power House you'll know somebody laid off to telephone.

Tallow oil, when derived from fresh tallow from properly fed animals, is a good lubricant, but lends itself readily to adulteration and may become rancid and acid. It forms the base of the best white soap, and, if a large enough percentage of soap is added to the oil, it becomes a grease.

Practical Ideas From Practical Men

HERE is an argument tending to prove that the smooth or hair side of a belt should be run in contact with only one pulley of a given drive, and the rough or flesh side of the same belt should come in contact with the other pulley. By so doing creep will always be in the same direction, the projecting fibres will always be smoothed down in the same direction, and as a result there should be less wear. To do this belts cannot be operated in the usual fashion. A "twist" must be made in the belt as indicated in Fig. 2.

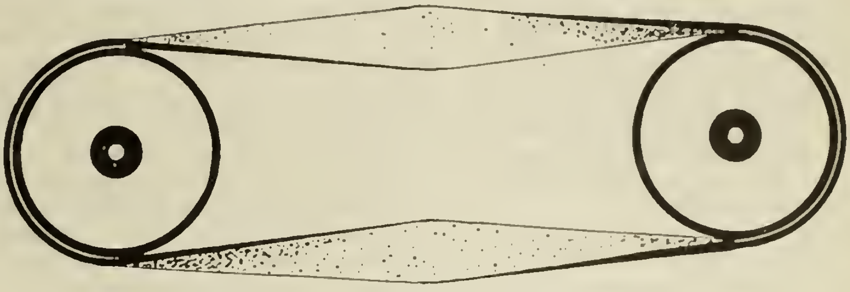


FIG II

Belt manufacturers and users will agree that a piece of leather or other fibrous material can be worn down more quickly by rubbing "back and forth" than by constantly rubbing in the same direction. When a carpenter sandpapers a piece of wood, he rubs the paper "back and forth" over the wood in every direction because he finds the wood will smooth down better and more quickly in that way. Pull a sack of rags, say, over a patch of grass constantly in the same direction and count the number of passes necessary to wear off the grass. Then repeat the experiment on a similar patch of grass except that the dragging will be "back and forth" over the same path. Doesn't it stand to reason that the grass in the second experiment will be "irritated" more and will wear off sooner?

Belts as ordinarily placed on pulleys are subject to this "back and forth" rubbing due to the fact that all belts creep. The writer has never seen this point covered in print, and since there are many thousands of belts in daily use all over the country it is a matter that seems well worth discussing. If the life of a belt can be lengthened by giving the belt a twist as indicated in Fig. 2, and for the reasons given above, the belt should by all means be twisted if the conditions of the drive are such that it can be done without impairing transmission.

Fig. 1 shows a belt with the projecting fibres exaggerated. Space is left between the pulleys and the belt for the purpose of showing distinctly how the fibres behave when coming into and out of contact with the pulleys and while in actual contact. Belts always creep toward the tight side. They must creep that way. There is nothing else for them to do so long as they possess elasticity. All belts, even steel, are elastic. That being the case, let us trace the action of the projecting fibres of the belt in Fig. 1. As the belt comes into contact with the driver pulley shown at the left the fibres are leaning over toward the right, because that is the way they were "rubbed" by the driven pulley which they just left. Immediately upon touching the driver pulley, though, the fibres find that the belt is creeping towards the tight side in opposition to the direction of rotation of the driver pulley. At the point marked "A" therefore, a turning point occurs and soon thereafter the fibres are smoothed over in a direction opposite to that in which they approach the driver pulley.

The fibres now rush over to the driven pulley with an antagonistic slope as shown on the top side of the drive. Upon touching the driven pulley, though, these fibres find that the belt is traveling faster than the driven pulley because creep is again toward the tight side and at the point marked "B" we have another turning point where the fibres are combed, bent or rubbed back to the original position. Then the fibres dash over to the driver pulley once more and they are again reversed. And so on.

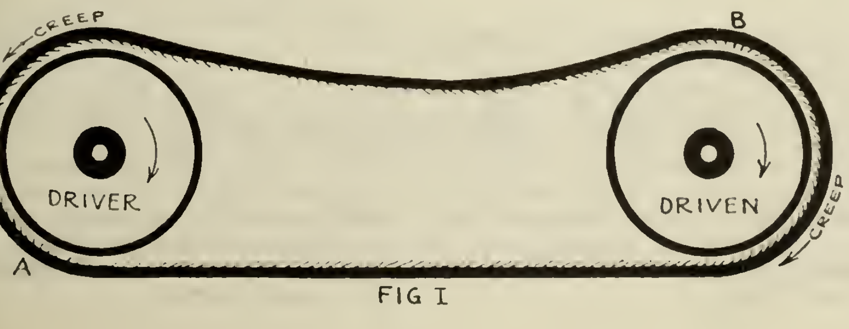


FIG I

Every time a projecting fibre comes in contact with a pulley in drives of this kind it is reversed in direction. This occurs revolution after revolution, day after day, year after year, and there is, therefore, little wonder that unless a belt is properly cared for it will wear out quickly.

No doubt there are ways in which this wear can be largely prevented. It is evident that if the belt is "bone dry" the wear is bound to be more rapid than if it is lubricated, for the same reason that metallic rubbing surfaces must be lubricated if wear is to be reduced to the minimum. Lubricant fills up the "rough spots" in the metal, thus allowing the "bumps" to pass over one another.

In the case of a lubricated belt the action may be somewhat different. The lubricant will probably not fill up the entire space sufficiently to prevent the projecting fibres from coming in contact with the pulleys, but the fibres will be so well lubricated that they will bend back and forth more easily and without appreciable or serious wear.

No doubt there are several solutions to this problem. For mechanical reasons it is often undesirable to give such a twist to a belt as shown in Fig. 11. Perhaps it can be avoided by applying a wearing face to the belt and operating in the usual way. The writer, however, does not know of any practical wearing face aside from sticky preparations, and they often do more harm than good along the line of excessive power consumption. It may be, also, that the reversal of direction of projecting fibres has much to do with the pulling power of a belt. In the opinion of the writer a greater pulling power can be obtained with a belt in which the fibres do not reverse, because contact can be made more intimate. That, however, must be left to experiments and experience, on which reports may be made later. The subject has at least been broached, and is left with the reader to do with it and think of it as he will.

COVERING PIPES

Faced as we are at present with the scarcity of coal and the need for conserving the supply as much as possible, the following comments may not be out of place.

It is not uncommon at the present time to go through a power plant and see various steam lines uncovered or only partially covered, the owner or manager of the plant apparently not having considered the loss he was incurring through the extra fuel required to make good the radiation losses of uncovered pipe lines. The following example will give an idea of the radiation of an uncovered pipe:

Example: Required the radiation per annum from a steam line 100 ft. long by 10 inches diameter, steam pressure 150 lbs. per sq. in. Average air temperature 76°F. Plant to operate ten hours per day, three hundred days per year. The temperature of steam at 150 lbs. pressure is 366°F. The difference in temperature between the steam and air = 366 - 76 = 290°F. Loss of heat per sq. ft. pipe surface per hour per degree difference in temperature = 3 B.T.U., approximately.

Then loss of heat per sq. ft. per hour = 3 x 290 = 870 B.T.U. Then loss of heat per sq. ft. per day = 870 x 10 = 8,700 B.T.U. Then loss of heat per sq. ft. per year = 8,700 x 300 = 2,610,000 B.T.U. 100 lineal feet of 10-in. pipe has an external area of 282 sq. ft. Therefore the loss per year from bare pipe is 2,610,000 x 282 = 736,020,000 B.T.U., approximately.

Assuming a net available heat value of coal at 10,000 B.T.U. per lb. for coal, the equivalent coal consumption is

$$\frac{736{,}020{,}000}{10{,}000} = 36.5 \text{ tons.}$$

For example take coal at $10 per ton. Then value coal lost in radiation: 36.5 x $10 00 equals $365.00.

Good pipe covering will save from 70 to 80 per cent. of this loss. Therefore saving per annum would be:

$$\frac{70}{100} \times 365 = \$255.50$$

Comparing this saving with the cost of 100 ft. of 10-in. pipe covering it should not take long to pay for the pipe covering.—M. C. ALLIN, 839 Lorne Ave., London, Ont.

FIGURING DENSITY

The density of an oil or other liquid can be determined with accuracy without the use of a hydrometer. If you have an accurate weighing instrument you can do a more accurate job in fact than with hydrometer.

In a nutshell, this is the method:—

(a) weigh a clean empty jug.

(b) weigh again when filled with water.

(c) weigh again when filled with oil.

The density can then be determined by using this simple formula:—

$$\text{Density} = \frac{c - a}{b - a}$$

This, you will note, is nothing more or less than dividing the weight of a certain volume of the oil by the weight of the same volume of water. If you have accurate and delicate weighing balances I would suggest that you use a small vial for this test. If you have nothing but large scales for weighing heavy objects, you can do the test very well by using a large or ordinary jug as suggested above. The temperature of the water, oil and jug should all be the same while doing the test. If possible, the temperature of all three should be 60 deg. F., as that is the standard.

Trade Catalogs

The B. F. Sturtevant Company, of Boston, Mass., in Catalog 311 emphasize the fact that their Type 12 Steam Turbine retains all the fundamentals of previous types and, in addition, embodies numerous refinements in detail construction. One of the principal and most advantageous changes made, it is claimed, has been the splitting of the castings on the horizontal center line. This allows the turbine to be entirely disassembled without disturbing the setting on the foundation in any way, besides allowing ready accessibility to the rator and nozzle segments for inspection purposes.

A complete and well-written fifty-six page bulletin has just been issued by the Sturtevant Company of Hyde Park, Boston, Mass., on the Type 12 Steam Turbine.

Part one gives in detail the construction of the various parts, profusely illustrated by photographs; it also suggests applications where such turbines can be used.

Part two is on the care and operation of the turbines, embracing such paragraphs as lubrication, bearings, adjustments, and points to remember. In this part also, dimensions are given.

Part three shows disassembled views and cross-sections with every part properly listed and numbered.

A copy of this bulletin, No. 311, will be gladly forwarded on request.

Double Suction Volute Centrifugal Pumps.—This is a new publication, No. 7350-C, 16 pp., 8½ x 11, issued by the Canadian Ingersoll-Rand Co., Limited, Montreal. It is well illustrated and clearly written, containing much interesting information on the special features of these pumps, methods of testing, etc., and will be gladly sent on request to any interested reader of Power House.

Construction

At a meeting of the Northern Mexico Power & Development Co., Ltd., held in Toronto in June 26, the following directors were elected: president, W. D. Ross; vice-president, Strachan Johnston; secretary-treasurer, W. L. Reed.

The Hydro-Electric Power Commission, North Bay, Ont., incurred a loss of approximately $100,000 when the sub-station on Harriet St. was completely destroyed during an electric storm, July 3.

The W. H. Yates Construction Co., Hamilton, have been awarded the contract for the construction of a $200,000 unit addition to the plant of the Canadian Westinghouse Co., Hamilton.

J. H. Black, of the Northern Canada Power Co., reports that work on the power development at Des Quinze is being rushed. The power plant at Lower Sturgeon will be in operation this month.

Hollinger Consolidated Gold Mines, Ltd., 85 Bay St., Toronto, are carrying on the construction of a power plant on the Abitibi River at Island Portage, in an aggressive manner in order to secure the benefits of the development at the earliest possible moment.

D. Woolsey, of Revelstoke, B. C., recently sent to the B. C. Chamber of Mines what is regarded as the best specimen of asbestos yet received. The possibility of making British Columbia independent of Quebec as regards the supply of asbestos is now being discussed by B. C. mining men.

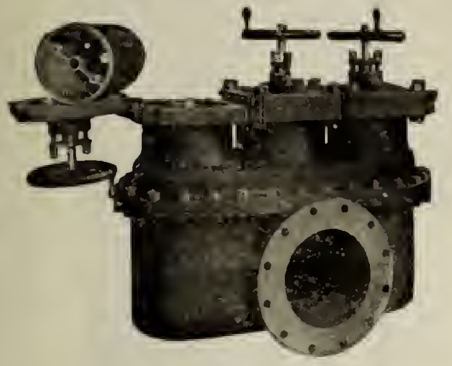
D. C. Coleman, vice-president of Western lines of the Canadian Pacific Railway, states that traffic demands and financial conditions will determine when the actual work of electrifying sections of the road through the Rockies will be commenced.

Edward McGivern, Victoria, B.C., master mechanic of P. Lyall & Sons Construction Co., Ltd., has invented a device which when attached to the carburetor of an automobile, acts as a fuel saver, giving the motor considerably more power, and practically eliminates carbon. This device has been thoroughly tested, and in two tests thirty miles to the gallon have been made.

John P. Forde, district engineer of the Public Works Department, Esquimalt, B.C., who is supervising the construction of the drydock there, states that all the mechanical equipment, which will include main, auxiliary, fire pumps, valves, sluice gates, machine shop equipment, capstans, caissons, traveling-cranes, etc., will be electrically operated arrangements having been made with the B. C. Electric Co. for the supply of the necessary power.

We Supply
Automatic Water Softeners

For the purpose of removing by chemical means the scale-forming matter from water.

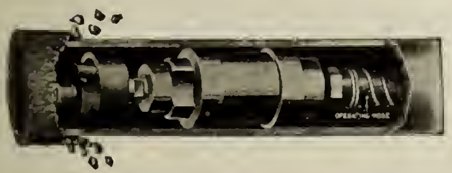


Three Basket Filter

These filters have from one to six baskets and can be arranged to remove foreign matter to any degree of fineness.

Lagonda Water Driven Cleaner for Curved Tubes

Lagonda Air Driven Cleaner for Straight Water Tubes



Cleaner Removing Scale from Outside of Fire Tube

ALL natural waters contain some impurities, which, when introduced into a boiler, may appear as solids deposited on the heating surface. No matter what the substance consists of, it must be removed at frequent intervals or it will decrease the capacity and efficiency of the boiler and may cause it to be badly damaged by over-heating.

Some waters, notably well waters, deposit such quantities of scale that it should be purified before going into the boiler, thereby preventing an accumulation of incrustation and consequent damage to boiler parts, and at the same time effecting a large saving in fuel by keeping all parts of the heating surface in a clean and efficient condition. If you have bad feed water it is a case for the chemist, for the scale is probably composed of several substances which must be known before the exact treatments necessary to get rid of them can be determined upon. The use of treatment without technical advice is poor policy.

Stony and vegetable matter in suspension can be removed by FILTERS, which we supply in various sizes and designs to suit all requirements. In most Canadian plants, lake or river water is used for feed, and these waters seldom carry large quantities of scale-forming materials in solution. Scale can be allowed to form in the boiler for a considerable period. Experience in each individual plant determines the limit at which tube difficulties will begin or a perceptible falling off in efficiency will take place. With such a limit of scale formation fixed, and the danger of allowing it to be exceeded, well understood, probably the most economical and efficient method of keeping the heating surfaces clean is by the use of the LAGONDA TUBE CLEANERS.

The cleaners are designed and so constructed as to thoroughly remove all the scale, in the shortest possible time, at the lowest cost of operation, and they require a minimum amount of repairs, reducing both the waste boiler time and labor cost of cleaning.

They are made to operate by either water, air or steam, and electricity. In every case a swing head is furnished so designed that three sets of cutters are thrown out by centrifugal force against the scale in such a manner that they make straight line contact with the tube and they do the work without damage to it.

You can be supplied with LAGONDA tools for cleaning Economizers, Condensers, Evaporators and other tubular plant.

Catalog and full particulars for the asking.

Babcock & Wilcox, Limited

Head Office for Canada; St. Henry, Montreal

Branch Office: Bank of Hamilton Bldg., TORONTO

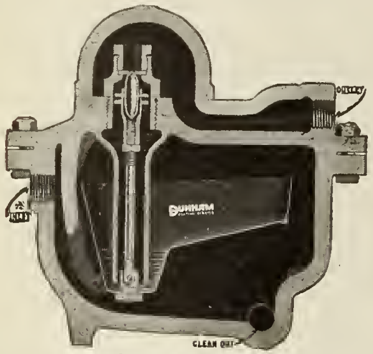
Progress in New Power Equipment

A BUCKET TRAP

The Dunham type No. 80 bucket trap for high pressure service which the C. A. Dunham Co. have recently placed on the market, attracted considerable attention at the C. A. S. E. convention at Toronto. This company specializes in the manufacture of heating and power plant specialties and produces a line of steam traps to meet a wide range of uses.

The manufacturers claim that a new and distinctive feature is incorporated in this new bucket trap—namely a quick, snappy, closing action.

It is quite fully appreciated that bucket traps generally are slow or draggy in their closing action, and this condition causes more or less wire-drawing and cutting of valves and seats, with incidental maintenance expense, and loss of steam.



Dunham Steam Trap.

The Dunham bucket trap operates on the same principle as other bucket traps, but the destructive effect of steam wire drawing the seat is reduced to a minimum, by the quick closing accomplished through the shape of the Dunham bucket. The proportion and shape of the bucket is such that when it begins to rise, all water inside the bucket is shifted towards the hinge, filling the water seal and the movement of the bucket upwards is accelerated, which produces a quick, positive, forceful action and reduces the wear on the valve and seat.

The C. A. Dunham Co., Ltd. have recently issued a new bulletin on this line, completely describing the product. Every steam plant engineer can procure a copy of it by writing the manufacturers.

NEW TYPE OF FURNACE

The Gates Engineering Co., Ltd., 314 Notre Dame St. West, Montreal, is one of the firms who specialize in boiler setting and furnace building, oven work and power plant brick work.

J. W. Gates has had a wide experience in this field of operation. He has United States and Canadian patents covering furnace linings, non-clinking furnace blocks, arches and jambs, air cooled and water cooled suspension harness for flat arches suitable for burning sawdust, shingle hairs, edgings, tan bark, paper mill refuse, etc.

To burn these waste fuels under boilers efficiently depends upon three conditions—high temperature, correct supply of air, complete mixture of preheated air with fuel gases and taking care of 50 per cent. moisture.

In a new type of furnace installed in a large pulp and paper mill, Mr. Gates claims to have provided a perfect method of feeding the fuel to the grates of the furnace at precisely the rate at which combustion takes place. The furnace, which is fitted with grates at an angle of 54 deg., permits the fuel to flow in a flat stream covering the grates with an even bed. As the fuel is consumed more is supplied by gravity and a bed of unvarying thickness is maintained. The thickness can be changed at will to suit the draft by raising or lowering the fuel louvers. The flat fuel bed of sawdust insures proper draft distribution and greatly increases the rate of combustion. With the furnace just installed the company are developing, it is claimed, 747 h.p. with a water tube boiler containing 5,000 square feet of heating surface.

A set of shaking and dumping grates is fitted to this type of furnace and also a moisture absorbing roof.

A DEEP WELL PUMP

A new type of deep-well pump has been developed by the Worthington Pump & Machinery Corporation, represented in Canada by the Storey Pump & Equipment Co., Excelsior Life Bldg., Toronto, operating on a principle heretofore not used in pumps of this kind. Although the pump is of the rotary class the water is not elevated by means of a conventional type of impeller, but a form of propeller is used similar to that employed for propelling ships.

The most radical departure in this pump, which will interest present and future users of deep well pumps, is shown in Fig.1. This is a section through a well casing and drop pipe. It illustrates one set of discharge vanes, the impeller, the shaft, the shaft coupling, and the bearing.

Fig. 2 shows the general arrangement of this pump as applied to deep wells with a direct connected standard vertical motor drive on the head. As will be noticed with this arrangement there is no conversion from horizontal drive to vertical drive. There are no right angled drives at all. Everything is in a perfectly straight line.

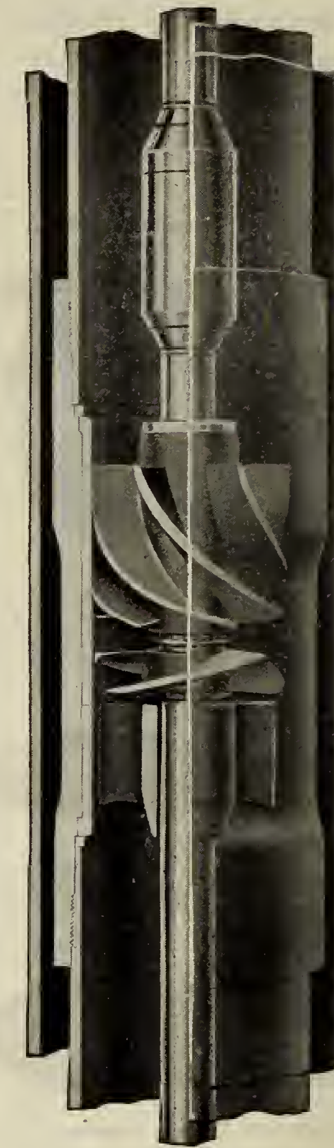


Fig. 1.

In comparatively shallow wells one set of impellers might suffice, but in very deep wells a number of impellers are necessary, these being placed one under the other, thereby making the pump equivalent to a two-stage, three-stage, or other multi-stage pump.

Where it is desired or necessary to operate this pump by means of a horizontal motor, steam engine, internal combustion engine, or by other means through a horizontal drive, a vertical pulley for belt driving may be placed on the head as shown in Fig. 3.

Where water must be elevated to a considerable height above the ground level a centrifugal "booster pump" is added and connected to the pump shaft at the ground level. This combination

Highest Efficiency in 1943

Asbesto-Sponge Felted Insulation

THE FACT that Asbesto-Sponge Felted Insulation is the most efficient insulation on the market to-day is important—but more important is the fact that after twenty years in your plant it will still retain its efficiency.

The construction of Asbesto-Sponge Felted is durable as well as efficient. It will not pulverize under vibration. It will not break or crack under shock. You can hit its laminated structure with a hammer and it will not crack or crumble. It lasts indefinitely—and without deterioration.

Here, then, is an insulation that will appeal to every far-sighted engineer — an insulation with greater ability to save heat, and greater endurance to keep on saving heat. Johns-Manville Asbesto-Sponge Felted Insulation combines maximum efficiency with maximum strength for maximum economy.

Many tests have conclusively proven the laminated construction of Asbesto-Sponge Felted Insulation the most efficient on the market.

You can hit Asbesto-Sponge Felted Insulation with a hammer — one of many tests that prove its durability.

CANADIAN JOHNS-MANVILLE CO. LTD.
Toronto Montreal Winnipeg Vancouver
Ottawa

Covers the Continent
Through
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials

gives one compact unit the same as would be ordinarily obtained by using two different pumps, one for deep well pumping and the other for above surface elevating. Fig. 4 shows this booster pump at the bottom with the discharge pipe emerging at the left. At the top is a standard vertical motor. Midway between the top and bottom is shown the housing for the thrust bearing.

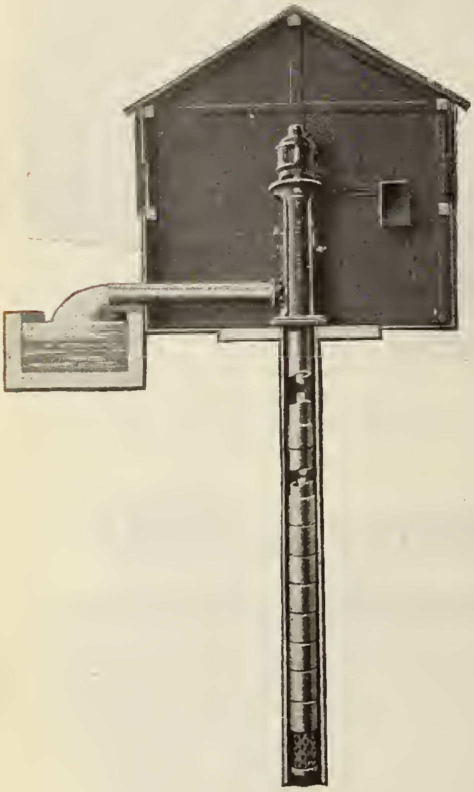


Fig. 2.

The impellers are made of hard bronze capable of withstanding the corrosive action of the usual well water. The number of, and angle of, impeller blades, together with their width and thickness vary with the conditions and are based upon calculations and tests which indicate the proper proportions for capacity and efficiency. The discharge vanes, clearly shown above the impeller in Fig. 1, receive water from the impeller and convert the velocity of flow into pressure and at the same time cause the water to flow upward smoothly along the axis of the pump. These vanes eliminate eddy currents and their accompanying waste. The shaft is of nickel steel and is divided into easily handled lengths, coupled together by long steel coupling insuring good alignment.

If your capacity to acquire has outstripped your capacity to enjoy, you are on the way to the scrap-heap.—Glen Buck.

The weight of the moving parts and the water column thrust are taken up in a specially designed three-plate self-adjusting type bearing. The top or plate thrust rotor is an iron plate which rotates with the shaft. In the center is a babbitt-faced bearing plate, the upper face of which is scraped to a true bearing surface with the top plate. The bottom plate or thrust washer supports the middle plate on a ball-and-socket seat.

The entire bearing runs submerged in oil, and holes through the center plate allow the lubricant to pass to the cavity inside the plates where it is picked up by the top plate and distributed through an oil groove arrangement to the bearing surfaces, between the top and middle plate. The oil bath is waterjacketed, a constant circulation of water being supplied by a small impeller attached to the pump shaft. The piping for water circulation is visible in Fig. 4. The self-aligning feature of this bearing and the fact that it runs submerged in a bath of water-cooled oil materially reduces the attention required by the thrust bearing. In fact, the only requirement here is the periodic filling of the thrust casing with oil.

The smooth operation of the pump, the uniform flow of water and the absence of sudden strains upon the driving parts insure a long life of economical pumping service.

There is no "royal road" to success. There is no way of paying debts, of receiving benefits, of acquiring property, of securing and retaining positions of employment or office, public or private, or obtaining assistants or workmen, skilled or unskilled, except on the basis of reciprocity, of returning fair equivalent to be mutually agreed upon. Every man or nation in order to measure up to obligations must work, and save; must be prudent and fair and economical.—Judge Gary.

AN OIL ENGINE

It is assumed by most engineers that the solid-injection oil engine cannot be successful when built in small sizes, consequently it is seldom that machines of this type are under 10 horsepower.

The Galt Motor Co., Galt, Ontario, has brought out a small engine that disproves this idea. The machine is of the two-stroke-cycle type with a compression pressure of 350 lb. The crankcase is used as the scavenging pump, delivering air at 15 lb. pressure to the working cylinder.

When direct connected to a 2-kw. 110-volt generator, the engine operates satisfactorily over a speed range from 100 to 1,500 r.p.m. At 700 r.p.m., the standard generator speed, the unit delivered 6 kw.-hr. per gal. of fuel oil.

The fuel is injected into the combustion chamber through a single nozzle, the fuel-pump timing being such that injection starts 5 deg. ahead of dead center and at full load the injection ends at 20 deg. past dead center.

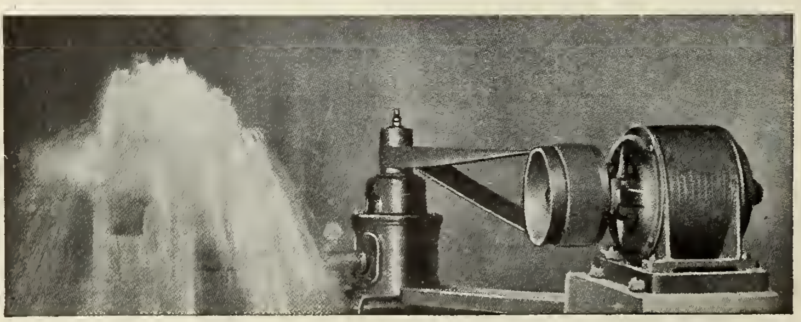


Fig. 3.

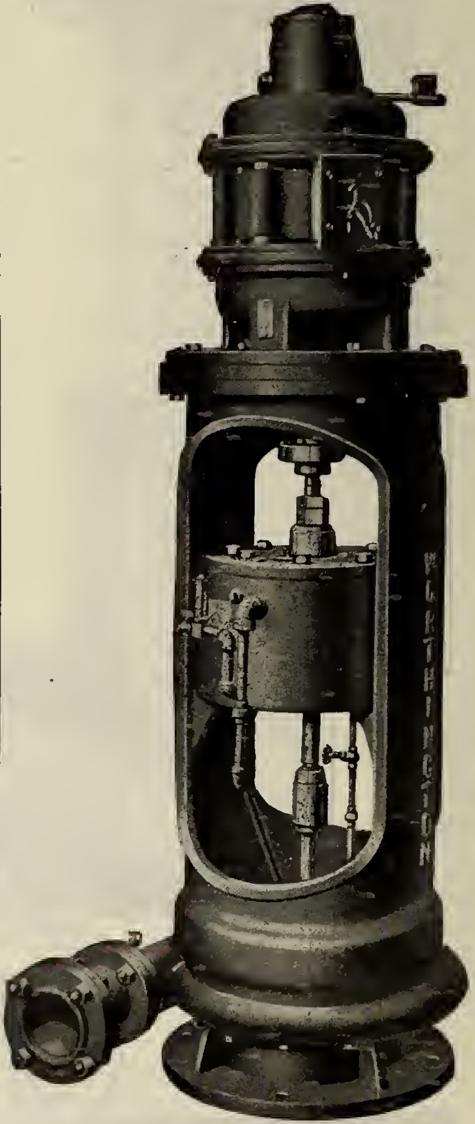


Fig. 4.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES • $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator --Lubrication --PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE, STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanics Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________________
Occupation ____________________
Employed by ____________________
Residence ____________________
Reference ____________________

The reason the champion is always the favorite is because he's better advertised.

POSITIONS WANTED

FACTORY SUPERINTENDENT OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

REFRIGERATING AND MECHANICAL ENgineer with 10 years' operating record, also with experience in heating and lighting work, desires employment in Toronto. Apply Box 108, Power House.

FOR SALE

BOILERS FOR SALE CHEAP—TWO 100 horsepower, 110 pound steam. Apply Box 102 Power House.

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

FOR SALE—ONE 10 H.P. STEAM BOILER with base and 20 ft. smokestack; new flues and in A1 condition; also 1 steam turbine bottle washer and sterilizer; both in excellent working order. Apply Box, 103 Power House.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

TAYLOR SAFE FOR SALE

Inside dimensions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110, Power House.

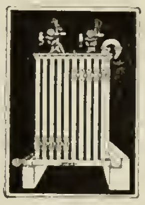
WELDING

ELECTRIC AND ACETYLENE WELDING—of broken castings and machine parts, boilers, tanks, and marine repairs. Carter Welding Co., Ltd., 165 Adelaide West, Toronto. Adelaide 2841.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer
Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W



Cut Your Fuel Bill

A saving of from 10% to 20% in coal bills is but one of the advantages of a Sturtevant Fuel Economizer. Ask for a copy of Folder 609 which outlines others.

B. F. Sturtevant Co.
of Canada, Ltd.
Montreal Galt Toronto

See
Buyers' Guide
Pages
58, 60, 62

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is **economical.** British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

Canadian Exhibition Train for France

Arrangements Now Completed—Formal Opening Fixed for July 15 at Le Havre—French Government Has Constructed Thirty Special Motor Trucks—Two Months to be Spent in Paris

ARRANGEMENTS with regard to the various exhibits of Canadian manufacturers and producers, which will compose the Canadian Exhibition Train for France, are now completed and the formal opening is fixed for July 15,, at Le Havre.

The French exhibition train in Canada was of the usual railroad type, but owing to the unsuitability of French railway trains and stations the French government have had constructed forty large motor trucks, thirty of which will contain exhibition cases approximately 19 ft. 6 in. by 6 ft. 6 in. by 6 ft. 6 in. These cases will be decorated as first-class modern show windows, and the manufactured products and produce of Canadian farms, mines, fisheries, forests, and factories will be attractively arranged within. Ten motor trucks will accompany the convoy to carry all necessary equipment in the matter of lighting, extra supplies, printed matter and baggage.

At each point in the itinerary the thirty exhibition trucks will be drawn up in a double line from twenty to thirty feet apart. The inner sides of the motor trucks will open outwards. The upper leaf will be raised to extend outward as a partial shelter; the lower leaf will be lowered to cover the wheels. The upper leafs will be joined by a vellum covering so that a covered passage-way will protect visitors from inclement weather.

Canadian manufacturers and producers who are represented on the train will benefit both by orders which they may book, and by the opportunity afforded them of establishing agencies or appointing representatives throughout France. A further point which may be of even greater advantage to them is the fact that they will be brought into close contact with buyers and will be able to gather information as to their real requirements as regards quality and style of manufactured goods which will enable them to sell successfully in French markets. No samples or goods of any kind are, however, to be supplied from the train, the entire furnishings of which have been admitted into France through courtesy without a tariff charge.

In co-operation with the French Committee the Government have made arrangements to supply representatives with a list of possible clients at every point visited. Provision has been made by the French Government for the transport and lodging while travelling of 40 persons with the convoy.

The Canadian Government are preparing an attractively designed poster, and have made arrangements to have it placarded in the chief towns and cities of France during the tour of the Exhibition train.

At the completion of the tour the motor convoy will proceed to Paris and will be set up close to the Orangerie near the Place de la Concorde. New features will be installed from time to time to keep up the public interest. The exhibition in Paris will continue for two months.

The MacLean Publishing Company's exhibit of which an illustration is given on this page will take up one end of one of the motor trucks. The exhibit is made to imitate a store window and will display copies of the various MacLean Company's publications. Accompanying the exhibit there will be an attendant who will have a bound file of the latest copies. Specially printed cards in French will also be distributed to inquiring individuals. The attendant has also been supplied with a bound and indexed folder which enables him to give full information in regard to every MacLean publication.

A complete list of exhibitors will be published in a future issue.

The MACLEAN PUBLISHING CO. Limited Fondée en 1886
Nos publications comptent 40.000 lecteurs parmi les marchands de gros, les détaillants, les hommes d'affaires, les capitalistes et les industriels, et 500.000 parmi la clientèle la plus riche au Canada. Lisez-les.
NOUS CONNAISSONS LE CANADA. CONSULTEZ-NOUS.
Power House
The Financial Post
Power House
Canadian Shipping and Marine Engineering News
Canadian Machinery
Canadian Foundryman
SI VOUS DESIREZ VENDRE AU CANADA, CONSULTEZ NOUS
SI VOUS DESIREZ VENDRE AU CANADA, CONSULTEZ NOUS
MacLean Publishing Co. Limited
143-153 UNIVERSITY AVENUE. Toronto, Canada
Men's Wear Review
Dry Goods Review
Bookseller and Stationer
Hardware and Metal
Men's Wear Review
Bookseller-Stationer
Canadian Automotive Trade
Hardware Metal
Printer & Publisher
Canadian Grocer
EDDY'S MATCHES
MACLEAN'S
Druggists' Weekly
Nous Connaissons Le Canada. Consultez-Nous.

Photograph of the MacLean Publishing Company's exhibit which occupies part of one of the coaches of the Canadian Exhibition Train which is to tour France. The exhibit shows copies of recent issues of the various papers published by the MacLean Publishing Company, viz.:—

The Financial Post
Canadian Grocer
Hardware and Metal
Dry Goods Review
Men's Wear Review
Bookseller and Stationer
Canadian Machinery
Canadian Foundryman
Druggists' Weekly
Power House
Printer and Publisher
Sanitary Engineer
Canadian Automotive Trade, and
MacLean's Magazine

HINTS TO BUYERS

The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.

CARHARTT

"FIRST IN THE HEARTS OF UNION MEN"

CARHARTTS
TRADE MARK

OVERALLS

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T. J. CUNERTY** *Company*
9 Richmond St E. *Toronto*

AMERICAN
STEAM ASH CONVEYORS

Labor-saving ash-handling equipment of proven economy. Information on request.

Canadian Representatives:
CLEATON CO (Canada) Ltd., Montreal.
GORMANS LIMITED Edmonton. Calgary.
WM A. GOULD Winnipeg.
T. M. GRINDLEY CO., Vancouver.

CONVEYORS CORPORATION OF AMERICA
326 W. MADISON STREET CHICAGO

Bronze to Bronze **DART** At the Joints

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING

Oil Burning Systems Installed

Full line of Power Plant Equipment and Supplies.

LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL.

EDWARD For Exacting Duty

Fitted with EDWARD Protected Seat and Disc.

THE EDWARD VALVE & MFG. CO.

General Office and Works: East Chicago, Indiana.

CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal; Valve Engineering Co., Toronto.

VALVES

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE MEANS ECONOMY

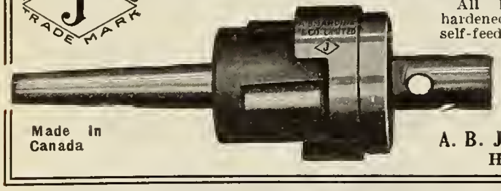
Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.

REGISTERED J TRADE MARK

Jardine's Self-feeding Tube Expanders



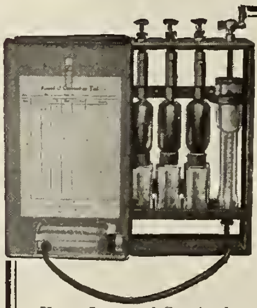
All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co., Ltd.
Hespeler, Ont.

NORTHERN CRANES

NORTHERN CRANE WORKS, LTD.
Walkerville, Ont.



Hays Improved Gas Analyzer.

Hays Improved Gas Analyzer

compact — rugged--accurate, employs the Hays patented steel wool method of breaking up the gas and presenting a large absorption surface—the most accurate and rapid known. CO2 analysis can be made in 30 seconds, complete analysis for CO2 O2 and CO in 4 minutes.

No troublesome pinch clamps and rubber connections, no glass cocks to stick. We use a special needle valve with renewable seat.

Neat leather carrying cases for Consulting and service engineers.

Better send for Literature.

AGENTS: P. A. Goepel, Vancouver, B.C.; Wm. A. Goold, Winnipeg, Man.; H. N. Brown, New Glasgow, N.S.; General Engineering Co., Reg'd., Montreal, Que.; The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos-W-Hays Corporation
Combustion Efficiency Appliances
1034 E. Eighth St. MICHIGAN CITY, INDIANA

BOICO BOILER COMPOUND Gets the Results!

Anti-Clinker Shell Bar Grates—Maximum air space ensures the last bit of heat from the last bit of fuel.

One-Piece Jointless Furnace Lining—Line your furnace with PLIBRICO. More efficient, less costly, lasts longer, easier to instal.

Tip-It Patent Welding Process. Gives you tools with shanks of carbon and tips of high-speed steel.

SHELL-BAR BOICO SUPPLY, Limited
1-15 Saunders Ave., Toronto.

SALES AGENTS: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot, Reg'd., Quebec; Adam Davis, Cobalt, Ont.

SUPERHEATERS ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

Power House

Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

$2.00 PER YEAR — Every Power Plant employee should read Power House

The De Laval Transformer Oil Purifier

Provides a positive and economical means of keeping transformer oil, switch oil and that used for similar purposes free from moisture and sludge. It does its work entirely by centrifugal force, which eliminates the need for filter media. It is positive in operation, so that under all ordinary conditions but one passage through the centrifugal is required to raise the dielectric strength of the oil to 22 kv. or better when tested with the new-style gap.

WRITE FOR BULLETIN No. 105.

The De Laval Company, Ltd.
PETERBOROUGH, ONT.
Montreal Winnipeg Edmonton Vancouver

Automatic Valved Soot Blowers

Diamond "VALV-IN-HEAD"

As with previous mechanical soot blowers, the use of the Diamond "Valv-in-Head" effects a saving of 4 to 8 per cent. fuel and increases overall boiler efficiency.

As compared to previous mechanical soot blowers the Diamond "Valv-in-Head" also possesses the following distinct advantages:

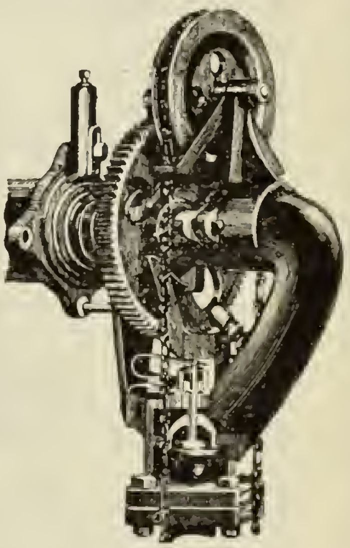
1. LABOR FOR OPERATION—A saving of approximately 50 per cent.
2. STEAM FOR OPERATION—A saving of 50 to 60 per cent. or more.
3. PIPE, VALVES and FITTINGS—A saving of 50 to 66 per cent. in cost of pipe, valves and fittings.
4. MAINTENANCE—A reduction in annual charges of 25 to 50 per cent. or more. Practically complete elimination of condensate obtained.
5. EFFICIENCY—Greater cleanliness of boiler assured.

One of the most interesting publications in the power plant field is yours for the asking. It describes the savings effected by Diamond "Valv-in-Head" soot blowers in detail.

Ask for your copy of Bulletin 287.

DIAMOND SPECIALTY, LTD.
WINDSOR, ONTARIO

Diamond
Soot Blowers - Save 4 to 8% Fuel



United Illuminating Co. Bridgeport, Uses Diamond "VALV-IN-HEAD"

GATES ENGINEERING CO., LIMITED

314 Notre Dame St. West, MONTREAL **'Phone Main 662**

Products:

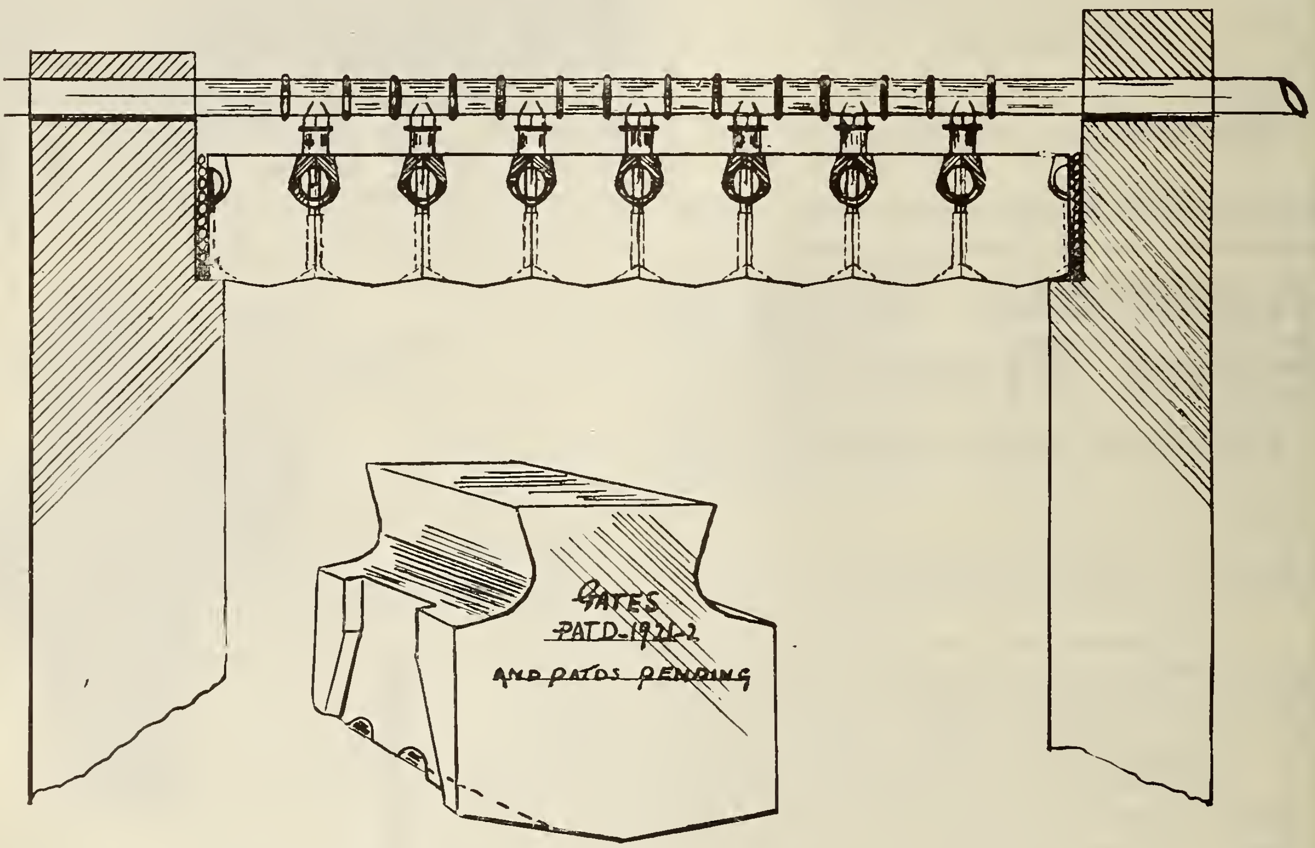
Air-Cooled Refractories
Air-Cooled Suspended Arch

We specialize in Boiler Settings and Furnace Design. Our Engineering Dept. has made a study of Combustion and are in a position to study your requirements, both from an economical and an efficient standpoint, thus enabling you to secure the right setting and furnace design.

Nothing Too Small **Nothing Too Large**

To Economize, call—

GATES ENGINEERING CO., LIMITED



The above cut shows the Gates Patent Air Cooled Suspended Arch. The face of each block is cooled by a current of air passing through slots and distributed over the face of the block thus keeping the refractory below its softening point. Air is also circulated through the harness which consists of 3″ extra heavy pipe, this air being discharged over the fuel bed in the distillation zone at a suitable pressure, velocity, temperature, and volume, thereby aiding combustion, and lengthening the life of the refractory. The construction of the arch is very simple, each block is designed to fit to the pipe and is held in position by retaining wedges, each block is supported independently, allowing any one block to be removed without disturbing any other portion of the arch.

Gates Engineering Co., Limited

Boiler Furnace Refractories

We beg to announce to our customers and others whom it
may concern that

We have purchased from

Gates Refractories, Limited

All their Patents

Covering New and Useful Improvements for Use in

Boiler Settings and Linings

Flat Suspended Arches

Door Arches and Jambs

Under these patents we control the right to sell and install the "Gates Patented" Boiler Arches and Furnace Linings, and these cannot be furnished by any other contractor or supplier without infringing on our patents and patent rights.

GATES ENGINEERING CO., LIMITED

314 Notre Dame St., West, MONTREAL :: :: Phone Main 662

When Does a Paper Really "Reach" You?

1.

Advertisers of the present day are continually having impressed upon them the large number of readers "reached" by this or that medium.

Altogether too much stress is laid upon the number reached; insufficient importance is attached to the manner of reaching them.

As you pass along the street a handbill is thrust upon you. You take it, glance at it, and in all probability immediately throw it away. That advertisement has undoubtedly reached you, but has it reached you in the manner in which you would like your own advertisement to reach the customers you are aiming to get?

It is this question of how people are reached that is really the important one for the advertiser to consider. It is useless "reaching" a large number if you reach them at an unsuitable time and under conditions in which your advertisement will have no effect; everything depends upon the nature of the contact. If this were not so you might as well save the expense of sending out salesmen and send out messenger boys instead. They would "reach" your clients. But you send out a salesman because a salesman is something more than mere flesh and blood. He can do your work more effectively than the messenger boy.

In the same way a publication is more than mere paper and ink. If it is the right kind of publication it is just as far ahead of the handbill or other unsuitable medium for carrying your message as the salesman is ahead of the messenger boy. It will do your work far more effectively.

This is the first of three talks designed to show you how you can satisfy yourself that the medium you choose can not only reach, but reach effectively, and under the most favorable conditions, the man whom you wish to secure as a client.

Look out for No. 2 in our next issue.

The MacLean Publishing Co.

143-153 University Avenue, Toronto

Publishers of:

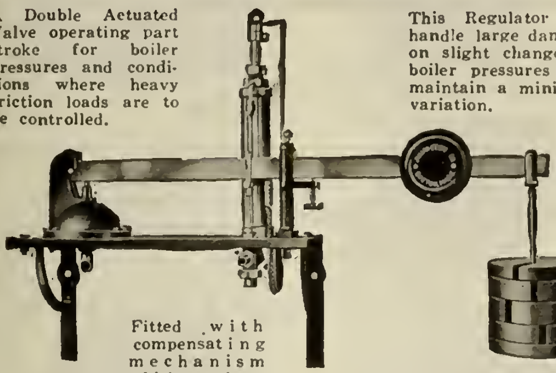
The Financial Post
Canadian Grocer
Hardware and Metal
Dry Goods Review
Men's Wear Review
Bookseller and Stationer
Canadian Machinery
Canadian Foundryman
Druggists' Weekly
Power House
Canadian Shipping
Printer and Publisher
Sanitary Engineer
Canadian Automotive Trade

D'ESTE

Hydraulic Damper Regulator

A Double Actuated Valve operating part stroke for boiler pressures and conditions where heavy friction loads are to be controlled.

This Regulator will handle large dampers on slight changes in boiler pressures and maintain a minimum variation.



Fitted with compensating mechanism which regulates opening and closing.

Our Catalogue No. 50 of CURTIS ENGINEERING SPECIALTIES sent on application.

Julian d'Este Company
Main Office: 26 Canal St., Boston 14, Mass.

"SAFETY"

Plastic Metallic Packing

For steam, water, air, gas, etc., is practically indestructible and may be used over and over again. It is

Packing in Cotton Tubes.

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL

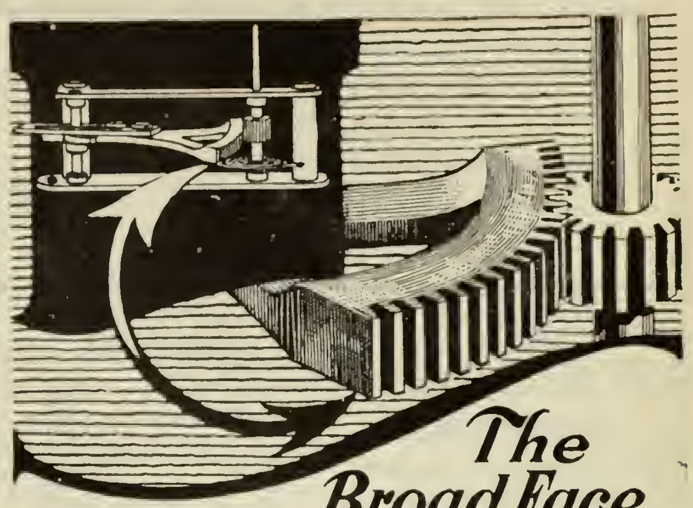
Packing in Bulk.

It is made of an alloy of the finest anti-friction metals, just hard enough for long service but not hard enough to damage any rod.

The metal is combined with the best lubricating material, making it practically SELF-LUBRICATING AND FRICTIONLESS.

Send for full particulars also about our "Safety" Superheat Sheet Packing.

STEEL MILL PACKING Company
Windsor *EST. 1899* Ontario
AGENTS WANTED.



The Broad Face gives ENDURANCE

Gears that do heavy work must be broad-faced in order to stand the wear-and-tear.

Note the unusually broad face of the segment illustrated above, and the corresponding broad face of the pinion. The wide working surfaces of these two units reduce wear on the teeth to a minimum in

S&B American

GAUGES

The segment itself is made of specially hard cast bronze, while the shafts and bushings of both segment and pinion are made of the same wear-defying metal. Both segment and pinion shafts also rest in phosphor bronze bushings to further reduce wear.

All the way through, these gauges are built to withstand the most exacting service.

The ability of an S & B American Gauge to resist wear means not only long life—it means that, between segment and pinion, there is a minimum of "play" or "lost motion," which is another way of saying that these accurately constructed gauges RETAIN THEIR ACCURACY long after ordinary gauges are worn out.

Another thing that insures ACCURACY is that each dial is hand-calibrated—each one designed particularly for the gauge on which it is applied.

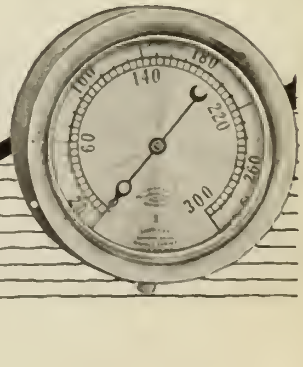
For dependability and economy S & B American Gauges are in a class by themselves.

Our Gauge Catalog A-33 tells the story in convincing detail. May we send you a copy?

The Schaeffer & Budenberg Mfg. Co.
and
American Steam Gauge & Valve Mfg. Co. Division
BROOKLYN, N. Y.

Canadian Agency

The Canadian Fairbanks-Morse Co., Limited
MONTREAL TORONTO



Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co., Limited, Montreal.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

ASBESTOS SPECIALTIES
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited. Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co., (Inc,) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co, Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

A COMPLETE SERVICE IN

"John Crane"

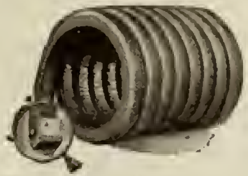
FLEXIBLE METALLIC PACKING

"MADE IN CANADA"

Style 100: Babbitt foil, impregnated with purest graphite and wrapped spirally. Flexible, uniform, compressible.

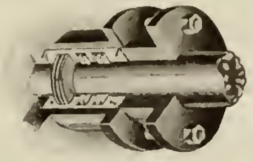
Style 104: Special Ammonia Sets: Alternate rings Styles 100 and 400. Speeds to 450 f.p.m.

Style 601: Condenser tube packing. Patented. Keeps condensers tight. Will not crush or deform tubes.



Style 300: Asbestos channel. Flexible metallic wearing face. For steam, air, gas under high pressures.

Style 400: Duck channel. Flexible metallic wearing face. For plunger pumps, etc., hot and cold water.

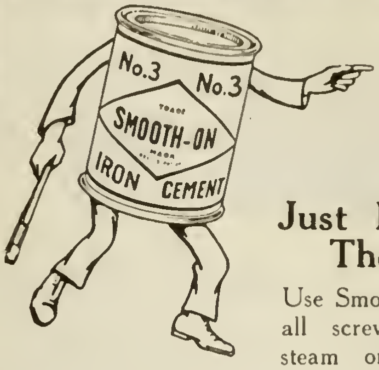


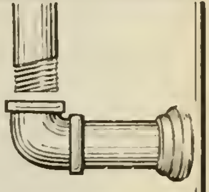
Style 801: Floating type inside split case. For use on rising and falling rods. Max. steam pressure 200 lbs.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA
BELDAM'S ASBESTOS Packing and General Manufacturing Company,
Limited, Toronto and Montreal.
H. E. CARMAN 334 Cordova Street, Vancouver, B. C.

Make tight screw-thread joints with

SMOOTH-ON "No. 3"





Just Paint It On The Threads

Use Smooth-On "No. 3" on all screw-thread joints, on steam or water lines, for ammonia lines, and for lines carrying hot or cold oil. Smooth-On "No. 3" costs slightly more than ordinary joint-making compounds, but the small difference is a cheap premium for insurance against leaky joints during the life of the pipe line!

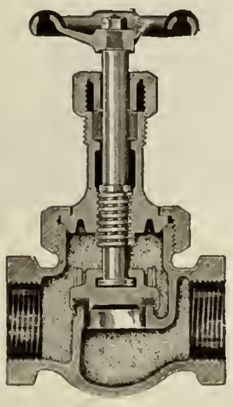
Smooth-On Cement "No. 3" is sold by Supply Houses, ready to use, in 1-lb., 5-lb. and 10-lb. tins.

☛ **Write for Free Sample**

THE CANADIAN ASBESTOS CO.
Dept. 52-G - Montreal, Que.

If your Supply House does not carry Smooth-On Cement "No. 3" send us their name and we shall see that you are supplied.

PRATT & CADY VALVES



It is real economy to install Pratt & Cady Bronze Union Bonnet Renewable Disc globe and angle valves. It is so easy to replace parts subject to wear that you are sure to take advantage of this feature.

P. & C. Folder No. 2 describes this valve in detail. May we send you a copy?

Reading Steel Casting Co., Inc.
Pratt & Cady Division
General Sales Office: Bridgeport, Conn.

CANADIAN REPRESENTATIVES:--CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.

BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

ELIMINATE LOOSE BRICK and FALLEN ARCHES

by using BETSON PLASTIC FIRE BRICK for repairs and for building complete, seamless, monolithic furnace linings, including front and rear arches, side walls, bridge walls and baffles.
No more fallen arches—no more in-leakage of cold air. But more power with less expense.
Shipped either mixed ready for use or dry to mix with water (the cost is the same) from warehouse stock in principal cities.

Write for valuable booklet.

Betson Plastic Fire Brick Co. Inc.
P. O. Box 386-6, ROME, N.Y.
Canadian Distributors:
INTERNATIONAL CHEMICAL CO.,
26-8 Adelaide St. E., Toronto, Ont., Canada.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto. Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F., Toronto and Boaton.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Stephens Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadepbia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa.

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome. N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati. Ohio
Reading Steel Casting Co., Hartford, Conn.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Reading Steel Casting Co., Hartford, Conn.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS, STEAM, WATER)
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati. Ohio.
Lytle Engineering Co., Montreal, Que.
Reliance Gauge Column Co., The, Cleveland, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

Furnace building has kept pace—

WITH greater commercial development came the call for higher boiler ratings. With higher capacities came jointless Plibrico Furnace Lining. Plibrico will withstand the over-ratings of the present day. It is a plastic lining that is pounded into place with a mallet and that, when baked, forms a seamless, rock-like wall that resists temperatures to 3,100 deg. F., that is air and gas tight and that far outlasts fire brick.

Plibrico is delivered only in steel containers of distinctive appearance as shown below.

Warehouses in 52 principal cities. Ask for 50-page booklet, "Modern Furnace Building."

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans. Coleman and Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's Ltd., Calgary, Alta.

PLIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO.
1142 CLAY ST. CHICAGO

SONDERGLASS

"The Unbreakable Boiler Gauge Glass"

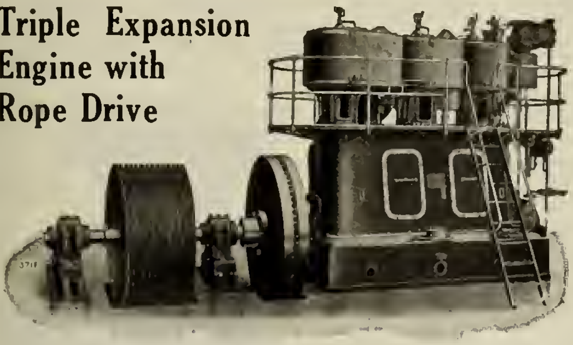
Two Glass Tubes in One

The different metals used allow for expansion and changes of temperature to which the glass is subjected, and add greatly to its pressure-resisting qualities, as each of these metals has different degrees of expansion. The inside of the tube expands in proportion to the temperature of the steam or hot water and the outside according to the temperature of the air.

There are no others "Just as Good"

LYTLE ENGINEERING CO. LIMITED
404-406 St. James Street, Montreal
VALVE ENGINEERING COMPANY
174 King Street West, Toronto

Triple Expansion
Engine with
Rope Drive



Belliss & Morcom Ltd.
Birmingham, England

Builders of:

STEAM ENGINES
AIR COMPRESSORS
STEAM TURBINES
CONDENSERS
CRUDE OIL ENGINES

Packing for Centrifugal Pump Spindles will not cut

Maxim Silencers

for Air Compressor Suction,
Gas Engine Exhausts, etc.

Welldeck Steam Traps

do not get out of order

AGENTS:

LAURIE & LAMB, Board of Trade Bldg., **MONTREAL**

PACKING, AMMONIA, STEAM AND WATER
Beveridge Suppy Co., Montrea.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Jenkins Bros., Limited, Montreal, Que.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.

PAINTS
Shell Bar Bolco Supply Ltd., Toronto, Ont.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Lunkenheimer Co. Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton,

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co. Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton,

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto,
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Canadian Planet Engineering Co., Ltd. Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg, Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co, of Canada, Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)
Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C. A. Dunham, Co.,
Laurie & Lamb, Montreal,

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM TRAPS
Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF
Waterous Engine Works. Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE
Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING
Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal,
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

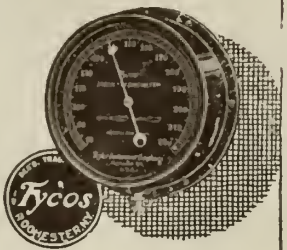
VALVES
Babcock & Wilcox, Ltd., Montreal,
Can. Fairbanks-Morse Co., Montreal.
Edward Valve & Mfg. Co., East Chicago, Ind.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont
Reading Steel Casting Co., Hartford, Conn.
Shell Bar Boico Supply, Ld., Toronto.
Valve Engineering Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa,
Underfeed Stoker Co., Toronto, Ont.

WALKWAYS, (Irving Subway)
Irving Iron Works Co., Long Island City, N. Y.

Tycos and the Economizer

It is as important to know the inlet and outlet water temperature as it is the incoming and outgoing flue gases passing through the economizer. *Tycos* Straight Stem or Angle Thermometers are used at these points unless inaccessible then *Tycos* index thermometers are used to bring the reading right to your instrument board.

Tycos Power Plant Catalog is within your reach—a postal brings it.



Taylor Instrument Companies
Tycos Bldg., 110 Church St., Toronto
There's a *Tycos* or *Taylor* Temperature Instrument for every purpose

870

Boiler Brand

The Simplest and Most Effective
FEED WATER TREATMENT

Silicate of Soda is the base of the majority of Boiler Compounds on the market—often made up under special names.

Boiler Brand is but one of our many grades of Silicate of Soda. It does the work of the most expensive compounds but as the engineer knows just what it is he can adapt it to varying conditions. Why bother with complicated treatments for the removal of boiler scale when the solution is so simple?

"Let a Technical Firm do a Technical Job"

G. F. Sterne & Sons, Limited
Chemical Manufacturers.
Consulting Chemical Engineers.
Brantford Ontario

The ANDERSON Steam Separator

will give you dry steam, under practically any working condition, at very low cost. It is one of the most reliable safeguards against the possibility of breakdowns caused by accumulation of moisture in engine cylinders or turbine casings.

The Anderson is made in both vertical and horizontal styles. Let us send you a catalogue.

THE V. D. ANDERSON CO.
West 96th St., Cleveland, Ohio

Mechanical Draft

Regardless of the size or the requirements of your power plant, Canadian Sirocco equipment of proper design is available. We offer a complete cooperative engineering service as well as the equipment of proven efficiency.

Write for Bulletins

CANADIAN SIROCCO CO., LTD., WINDSOR, ONT.
BRANCH OFFICES IN ALL PRINCIPAL CITIES

(309)

"Sirocco" Products
BLOWERS EXHAUSTERS VENTILATING FANS AIR WASHERS ENGINES
FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

Established 1907

POWER HOUSE

Member A.B.C.

B. G. NEWTON, Manager

CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740. Montreal: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. Winnipeg: 810 Confederation Life Bldg., Tel. Main 3449.

S. S. MOORE, Advertising Manager

UNITED STATES—New York: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. Chicago: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. Boston: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—London: The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.

JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A
Anderson Co., V. D. 63
Armstrong Cork and Insulation Co., Ltd. 12
Audel Co., Theo 49
B
Babcock & Wilcox 45
Betson Plastic Fire Brick Co. 59
Bristol Co., The 15
Buyers' Directory 58, 60, 62
Bawden Machine Co. 17
C
Can. Fairbanks-Morse Co. 6
Canadian Ingersoll-Rand Co.... 13
Can. Johns-Manville Co. 47
Classified Adv. Section 49
Conveyors Corp. of America ... 51
Counerty, T. J. 51
Crane Packing Co. 59
Can. Sirocco Co. 63
Carhartt Co., Hamilton 51
Can. Link-Belt Co. 2
Canada Cement Co., Front Cover
Crane, Ltd. .. Inside Back Cover
D
DeLaval Steam Turbine Co. ... 12
DeLaval Co., Ltd., The 53
Dart Union Co., Ltd., The 52
D'Este Co., Julian 57
Diamond Specialty, Ltd. 53
Durabla Mfg. Co. 6
E
Elk Fire Brick Co. 52
Engineering & Machine Works of Canada 9
Edward Valve Mfg. Co. 52
F
Foxboro Co. 3
Flexible Metallic Packing Co. .. 59
Frick Company 10
G
Garlock Packing Co. 8
Garth Co., The 51
Goldie & McCulloch Co. 20
Greene, Tweed & Co. 5
Gutta Percha & Rubber, Ltd. .. 4
Gates Engineering Co. 54, 55
Green & Sons, Ltd., E. 15
H
Hints to Buyers 50
Hepburn, John T. Co. 19
Hays Co., Jos. W. 52
J
Jardine, A. B. 52
Jenkins Bros. 7
Jointless Firebrick Co. 61
K
Kerr Engine Co. 16
L
Laurie Engine Co. 51
Laurie & Lamb 61
Linde Can. Refrig. Co. 11
Lytle Engineering Co., Ltd. ... 61
M
Mueller Mfg. Co. 18
McLaren, D. K. Co. 14
McGowan Co., John H. 52
Magnolia Metal Co. 64
Moncrieff Ltd., John 49
Morrison Brass Mfg. Co., Jas. Outside Back Cover
N
Northern Crane Works 52
P
Pilley Packing & Flue Brush Mfg. 51
Pratt & Cady Co. 59
R
Railway & Power Engineering Corp., Ltd. 16
Reading Steel Casting Co. 59
Refrigeration Dept. 10
Refinite Co. of Canada 51
S
Schaeffer & Budenberg Mfg. Company 57
Smooth-On Mfg. Co. 59
Superheater Co. 52
Sturtevant & Co., Ltd., B. F. .. 49
Steel Mill Packing Co. 57
Shell Bar Boico Co. 52
Sterne & Sons, G. F. 63
Stephen Chemical Co.. 61
T
Taylor Instrument Co. 63
U
Underfeed Stoker Co. of Canada, The ... ... Inside Front Cover
V
Vilter Mfg. Co. 10
Valve Engineering Co 61
W
Wall, W. J. 49
Waterous Engine Works Co. .. 1
Watson, M. Barry 49
Watson & McDaniel Co. 51
Y
Yarnall-Waring Co. 19
York Mfg. Co. 11

MAGNOLIA

Magnolia Anti-Friction Metal has been proven by U. S. Government tests to improve bearing service, effect saving in metal, power, fuel, lubricants, machinery parts and maintenance attention, and to be decidedly superior for its work. It is easy to handle, is absolutely homogeneous, and comes in convenient forms, for ready use. It will pay you to standardize on Magnolia Anti-Friction Metal. Its users invariably prefer it to lower grades.

Magnolia Metal Company, 113 Bank Street, New York

Chicago San Francisco Montreal

REG. U.S. PAT. OFF.

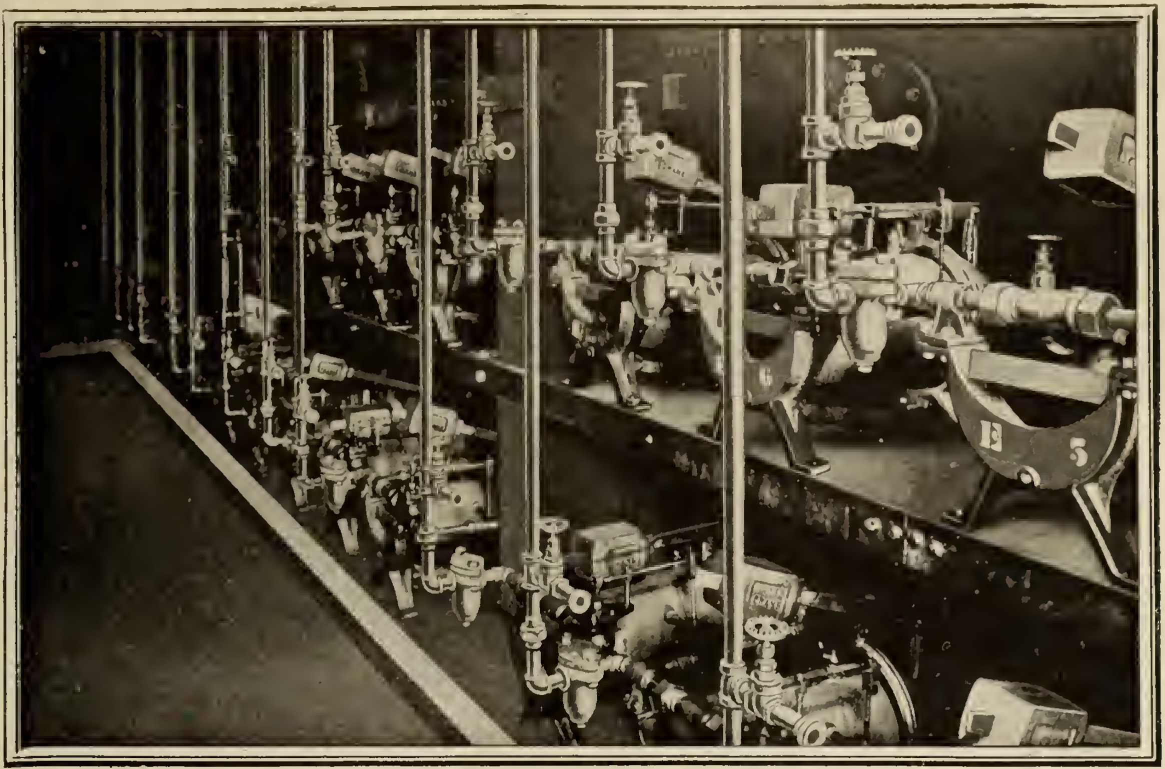
ANTI-FRICTION METAL

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you.

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada



CRANETILT STEAM TRAP INSTALLATION, ACADIA SUGAR REFINERY CO., DARTMOUTH, NOVA SCOTIA

INCREASING STEAM PIPE LINE EFFICIENCY

An increase in the efficiency of a steam heated process system can often be effected through the prompt removal of the condensed steam where it accumulates. The savings made possible by this practice may be lost, however, if the steam traps used do not function properly.

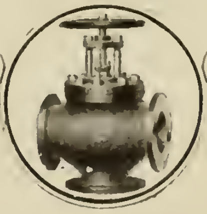
The visible operation of Cranetilt steam traps makes possible inspection at a glance. The positive action of the valves seals the pipe line against loss of steam into the condensation receiver.

Crane service provides thousands of devices and fittings which meet steam, gas, air, oil and water piping requirements of every description.

CRANE

CRANE LIMITED, GENERAL OFFICES: 386 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., HEAD OFFICE: 45-51 LEMAN STREET, LONDON, ENG.

Branches and Sales Offices in 21 Cities in Canada and British Isles
Works: Montreal, Canada, and Ipswich, England



STEAM MORRISON GOODS

For half a century the quality of Morrison's products has been adding to the prestige of the Morrison name, until now the name on a steam specialty is accepted as an absolute guarantee of quality.

Accurate, reliable and unvarying in quality they represent the highest quality and the most modern designs in their line.

"Every Installation is a Demonstration of Merit"

Morrison Injector

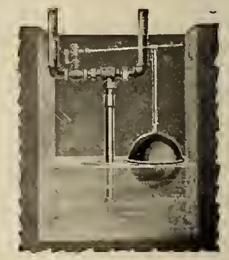
Model "C" Safety Valve.

Gem Ejector

J.M.T. Globe Valve.

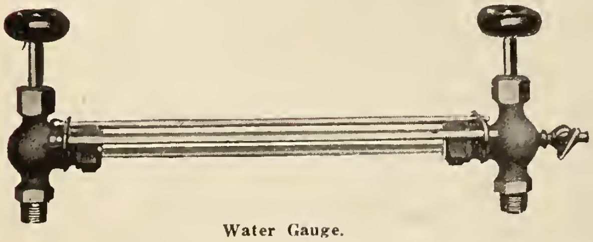
Automatic Damper Regulator for Low Pressure Boilers.

Balanced Valve.



Morrison Automatic Drainer. Operates on Water pressure. Keeps cellars, wheel pits, etc., free from water.

Morrison Pressure Gauge.



Water Gauge.

If you are not getting our Monthly Bulletin let us know and we will put your name on our regular mailing list.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Fostering Economy in the Development of Power for All Industries

Vol XXVI—No. 14.

Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.

July 20, 1923

JENKINS

Extra Heavy Iron Body
Globe and Angle Valves

Maximum strength and rigidity are rigorously preserved throughout in the design and construction of Jenkins Extra Heavy Iron Body Valves. This reserve strength amply meets the strains and stresses due to expansion and contraction of piping or other causes.

These valves are suitable and guaranteed for 250 pounds working steam pressure, or 400 pounds working water pressure—the margin of safety is wide, for each valve before it leaves the factory is tested to 800 pounds hydraulic pressure.

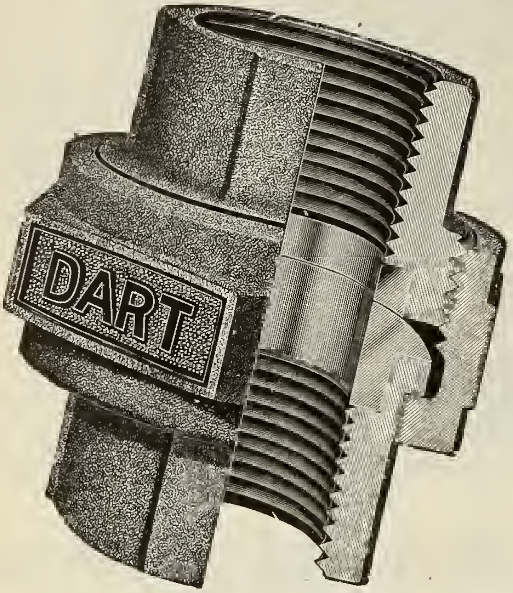
The bodies of these valves are made of high-grade cast iron; the spindles are manganese bronze, having a tensile strength from 50,000 to 60,000 pounds per square inch. Regrinding discs and seat rings made of durable steam metal.

JENKINS BROS. LIMITED
Head Office and Works: 103 St. Remi St., Montreal

SALES OFFICES: Toronto, Vancouver.
European Branch: 6 Great Queen St.,
Kingsway, London, W.C. 2, Eng.
FACTORIES: Montreal, Bridgeport, Elizabeth.

Fig. 163

DART UNIONS



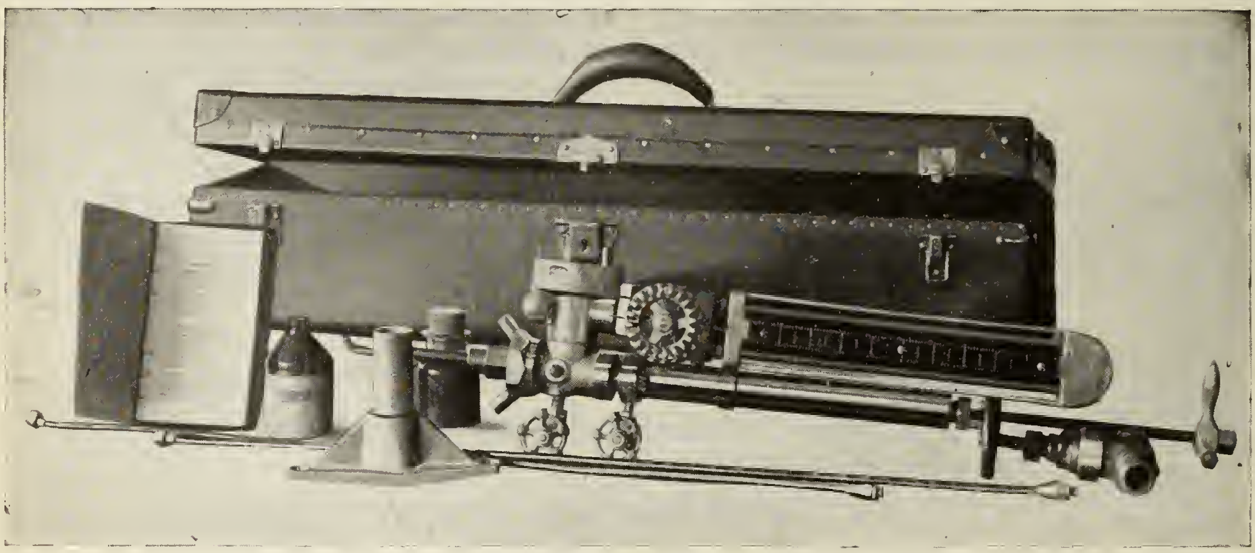
Stay Tight Permanently

No Upkeep Cost
No Replacement Cost
No Loss from Leaks

Because—THEY ARE BRONZE TO BRONZE AT THE JOINT

Your Jobber Sells Them

Manufactured by
DART UNION CO., LIMITED, TORONTO, ONT.



Cory-Royer Flow Indicator
Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

CHAS. CORY & SON INC.

183-7 VARICK STREET - - NEW YORK CITY

VANCOUVER
P. A. Goepel,
525 Pender St. W.

Est. CORY 1845

TORONTO
The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

POWER TRANSMISSION BELTING

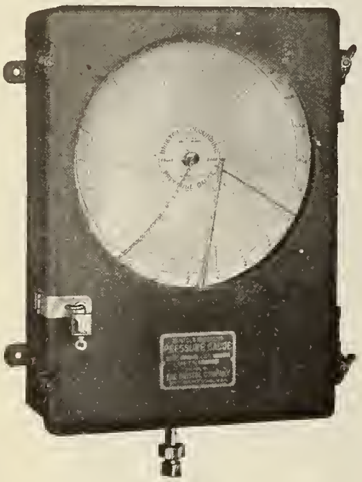
GUTTA PERCHA & RUBBER, LIMITED
TORONTO — CANADA
Sales Offices - - Coast to Coast

MAINTAINED ACCURACY IN SERVICE

Even automatic control should be proved as accurate.

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

RECORDING PRESSURE GAUGES



Are successfully demonstrating their ability in checking up the accuracy of other controlling apparatus, in hundreds of the best operated power plants.

Bristol's Recorders are first aid for the speedy detection of the several sources of heat waste and other preventable operating losses.

The name BRISTOL'S is your protection against inferior quality. Bristol's Recording Instruments are the world's standard.

Our Catalog 1006-A deals with the subject in an interesting way. Write for a copy.

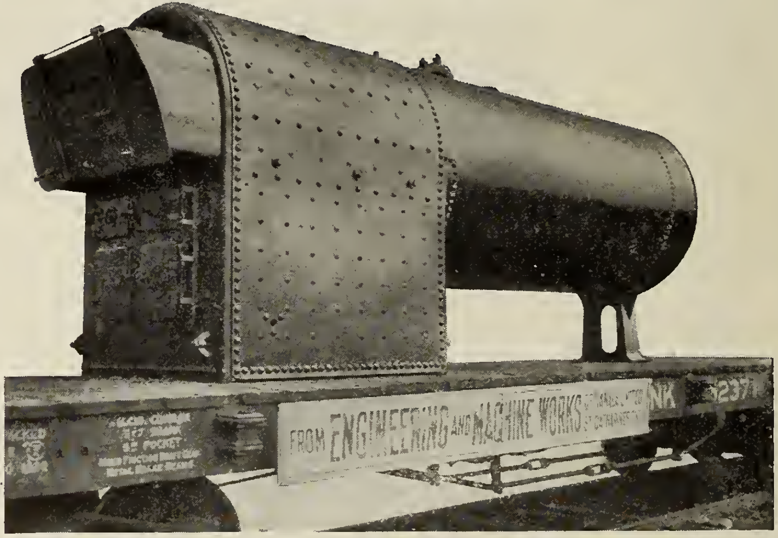
THE BRISTOL COMPANY
Waterbury, Conn.

Canadian Distributors :

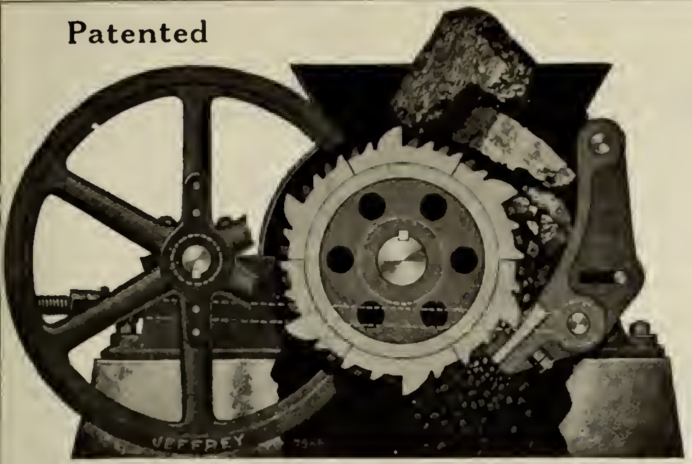
Eastern Territory—Powerlite Devices, Toronto and Montreal.
Western Territory—Gorman's Ltd., Edmonton.

Now for that Heating Boiler

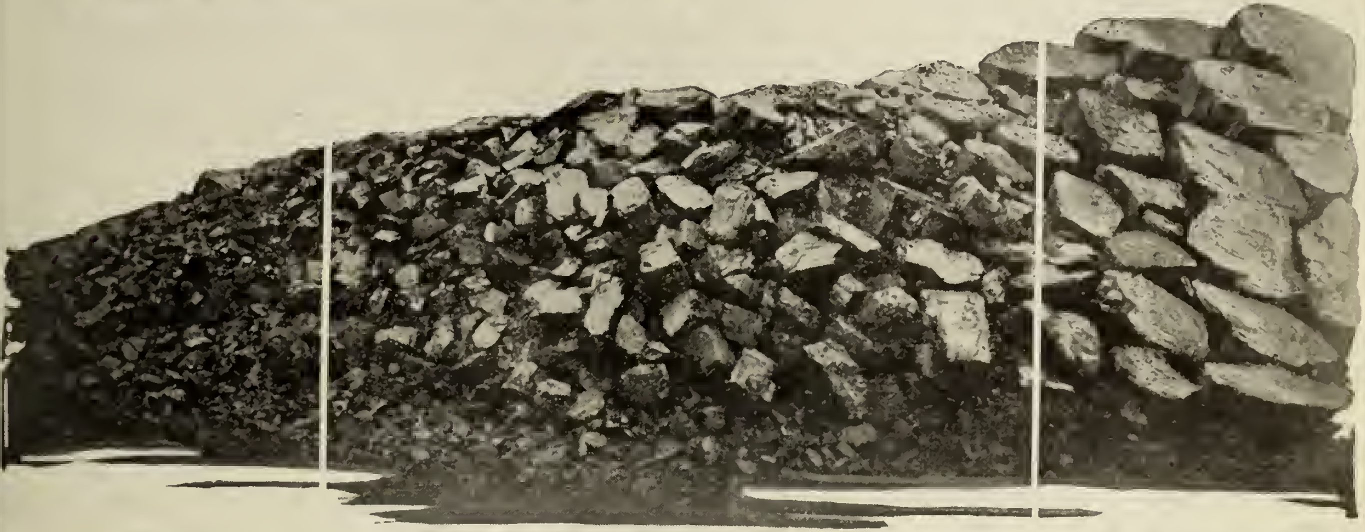
Strange topic for these hot, sizzling July days but—next winter is coming and you don't want last winter's discomfort again, do you? This Keystone Heating Boiler, with smoke consuming device when required, is the last word in efficient, low cost heating. Takes time to build it. Talk to us now.



Engineering and Machine Works of Canada, Limited
ST. CATHARINES, ONT.
Eastern Sales Offices: HALL MACHINERY CO., Sherbrooke, Que. and Birks Bldg., Montreal



A Single Roll Crusher For Any Size Lump



18" x 18" Crusher
8" Maximum Lump
Small Capacities

24" x 24" Crusher
Average Conditions
14" Maximum Lump—50 Tons per Hour

30" x 30"—36" x 36"
36" x 54" Crushers
Big Lumps
Large Capacities

5908

1¼" Product and Under for Automatic Stokers.

11715

6" Product and Under for Hand Firing.

JEFFREY

Single Roll Crushers Are Built In Five Sizes

The 24 in. x 24 in. Crusher meets average requirements, such as Boiler Plants, Producer Gas Plants and Pulverized Coal Plants.

The 30 in. x 30 in., 36 in. x 36 in., and 36 in. x 54 in. sizes take Run-of-Mine coal and have large capacities, being generally used for service at the mine in reducing the entire output of coal to a size suitable for use with mechanical stokers, either in boiler houses or locomotive service.

The Jeffrey Single Roll Crusher

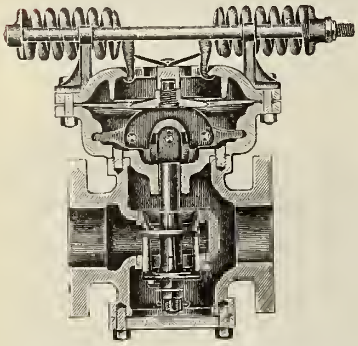
reduces Lump Coal to any desired size in a single operation —is easily adjusted—consumes little power—costs little to install—occupies little space—has rugged design and construction throughout — Efficient Safety Device protects against shocks and accidents.

Write for Catalogue No. 359-O

The Jeffrey Manufacturing Co.

Canadian Branch & Warerooms: Power Bldg., MONTREAL

Foster Class "W" Pressure Regulator



The leader for general service on steam, air (certain conditions), and hot water, where delivery pressure is practically constant. It is standard for working pressures of 125 to 250 lbs.

Made in two weights.

For these Reasons—

1. A compensating spring movement exerting a uniform power on the diaphragm, without regard to the opening of the valve.
2. Renewable Seat Rings.
3. Ample Steam Capacity.
4. Drop forged steel stem, levers, toggle levers (case hardened) insuring durability.
5. No small parts to clog.
6. Ease of adjustment and accessibility for repairs.
7. No friction of parts. No dash-pot required. Noiseless in operation.
8. Small movement of diaphragm insuring long life.
9. Absolutely automatic after adjustment is made.
10. Great simplicity of construction and operation.

For prices and full particulars, write

The Canadian
Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg,
Regina, Calgary, Vancouver, Victoria.

104

Durabla Gaskets Make Tight Joints

Withstanding all Temperatures and Pressures

Wherever a permanent Gasket is required, use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids.

Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla Trade Mark which guarantees strength, and quality.

Made in Canada in Stock Sizes 36" wide x 150" long, in thicknesses of 1/64, 1/32, 1/16, 1/8".

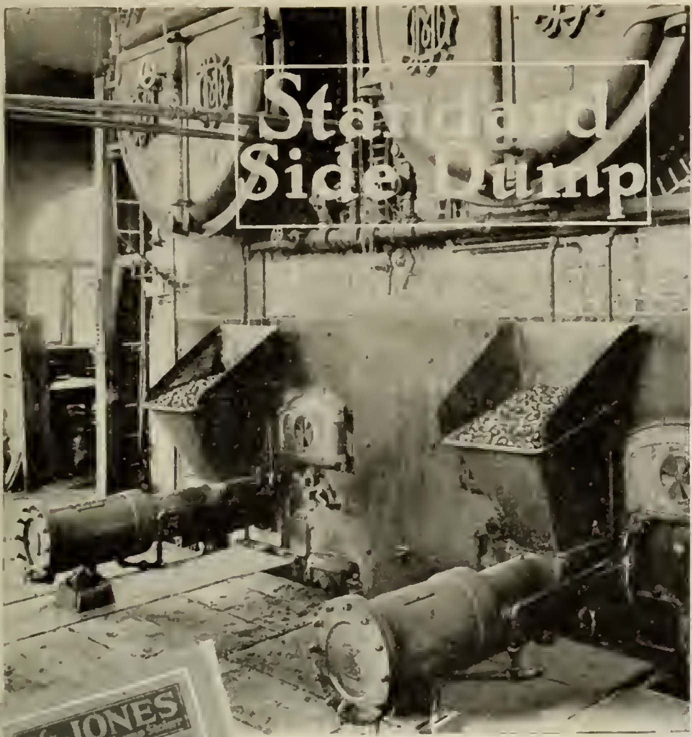
Let us send you a trial shipment

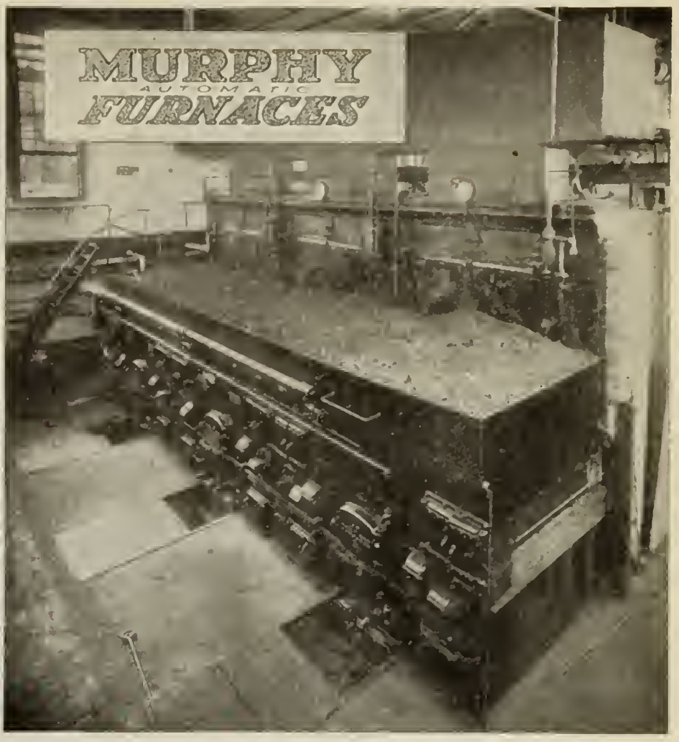
DURABLA
TRADE MARK REGISTERED

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA





For smaller boilers, one of these stokers will meet your requirements

HUNDREDS of small and medium sized boilers in Canada are being fired by hand—are being fired by hand when one of these stokers (the type depends upon conditions) would cut costs and give better service, when one would meet requirements exactly.

Continuously and automatically the "Jones Standard Side Dump" Stoker and the "Murphy" Furnace feed the coal, burn it at maximum efficiency and discharge the ash. Fuel and labor costs are cut. Efficiency and capacity are raised. Smoke and clinker trouble are practically eliminated.

The Jones "Standard Side Dump" is for use with boilers requiring forced draft. It can be installed at moderate cost. Coal is burned by the superior underfeed principle and ash is deposited on side dump plates. Sudden peak loads can be easily met.

The "Murphy" Automatic Furnace is used where lighter, less fluctuating loads are met. It does not require forced draft. It is ideal for a great many smaller boilers where extreme combustion rates are not essential.

Ask for the separate bulletins which describe these stokers. Will you use forced or natural draft?

Branch Offices:

Alta. & West. Sask.:
Mr. J. Twomey,
Camrose, Alberta.

Man. & East. Sask.:
W. W. Hicks & Co.,
Winnipeg.

British Columbia:
E. A. Earle, Ltd.,
Vancouver, B.C.

Quebec: Cleaton Co.,
(Canada), Ltd.,
Montreal, Que.

THE UNDER-FEED STOKER CO. OF CANADA, LTD.
146 King St. West. Toronto, Ont.

RILEY JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

"Murphy" Furnace—for natural draft
"Standard Side Dump"—for forced draft

Do your Temperature Curves run

Zig-zag, like this?

or

Straight, like This?

Although you may **think** you are getting uniform temperatures in important processes involving the use of heat, you would probably be amazed if you could see the wide fluctuations that result from so-called hand "regulation."

The zig-zagging of temperature usually means waste of ingredients, spoiling the finished products, or lowering of quality of the goods, which means undermining your reputation. These conditions are permanently corrected by using the

SARCO

Temperature Regulator

No human hand can begin to compete with the Sarco. Responding instantly to the slightest temperature changes, it automatically admits or shuts off the steam, preventing excessive variations. Once set for a given temperature, **it maintains that temperature.**

The Sarco is entirely self-contained and self-operated. No electricity, compressed air, water or other outside agencies required, consequently it costs nothing to operate.

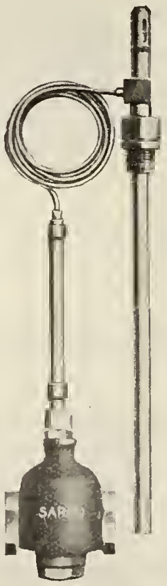
Has no perishable parts. No weights or levers to tamper with and throw it out of calibration. Not affected by temperature of room.

Write for Booklet J-77 and particulars about our free trial offer. You can try it before you buy it.

SARCO CO., Inc.

239 Broadway, New York City

Peacock Brothers, Limited
Montreal



The Brains of a Vacuum Pump

Many installations require constant, unvarying vacuum. Excess vacuum may derange delicate apparatus. Loss or fluctuation of vacuum, even temporarily, may destroy the efficiency of an operation.

FISHER
Vacuum Pump Governor
(Type 8)

furnishes brains to any vacuum pump.

It is a delicately responsive controller, that maintains exactly the vacuum desired—does it automatically, without the slightest regulation.

Thousands of these and other Fisher Power Plant Specialties are in use in Canada. More than forty years of demonstrated excellence recommends any Fisher regulating device to your consideration.

Our catalog contains much information of interest to all engineers. Let us send it to you.

The
Fisher Governor Company
947 Fisher Avenue, Marshalltown. Iowa, U.S.A

EMERGENCY Sluicing With

Sterling

THE ENGINE OF REFINEMENT

EMERGENCY Gasoline Engines

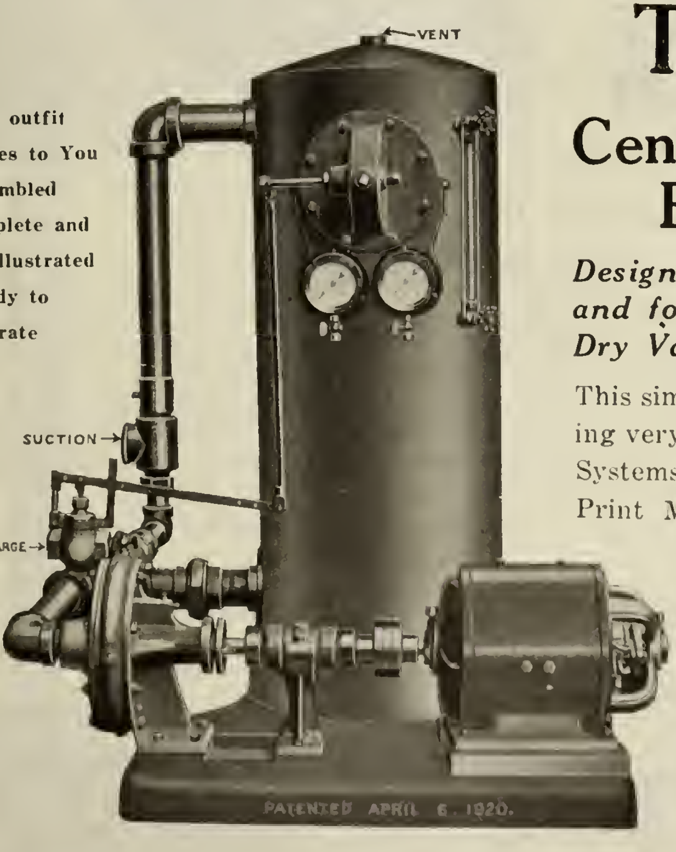
The dam at Traverse City, Michigan, was sluiced by the Winters Contracting Company of Detroit with two Union Centrifugal pumps, pumping 1,000 G.P.M. each against 435 ft. head, using two STERLING six cylinder gasoline engines at 1,400 R.P.M.

Exclusive of banked fires at night, cost of hauling coal 7 miles on clay roads, and salary of fireman, it would have cost $7.48 an hour for coal. STERLINGS did it for $6.69 an hour. Two engines (total) 420 h.p., on 306 h.p. load. Compare their cost at $23.00 a horsepower against the cost of a steam plant, and auxiliaries, and installing. As to dependability, one engine ran 53 days and one 83 averaging about 8 hours a day, and could have continued indefinitely.

STERLINGS can operate your reserve pump and generators. Cost you less initially, less to run, less to maintain, and require little space.

Sterling Engine Co.(Dept. C4)Buffalo, N.Y., U.S.A.

The outfit comes to You assembled complete and as illustrated Ready to Operate



The YOUNG

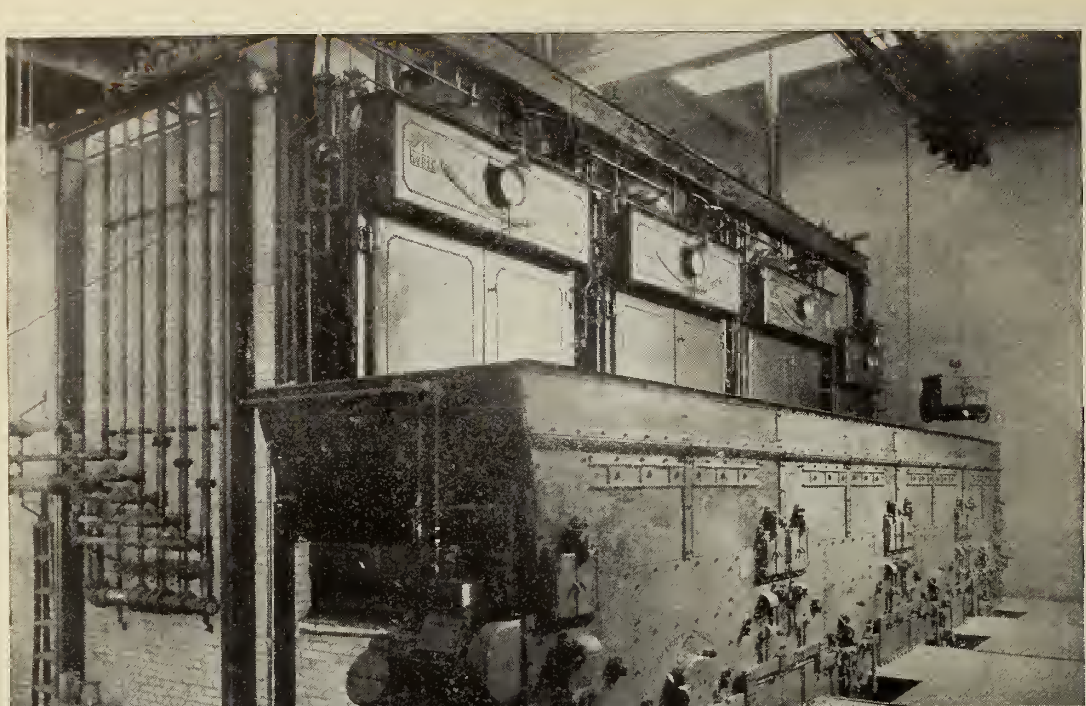
Centrifugal Vacuum and Boiler Feed Outfit

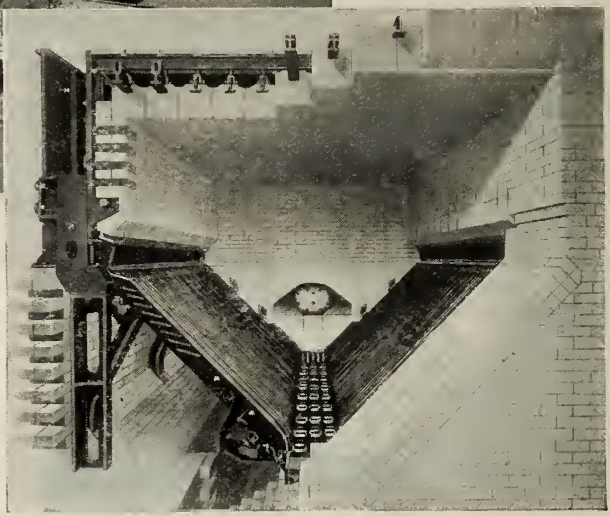
Designed for Vacuum Heating Systems and for All Conditions Where a Wet or Dry Vacuum is Desired—Highly Efficient

This simple, inexpensive and noiseless outfit is giving very satisfactory results with Vacuum Heating Systems, Dry Kilns, Paper Driers, Feed Driers, Print Mills, Cooking Apparatus, Vacuum Pans, etc., for the purpose of effecting a saving by returning the condensate for boiler feed.

Manufactured in Canada by

Young Pump Co. of Canada
96 Mary Street
HAMILTON, ONT.





DETROIT NATURAL DRAFT STOKERS INSURE CHEAPER STEAM

You Reduce the Cost of Producing Power When You Install Detroit V-Type Stokers

Coal consumption is reduced 15 or 20 per cent, because it is possible to maintain overall boiler efficiencies of 70 to 75 per cent with Detroit Stokers, whereas good hand-firing practice shows 55 to 60 per cent boiler efficiency.

You save labor if you have several boilers, because one man can attend to them all.

You can burn lower grades of fuel with Detroit Stokers than can be burned successfully by hand-firing. This may enable you to save as much as a dollar a ton on your coal.

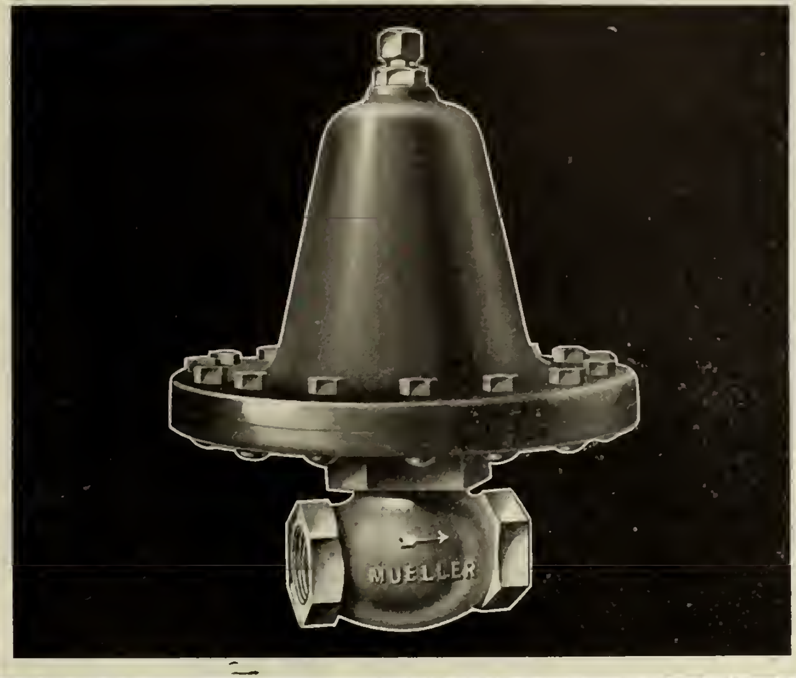
Detroit V-Type Stokers may be profitably installed in both tubular and water tube boilers. You can readily install them in connection with old boilers with little alteration.

Remember there is a complete line of Detroit Stokers—V-Type Overfeed for natural draft,—Single Retort Underfeed for forced draft with boilers up to 250 H. P.—Multiple Retort Underfeed for large boilers.

Ask for Bulletin 338

DETROIT STOKER COMPANY
Underfeed Forced Draft and Overfeed Natural Draft Stokers
338 GENERAL MOTORS BUILDING DETROIT, MICHIGAN

SAVE FUEL "V" AND LABOR
DETROIT TYPE STOKER



Make Canada Prosperous by Buying Canadian Products

What Is It Worth

to be free from the danger of explosion through built-up pressure? To know that the safety of life and property is assured?

The A-5060 Mueller Relief Valve

will, at slight expense, give you this freedom, this assurance. Highly sensitive—quick and positive in action—thoroughly dependable—easily adjusted—this Mueller Relief Valve should be on your system now!

State kind of service, size of pipe, and pressure at which valve is required to relieve, when ordering.

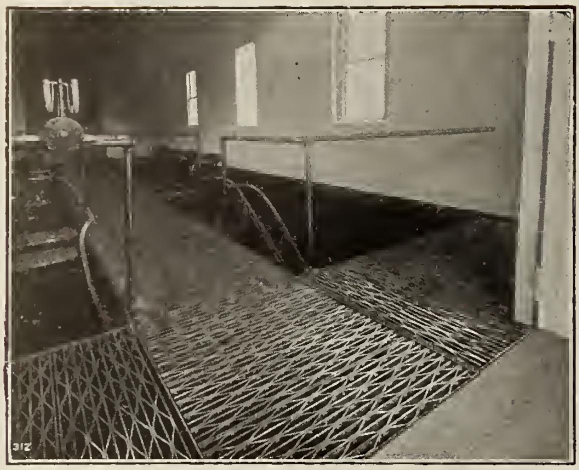
H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Illinois, U. S. A. **Branches, New York and San Francisco**

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod; Brass and Copper Tubing; Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

IRVING SUBWAY TRADE MARK (PATENTED) THE FIREPROOF VENTILATING FLOORING



IRVING SUBWAY TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

Men who walk and work on a floor of Irving Subway, walk and work in comfort and safety. Their minds are on their jobs—not on their feet. With a feeling of under-foot security, they work better—which means higher plant efficiency. When you floor your plant with Irving Subway, you're adding another big factor which makes for lower costs and increased production and higher economy. And—you pay for it only once. Let us send Catalog 3A50.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Canadian Agents:
Montreal, P.Q., 304 Coristine Bldg. (St. Laurent).
Winnipeg, Man., 141 Bannatyne Ave.
Welland, Ont., Standard Steel Cons. Co.

Manufacturers of

IRVING SAFSTEP TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS

Bearing Metal plus Service

Ordinary bearing metals may look quite similar to Magnolia Metal, weigh the same, and cost even a trifle less. But when you buy Magnolia Metal, you get the assurance of long and efficient service as well as just so much metal. U. S. and other government tests have proven Magnolia Metal to have the lowest frictional coefficient of any known bearing metal and to have every other requirement for its purpose besides. Magnolia Metal melts and pours well, is easily peened and scraped in, and is always uniform in composition. It is perfectly adapted to a wide range of speeds and pressures, quickly adapts itself to inequalities in the shaft and embeds the grit that might score the shaft or increase friction. Try Magnolia Metal on one of your bearings and test its superiority to your own satisfaction.

19

Magnolia Metal Company
113 Bank Street, New York

Chicago Fisher Building | San Francisco 358-360 Bryant St. | Montreal 37 Shannon St.

MAGNOLIA ANTI-FRICTION METAL
TRADE MARK

The Simplest and Most Reliable of Feed Water Regulators

Just a straight expansion tube, connected to a balanced control valve—that is all there is to it. No springs or diaphragms; no pilot valves or needle valves; no floats or displacement bodies. The Copes is reliable, because it is mechanically right.

What it does—The Copes saves from 2% to 8% in fuel costs; it increases boiler efficiency, by momentarily cutting down the feed rate when there's a sudden increase in load, and by temporarily increasing feed water input when the load suddenly drops.

The Copes is used by nearly all of the large central stations; and a large majority of industrial plants. It is giving satisfactory service in every industry, and on every make and type of boiler.

The facts given here are merely an outline. Let us send you our latest bulletin. Drop us a line for Catalog "D."

Northern Equipment Co., 112 West 11th St., Erie, Pa.
Branch Plants: Canada; England; France; Germany; Austria; Italy.

SYSTEM OF BOILER FEED CONTROL

DO YOU RECOGNIZE THEM?

Brown Company
La Tuque, P.Q.

Wilputte Coke Oven Corp.
Hamilton, Ontario, Canada

Granby Consolidated Mining, Smelting and Power Co.
Vancouver, B.C., Canada

Beaver Wood Fibre Co.
Montreal, Canada

Canadian National Railways
Moncton, Canada

Spanish River Pulp & Paper
Espanola, Ontario, Canada

Imperial Oil Company

Of Course You Do

This represents a few of the prominent Canadian power plants equipped by Combustion Engineering Corporation, Ltd.

We manufacture and supply

Type "E" Stokers
Self-contained Stokers
Detrick Flat Arches
Uehling Recording Instruments
Combusco Ash Conveyors
New Frederick Stokers
Type "K" Stokers
Lopulco Pulverized Fuel Systems
Quinn Oil Burning Equipment
Custodis Radial Brick Chimneys
Economisers and Air Heaters
Green Stokers

Everything in the boiler room except the boilers

COMBUSTION ENGINEERING CORPORATION

LIMITED

A. J. T. TAYLOR
President

JOHN T. FARMER
Chief Engineer

MAIN OFFICE : TORONTO

VANCOUVER MONTREAL WINNIPEG

Why Individual Boiler Feed Water Treatment

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

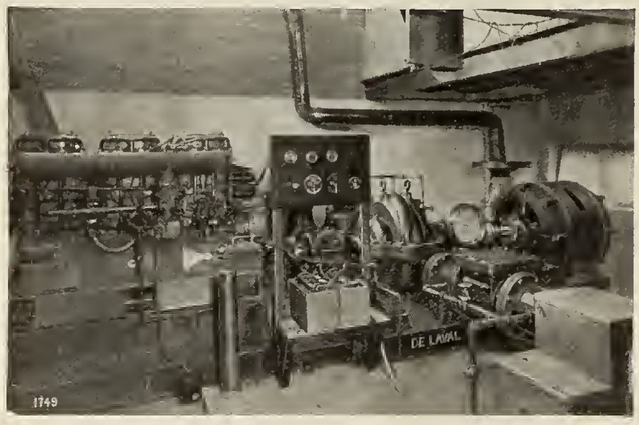
Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)

Distributors : William C. Wilson & Co., 21 Camden Street, Toronto

Phone Adel. 1054 or write for full particulars.

De Laval Centrifugal Pump at Burlington, Ont.



FOR domestic service the pump is driven at 1160 r.p.m. by the 100 h.p. induction motor, which is supplied inexpensively with current from a hydro-electric power transmission line. Its capacity is then 900 gal. per min. against 260 ft. head.

For fire service the pump is driven at 1400 r.p.m. by the 200 h.p. gasoline engine. It will then deliver 1200 gal. per min. against 350 ft. head. For starting the gasoline engine, a storage battery with starting outfit is installed.

Our Engineering Department will give you full and unbiased advice concerning the best type of pumping equipment to suit your individual conditions.

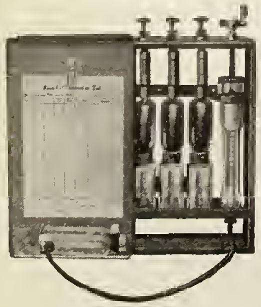
Ask for Catalog B-100

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

244



Hays Improved Gas Analyzer.

Are You Wasting Fuel?

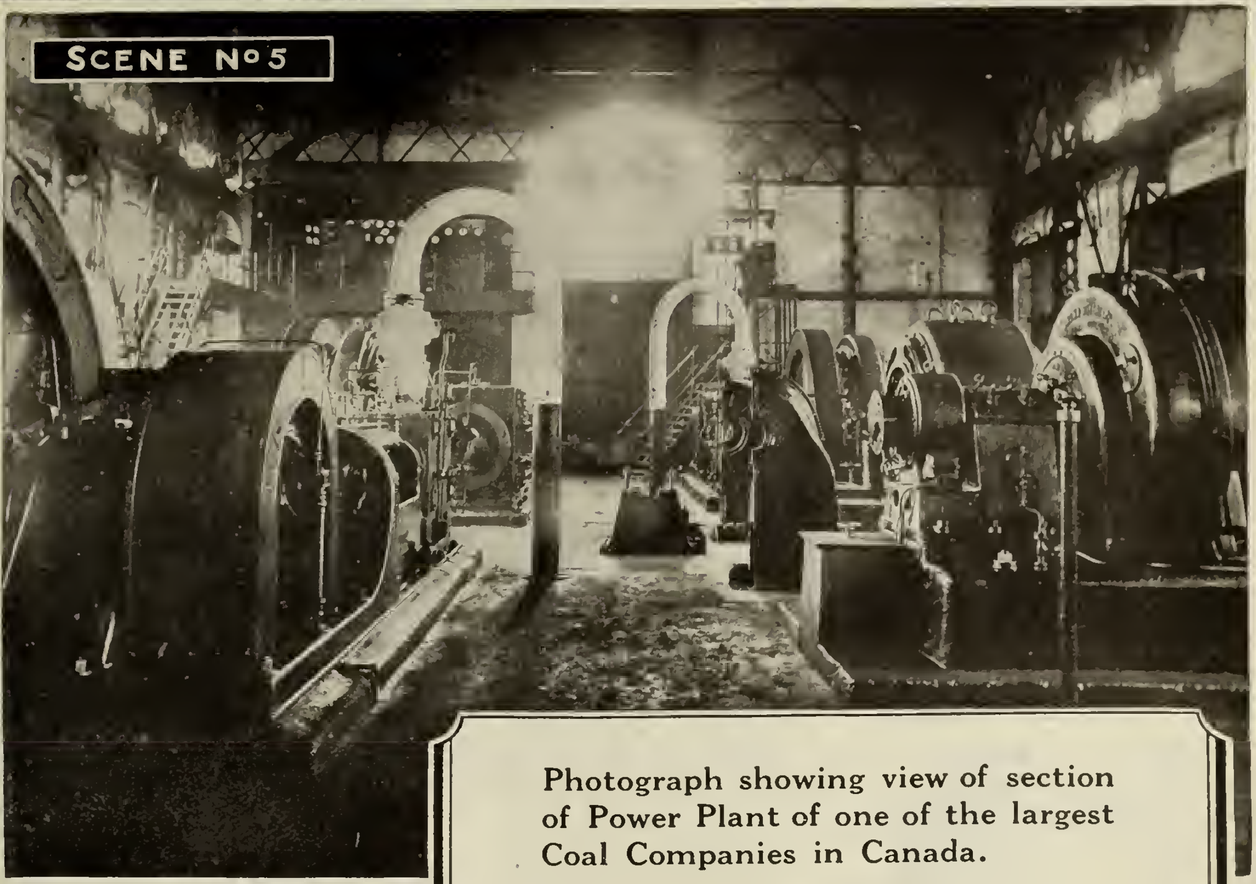
Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO_2, O_2 and CO; 1-chamber Analyzer for CO_2 only. Stocked by Canadian Agents listed below.

HAYS DRAFT GAGES, "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts and Draft Regulation."

P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos-W-Hays Corporation
Combustion Efficiency Appliances
Michigan Citp, Indiana

General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.



Photograph showing view of section of Power Plant of one of the largest Coal Companies in Canada.

All lubricants in use in this plant are supplied by Imperial Oil Limited.

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

Imperial Lubricants are speeding up production and cutting down operating costs in practically every line of Canadian industry. Engineers all over the country specify these oils for the most exacting lubrication jobs because they know their long-time record for satisfaction and dependability.

There's an Imperial Lubricant suitable for every plant requirement. The service of an expert lubrication engineer is available on request at our nearest branch.

IMPERIAL OIL LIMITED

The Trade and Technical Paper Divisions of the Canadian National Newspapers and Periodicals Association will hereafter be known as the

BUSINESS NEWSPAPERS ASSOCIATION
OF CANADA

MANY Canadian business papers have been among the finest and most respected of their kind in the world; but this association has been formed to establish and maintain for *Canadian business papers generally*, standards which to readers and advertisers will be a guarantee of the high quality and merits of its publication members.

As its "Standards of Practice," the Business Newspapers Association has adopted a set of working principles unsurpassed in any field of advertising or publishing. Only such papers that can live up to these standards are accepted to membership.

Not only does the Business Newspapers Association of Canada stand for honest, proven circulation methods and claims, demanding that all its members' circulations be audited by the Audit Bureau of Circulations; but also for (what is not less important) high editorial principles, fair competition, reputable advertising, and a general publishing policy which seeks to give the greatest possible service to the industries they represent.

Members of Business Newspapers Association of Canada:

BOOKSELLER AND STATIONER
CANADIAN AUTOMOTIVE TRADE
DRYGOODSMAN AND
WOMEN'S WEAR
CANADIAN FOUNDRYMAN
CANADIAN GROCER
CANADIAN MACHINERY
AND MANUFACTURING NEWS
CANADIAN RAILWAY
AND MARINE WORLD
CLOTHIER AND HABERDASHER
CONSTRUCTION
CONTRACT RECORD
DRY GOODS REVIEW
DRUGGISTS' WEEKLY
FINANCIAL POST
FOOTWEAR IN CANADA
HARDWARE AND METAL
MARKETING
AND BUSINESS MANAGEMENT
MEN'S WEAR REVIEW
MOTOR TRADE
MUNICIPAL WORLD
POWER HOUSE
LE PRIX COURANT
PRINTER AND PUBLISHER
SANITARY ENGINEER
WESTERN LUMBERMAN

Association Offices - - - - - 70 Lombard St., Toronto

REFRIGERATION DEPARTMENT

LINDE

REFRIGERATING AND ICE MAKING MACHINERY

Made in Canada since 1896

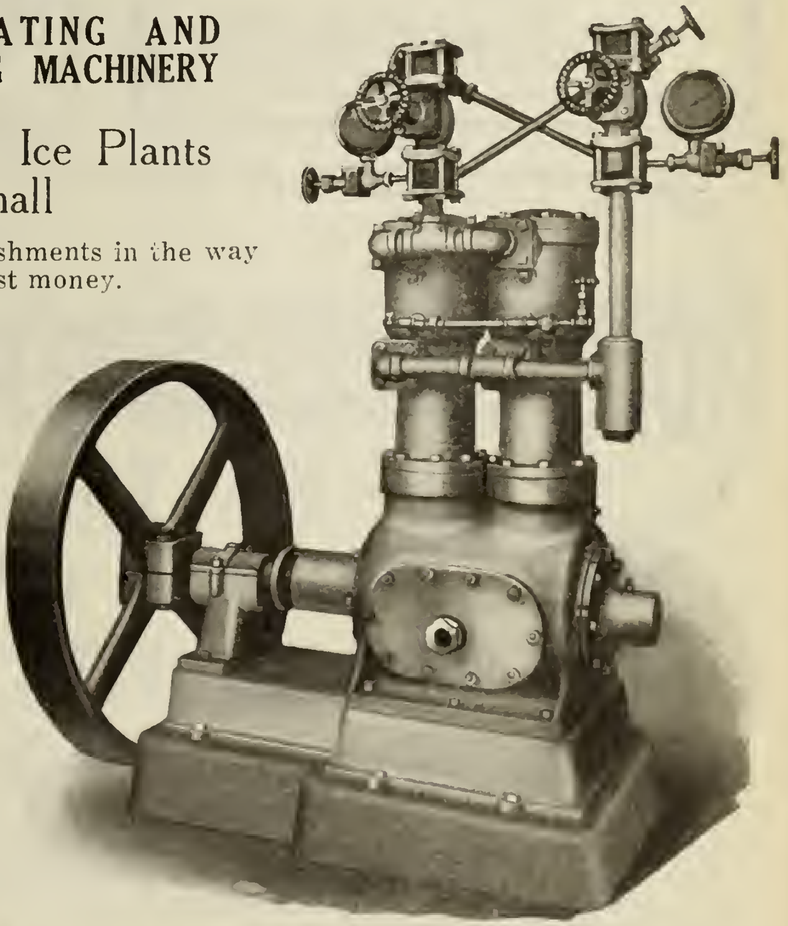
For Refrigerating and Ice Plants Large and Small

They surpass all previous accomplishments in the way of doing the most work for the least money.

They embody every improvement that adds efficiency and durability, and are the ultimate development of specialized engineering, and manufacturing experience during **fifty years.**

Vertical enclosed type machines made for capacities from one to fifty tons.

Horizontal frame heavy duty type machines made for plants up to 300 tons capacity.



All our present-day machines are fitted with our patent silent valves, giving increased efficiency and guaranteed to be mechanically silent in operation.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

TEMPERATURE INSTRUMENTS,
INDICATING - RECORDING - CONTROLLING

give the power plant engineer definite temperature facts. Knowing this power production can be checked up. Below are some of the essential points where *Tycos* Temperature Instruments are usually installed to indicate, record or control temperature.

Air Ducts,
Bearing Temperatures,
Blow off lines,
Boilers,
Coal pile temperature and alarms
Condensers,
Economizers,
Feedwater heaters,
Feedwater lines,
Furnace temperatures,
Furnace drafts,
Generator Temperatures,
Gravity overhead tank heaters temperature and alarms
Hot water heaters
Hot wells,
Pressure lines,
Steam lines,
Superheaters,
Superheated Steam mains,
Transformer temperatures and alarms,
Vacuum lines and tanks.

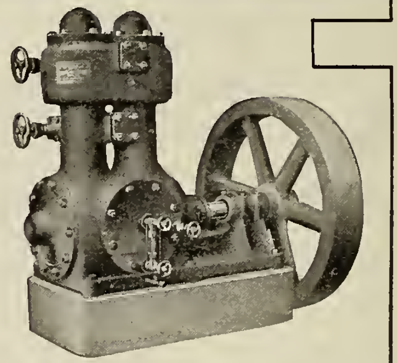
Taylor Instrument Companies
110-112 Church St., *Tycos* Bldg., Toronto
There's a Tycos or Taylor Temperature Instrument for Every Purpose
850

YOU REFRIGERATION ENGINEERS
— REMEMBER —
That "Sundh" (pronounced Sund) Refrigeration Electric Panel Control Equipment is sold by:
DOMINION ENGINEERING AGENCY, Limited
D. M. FRASER, Pres. and Gen. Mgr.
TORONTO 24 ADELAIDE ST. E. MAIN 6926

REFRIGERATION SUPPLIES
REPAIRS - FITTINGS
AGENT FOR FRICK REFRIGERATING EQUIPMENT
REFRIGERATING ENGINEERS
LIMITED
457 King W. TORONTO Adel. 7753

Refrigerating Machinery.
Expansion Pipe.
Ammonia Fittings.
Calcium Chloride.
Ammonia.
Agents For "TRIUMPH" Ice Machine.

35,000 ft. of Pipe in floor of Toronto Skating Club
J. L. WILSON & SONS
REFRIGERATING ENGINEERS
3 SILVER AVE. TORONTO



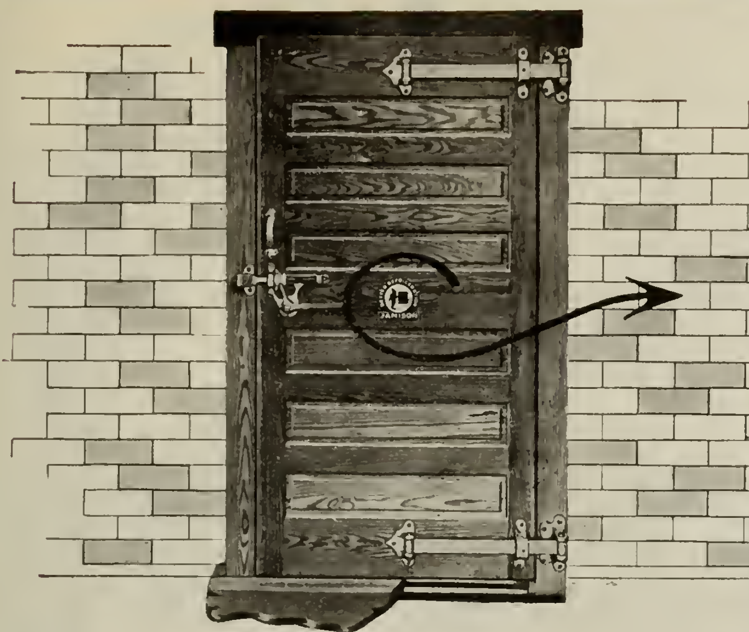
YORK MECHANICAL REFRIGERATION

The Key That Unlocks the Door to INCREASED PROFITS

THOUSANDS of York Machines have paid for themselves, and are now earning substantial dividends for their owners. These machines are designed for service, built of the best materials for the purpose, thoroughly tested and rigidly inspected before shipment. They are self-contained, require very little attention and do not require a skilled operator. There is probably no other equipment you can buy that will be a greater help in increasing your profits than a York Refrigerating Machine.

CANADIAN ICE MACHINE CO., LTD.
TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals; MONTREAL: 324 Craig St. West; WINNIPEG: 1415 Whyte Ave.; VANCOUVER: 1158 Homer St.

YORK MANUFACTURING COMPANY
Ice Making and Refrigerating Machinery Exclusively.
YORK PENNA. U.S.A.



BETTER REFRIGERATION

JAMISON

HAGERSTOWN MD., U.S.A.

Safety First!

The growing concentration of population in the cities of the nation imposes a correspondingly increasing tax upon the cold storage facilities of the country. The millions must be fed!

This industry in a large measure aids in the conservation of the health, life and comfort of the people through the proper preservation of food products. Hence the invariable application of the rule—"Safety First."

Be sure your plant is properly constructed and fitted with every modern appliance that will help in controlling humidity and maintaining temperature. Finally remember when all else is done, "Your Plant is Only as Good as Your Door."

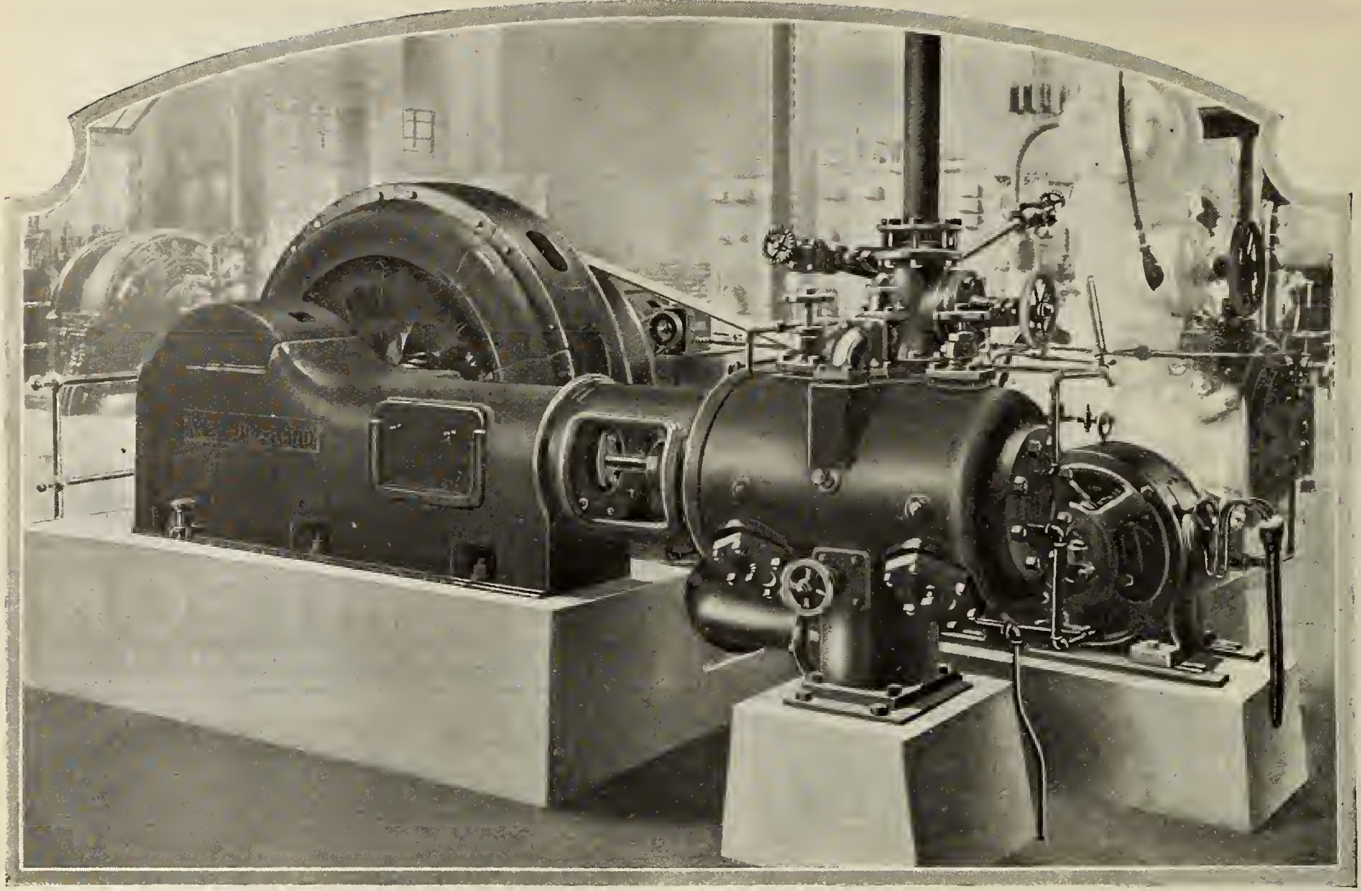
Jamison makes Doors and Windows in a scientific manner, built with brains rather than muscle, and representing 17 years' study of refrigerating and insulating problems. This is why they are better doors!

Architects and Engineers

Jamison Cooler and Freezer Doors, Cold Storage Windows and Automatic Ice Chutes made for all standard requirements. Also, built-in refrigerator fronts to specifications for all purposes when required.

If you have an interest in "Better Refrigeration" write for illustrated descriptive catalog. Address "Desk 11" please.

JAMISON Cold Storage Door Co.
HAGERSTOWN, MD., U. S. A.



At the Chateau Laurier

Dependence is placed on "Ingersoll-Rand"

For increasing the capacity of the refrigeration and artificial ice plant at its famous Chateau Laurier Hotel, Ottawa, Ont., the Canadian National Railways, chose an Ingersoll-Rand Class "PRE-2-A," Two Stage, Direct-Connected, Electric Motor-Driven, Ammonia Compressor, on account of its ability to meet, with highest efficiency, the varying demand for refrigeration throughout the year.

This machine takes over the load formerly handled by two old style, steam-driven units and supplies ice for icing water coolers on passenger cars and for table service at the Chateau. It also supplies refrigeration for a number of cold storage rooms and boxes at this famous hotel.

The Chateau is renowned for its cuisine, so that reliable refrigeration equipment is particularly essential. The load also varies considerably from time to time, so that a compressor permitting economical operation at under-load points is also necessary.

Ingersoll-Rand Ammonia Compressors meet the demands of modern ice and refrigeration plants in every essential and are backed up by the reputation and service of the largest manufacturers of air and gas compressors in the world.

Let our nearest branch help you solve your problems.

Canadian Ingersoll-Rand Company, Limited
Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

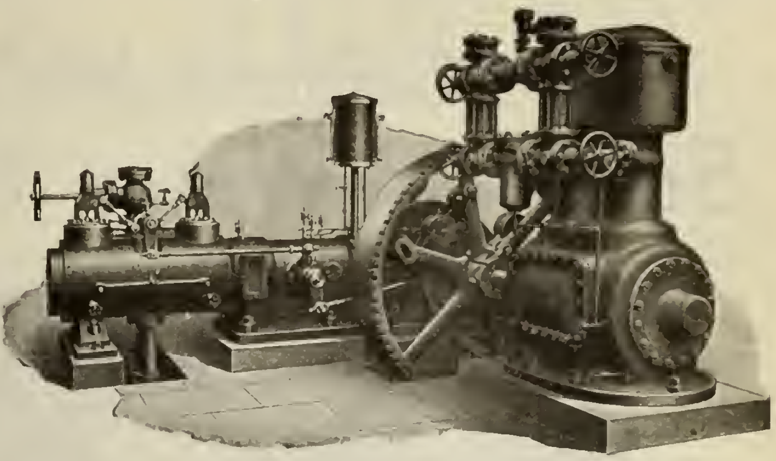
Refer U.S. inquiries to Ingersoll-Rand Co., 11 Broadway, New York

Ingersoll-Rand

FRICK COMPANY, INC.
TRADE FRICK MARK
WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical



Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

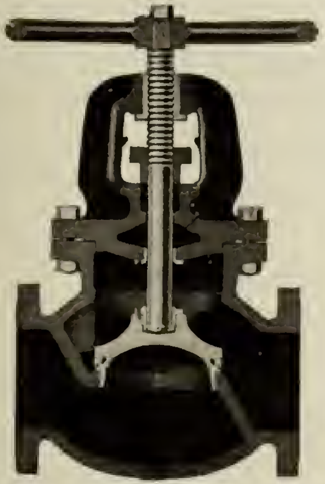
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

Standardize on EDWARD VALVES

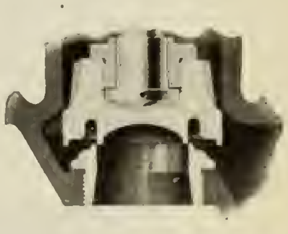
The Great Popularity of Edward Valves Rests Firmly upon Their



Demonstrated Superiority

Extra Heavy and High Pressure Stop Valves,
Non-Return Valves,
Check Valves, Blow-off Valves,
Atmospheric Relief Valves,
Back Pressure Valves,
and a full line of Screwed End Forged Steel Valves for both steam and oil.

Write for descriptive literature



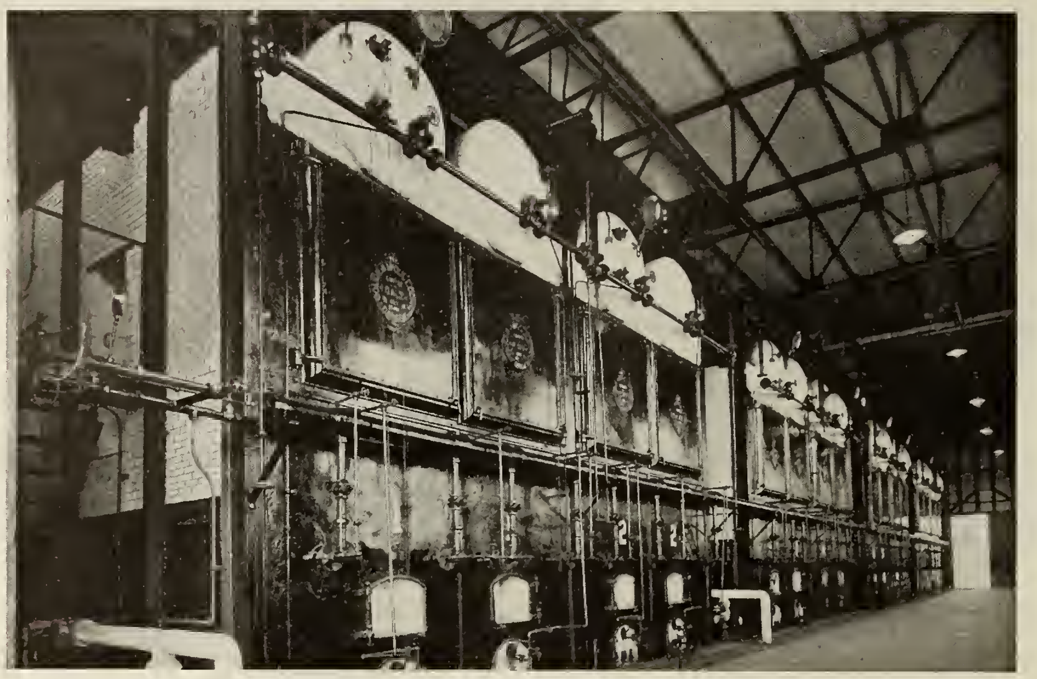
The Edward Protected seat and disc, a feature of Edward stop valves, affords the ideal seating surface, insuring positive protection against cutting from wire drawing.

THE EDWARD VALVE & MANUFACTURING CO.

GENERAL OFFICES AND WORKS
NEW YORK, N.Y. EAST CHICAGO, INDIANA SAN FRANCISCO, CAL.

Canadian Agents:
LYTLE ENGINEERING CO., Ltd., Montreal. VALVE ENGINEERING CO., Toronto.

Goldie & McCulloch
Sectional Water Tube Boilers



One of several boiler rooms of the Imperial Oil Company, equipped with G. & McC. Co., Sectional Water Tube Boilers.

Provide Increased Steaming Capacity

Goldie & McCulloch Sectional Water Tube Boilers are equipped with large steam and water drums and connecting nipples of increased size. Thus they assure positive and rapid circulation and increased steaming capacity. These boilers are built to meet the demands of the largest plants. They are constructed of the best quality of material and all parts which are subjected to steam pressure are made of forged steel.

Goldie & McCulloch boilers are always drilled—never rivetted. They are thus built to stand up under the heaviest of strains that may be put upon them.

Send for Further Information

The GOLDIE & McCULLOCH CO., Limited

Head Office and Works: Galt, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2
Bank of Hamilton Bldg.

QUEBEC AGENTS:
Ross & Greig, 400 St. James St.,
Montreal, Que.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

BRITISH COLUMBIA:
Robert Hamilton & Co.,
Vancouver, B. C.

POWER HOUSE

ESTABLISHED 1907 *Toronto, July 20th, 1923* A SEMI-MONTHLY NEWSPAPEI

Economies of Refrigeration in the Power Plant

* By ARTHUR MURPHY

A Brief Outline of the Theory and Principle of Mechanical Refrigeration—The Vapor Compression and the Ammonia Absorption Types— Points for the Engineer to Observe in Cutting Costs

SINCE earliest times man has been faced with the necessity of cooling bodies below the temperature of the surrounding air. In tropical climates cooling drinking water by evaporation from the moistened surface of a porous vessel is a common procedure.

In more northern climes low temperatures in warm weather are secured either by the use of natural ice, harvested in the winter months and stored until required, or artificial ice manufactured as seasonable need demands. As every engineer knows, ice requires heat to the extent of 143.4 B.t.u. per pound to change from the solid to the liquid state, which heat must be supplied from some external medium, in the case of an ice box, for example, by the circulating air in it.

Since ice must change from a solid to a liquid state before any heat can be removed it follows that with ice alone a temperature lower than 32 deg. F. cannot be obtained. On the other hand certain mixtures such as salt and ice have a lower melting point than 32 deg. F., and under such conditions fairly low temperatures may be produced, as shown by the following table:

Per cent. salt in mixture by weight.	Temperature of mixture, deg. F.
0	32
5	27
10	20
15	11
20	1.5
25	-10

Ice is in wide use as a refrigerant in households, stores, dairies, refrigerator cars, and other places too numerous to mention. Although natural ice is widely used as a means of producing low temperatures, on account of high labor costs and transportation difficulties, it is often cheaper to produce ice by mechanical means at a point near the market than to harvest and store it.

The advisability of buying ice or installing a small refrigerating unit is a problem often confronting engineers in charge of the equipment in large public institutions, hotels, etc. It is largely a matter of first cost, convenience desired, local conditions such as temperature required, cost of power and distance from source of ice supply.

For the production of low temperatures by mechanical means the engineer in Canada has the choice of several types of machine, such as the air, the ammonia compression, the ammonia absorption, the CO_2 and the SO_2 machines.

Air Machine Simple

The simplest form of producing cold mechanically is by the compressed air machine. When air is compressed rapidly its temperature rises. This effect is readily seen in pumping air into an automobile tire. In the air machine, air is compressed in a cylinder, then the warm air is passed through coils surrounded by cooling water, which extract heat from it, lowering the temperature to approximately that at the inlet. The air is then passed through an expansion cylinder, its work on the piston causing a decrease in temperature, in other words the air does work at the expense of its intrinsic energy. This expanded air is at such a low temperature (possibly many degrees below zero) that it is capable of extracting heat from a room or space through which it may be passing either in pipes or in the open on its way to the suction of the compressor.

In practice the compression and the expansion cylinder are mounted on the same shaft, the expansion cylinder returning a portion of the work to the machine, but since friction is always present where there is motion of one part on another, and the cold air in the expansion cylinder occupies less volume than in the compression cylinder external energy is necessary to operate the system.

In the open system air is supplied to the compressor at atmospheric pressure and allowed to expand freely in the storage room. This necessitates a large machine for a given capacity, so the closed system is often adopted in which air is supplied to the compressor at 60 to 70 lbs. per sq. in. gauge and discharged at pressures from 200 to 250 lbs. gauge. In this way the size of machine is materially reduced, but a small auxiliary plunger or pump is required to supply a small quantity of air to the system in order to keep the inlet air to the required pressure.

The advantages claimed for the air machine are: simplicity of construction, ease of control and safety, as there is no gas used which would lead to an ex-

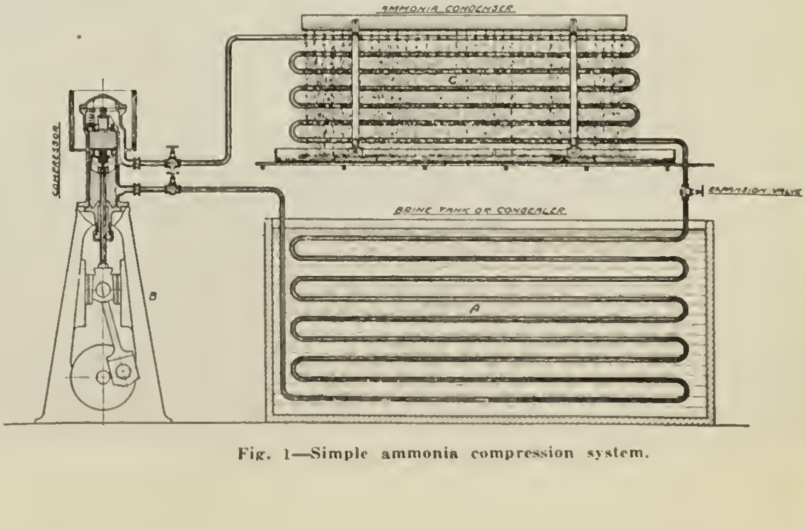


Fig. 1—Simple ammonia compression system.

---

*Editor, Power House.

plosion or loss of life in case of broken piping. The ease of recharging in out-of-the-way places in case of loss of working fluid, and the production of extremely low temperatures, 100 deg. below zero being readily obtainable, are other attributes of this machine which find favor.

The Vapor Compressor Type

In the air machine the working fluid is not condensed, therefore, no advantage of the latent heat of vaporization can be secured as in another system known as the vapor-compression type in which a vapor is raised by a compressor to such a pressure that on being cooled by suitable means to a moderate temperature the vapor is condensed, then allowed to expand at low pressure to a gaseous state.

In this type of machine ammonia (NH_3) is in wide use, although other substances, such as sulphur dioxide (SO_2), carbon dioxide (CO_2), methyl chloride, and mixtures of two or more gases are also used.

The table below will give the engineer some idea of the conditions necessary for machines employing the various vapors, assuming 70 deg. F. as the temperature of the fluid and 15 deg. F. as that of the cooling coils.

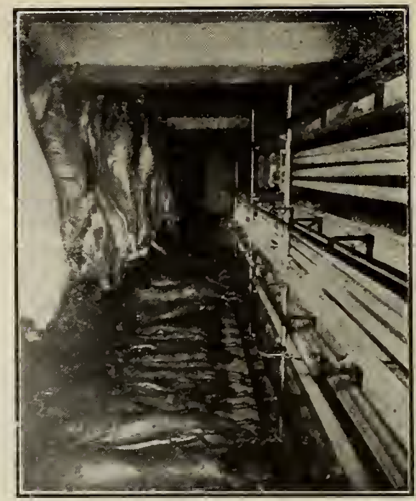
Pressure Lb. Per Sq. In.	Ammonia	Carbon Dioxide	Sulphur Dioxide	Ethyl Chloride	Methyl Chloride	Nitrous Oxide	Pictects Fluid
Suction	42.7	391	15.2	6.0	25.9	431	203
Discharge	129	847	49.6	20.0	73.3	832	51.6
Relative Volume per Unit Weight of Refrigeration	4.4	1	12				

The engineer, from a study of the above table, can form his own opinion as to the best type for his plant, bearing in mind local conditions such as temperature of cooling water and the space available. It can be readily seen that with ammonia the pressures and temperatures are moderate and for a given capacity the volume of fluid required is not excessive.

A simple vapor compression machine is shown in Fig. 1, consisting of a compressor, an expansion valve, a condenser and an expansion coil, surrounded by brine. Anhydrous ammonia at ordinary temperatures is a colorless liquid having a pungent alkaline odor weighing approximately forty pounds per cubic foot. Ammonia at ordinary temperatures and at 150 lbs. gauge pressure or over is in liquid form, if the pressure be reduced the liquid changes to a gas, taking up heat in the process.

The latent heat of vaporization of ammonia or the amount of heat required to change from a liquid to a gas is 565 B.t.u. per pound; the boiling point is about 27 deg. below zero. The simplest form of refrigerating apparatus would consist of but two parts, a tank containing liquid ammonia and a coil in which the ammonia could expand. As the liquid ammonia expanded and changed to a gas in the coil, after passing through an expansion valve, 565 B.t.u. would be removed from the medium surrounding the coil for each pound of gas used.

With such a simple apparatus the gaseous ammonia would then be wasted, and new liquid would have to be supplied continuously. In practice this would be much too costly so that escaping gas is piped to a compressor B (see Fig. 1) driven by external power, by means of which the gas is removed from the cooling coils A as fast as it is formed and compressed to a high pressure (150 to 200 lbs.). The gas then passes to the ammonia condenser C consisting of coils surrounded by cooling water in which the hot gases are cooled to such a degree that it is liquified. The cooling water extracts heat equivalent to that required to heat the ammonia from the temperature of the cooling water to the temperature leaving the compressor as well as the latent heat of vaporization. The liquid ammonia collects in a small tank below the condenser, from which it flows through an expansion valve to the expansion coils A completing the cycle. The liquid ammonia in changing to gas must take up heat which must be supplied by the medium around the expansion coils, in this case the brine. The CO_2 and the SO_2 systems work on exactly the same principle as the ammonia machine, the pressures used, however, are widely different. The ammonia type commonly works on suction pressures of 15 pounds and 180 pounds discharge, with the CO_2 1,200 is an average.



Beef cooler.

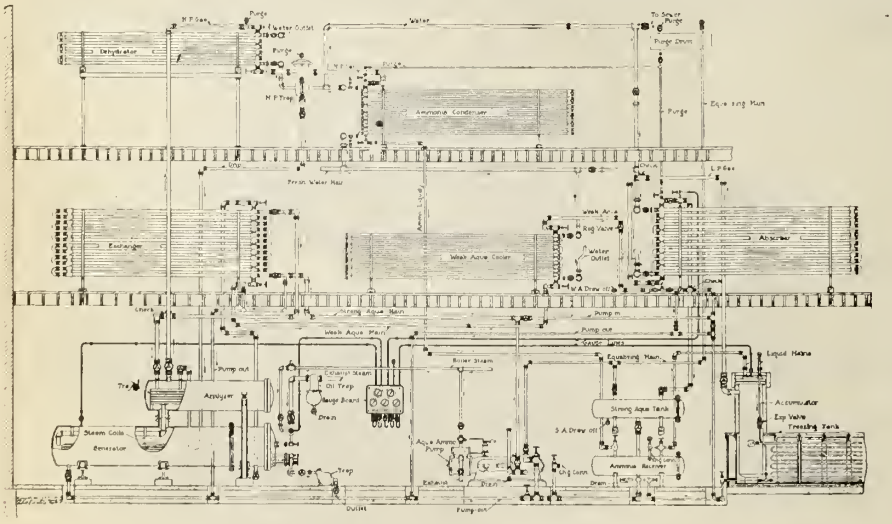


Fig. 2—Ammonia absorption system

Compressor Eliminated

The ammonia absorption system principle is in practice an alternative method of securing compression and liquefaction of the ammonia gas after it has expanded from the liquid form. Instead of a pump and mechanical power to compress the gas as in the compression system, heat and chemical action are the agencies employed to compress the gas to a point where it will liquefy, in the absorption system.

There are no moving parts except one small pump. Its action depends on the affinity of water for ammonia; a pound of water at 32 deg. F. will absorb .899 lbs. of ammonia or 1,180 times its own volume, at a temperature of 76 deg. F. it can dissolve only .45 of a lb.; at 190 deg. .122 lbs, and at 212 deg., but .074 lbs.

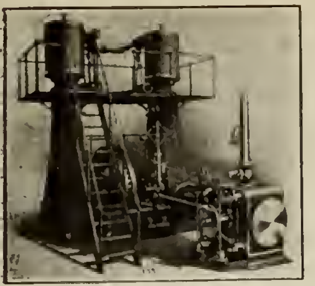
If a vessel of cold water be connected to the expansion coil filled with ammonia gas the water will absorb the gas so rapidly that the coils will be empty in a moment.

The simple absorption process absorbs the gas in a tank of water and then drives off the gas in a boiler or generator. As shown before, a low temperature will suffice, at 213 deg. F., practically all the gas will be driven out of the water. Four or five pounds pressure is sufficient to drive the gas off at a pressure of 150 to 170 lbs. per square inch, which will cause the gas to liquefy when cooled in the condenser—230 deg. F. is a common temperature in the generator.

Fig. 3 shows a complete absorption plant, each part and the direction of flow of the fluids being clearly marked.

Ammonia

Aqua ammonia is heated by steam in the generator, shown in the lower left of Fig. 2, driving off the ammonia gas at a pressure of 170 lbs. The gas then goes



Vertical Steam Driven Compressor.

through condenser coils, expansion valve and expansion coil, back to the absorber. A small pump then forces the aqua ammonia into the generator. To remove any excess heat and the heat supplied to the generator, the cool strong solution from the absorber flows over trays through which the heated gas from the generator is passing. In this way the liquor fed to the generator is heated and economy effected. The apparatus for this purpose is known as an analyzer.

Water vapor in the condenser would absorb some ammonia, reducing its efficiency, so is removed, on leaving the generator, by passing through tubes surrounded by cold aqua ammonia. This apparatus is commonly called a rectifier or dehydrator. A separator to remove any further moisture remaining is sometimes added.

To secure still greater economy the warm, weak liquor, on its way to the cooled absorber, is passed around the pipes carrying the strong solution to the generator. This results in an interchange of heat in the exchanger.

Though at first the process appears complicated, the mechanical equipment is simple, the only moving parts being in one small pump.

The system is capable of producing ice or refrigeration from exhaust steam which in many plants would otherwise be wasted. Another advantage lines in the fact that the system is closed, therefore, loss of ammonia is negligible over long periods of time.

The CO_2 and the SO_2 machines are in principle the same as the ammonia compression machine so need not be described again.

The CO_2 machine, working at high pressures requires care in packing and in pipe fittings. The advantage claimed for this machine is its small size; the cylinder is much smaller but the extra large flywheel required to give smooth running with the high pressures in the cylinder tends to make the overall size of the machine larger.

The chief advantage claimed for the CO_2 machine is that the gas employed, being non-poisonous, (as much as 8 per cent. can be breathed without danger), in case of accident, no lives will be endangered.

Insulation Important

The object of insulation or covering is to force the heat to flow in one direction only, in the case of a steam line along the pipe and not through the walls. For cold storage work the object of insulation is to keep heat out.

Heat travels in several ways, by radiation, by conduction, and by convection. It is impossible to prevent the passage of all the heat, but with the best insulations properly applied but very little loss occurs. A vacuum is the best insulator but dead gas is the only practical insulation medium for any service. The fewer and therefore the larger the air spaces in any insulating substance, the more readily will heat pass from one to the other. The best insulator is one containing the greatest number of the smallest possible air spaces.

On the market to-day there are several insulating materials which contain when new the large number of small air spaces necessary for efficiency in preventing the transfer of heat, on the other hand the requirements of cold storage demand that moisture will not impair its efficiency. Moisture is a good conductor of heat and thus any insulator for cold storage or refrigerating service must be moisture proof. Cork, ground and then baked into flat sheets or forms or held with a binder, find wide use to-day. Fibrous materials suitably waterproofed are also in use.

Experiments on cork board insulation gave a heat transfer as low as 6.2 B.t.u. per square foot per 24 hours per degree difference in temperature.

Obtain Clear Ice

Formerly the greater proportion of artificial or more correctly manufactured ice was made from distilled water, due to the difficulty of obtaining clear ice from untreated water, especially in districts where the water contained a fairly high percentage of impurities. Steam power was in use for driving the compressor, the exhaust steam then furnishing part of the heat necessary for the distillation of the water used in the manufacture of the ice.

With the increasing cost of fuels and the introduction of the electric motor for driving the compressor, the cost of distilled water became prohibitive, manufacturers of ice then turned to the city water supply, or other potable source. The difficulty of obtaining clear ice again confronted them, but the increased production from the same amount of power made it the only practical method.

With raw water, steam plants have been able to produce from 7 to 16 tons of ice per ton of coal, whereas with distilled water 4 to 8 tons per ton of coal was considered average.

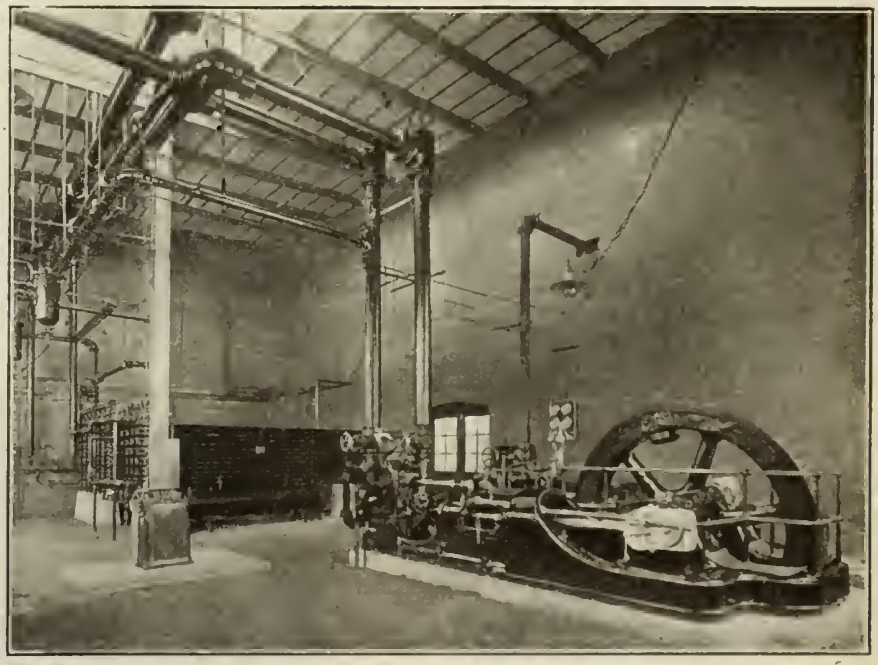
It was found that clear ice could be produced by air agitation of the water in the can during the time of freezing, the freezing surface being continuously washed by the movement of the water. When using raw water, white ice is caused by impurities, such as calcium carbonate, calcium sulphate, and magnesium salts.

The carbonates cause most of the trouble, fortunately they are easy to eliminate. Sulphates do not have to be removed. The greater the amount of impurities the water contains the more agitation required.

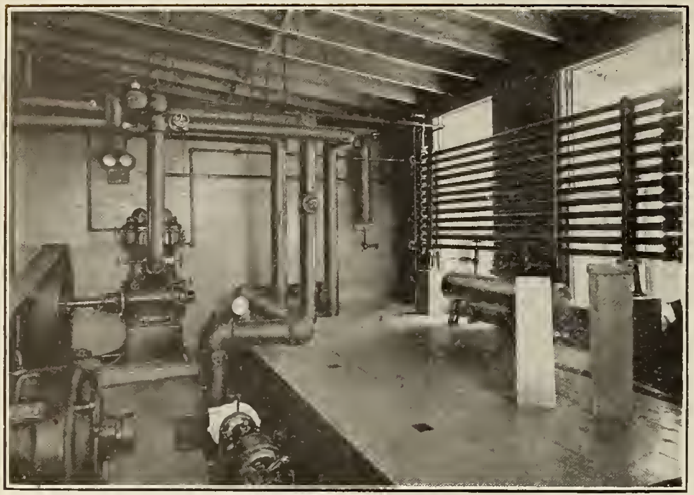
The process of freezing consists in the formation of small crystals of pure water in the form of ice; as the crystals form, the mineral salts, being more soluble in the unfrozen water than in the ice, are removed by the unfrozen water.

This occurs only with salts soluble in water, but carbonates of lime and magnesia are usually present, which, though insoluble in water, in the presence of free carbon dioxide, become soluble.

Water which is unsuitable for ice making should not be used. If the water contains a fair proportion of impurities



Horizontal Compressor, With Condenser in Rear



Small Ice Plant.

good ice can be made by sucking out the core and refilling with fresh water.

Detect Leaks

In the ammonia system any large leak is detected at once by the peculiar pungent odor present. This test is not sensitive enough for small leaks; a more reliable method is to make a sulphur torch by pouring some pulverized sulphur into a shallow laddle or large iron spoon and light with a match, then slowly pass along the pipe and fittings, keeping the torch as close to the pipe as possible.

Fumes from the sulphur coming in contact with the escaping ammonia immediately change the smoke from the sulphur torch to a whitish or foggy cast. Should any leak be found it will be necessary to pump out the ammonia and repair any defective pipes or leaking joints at once.

Another test is to hold acid (red) litmus over any suspected leaks. If the red litmus changes to blue it shows the presence of ammonia.

Ammonia may be leaking into the cooling water and being extremely soluble in water at ordinary temperatures may continue undetected for some time. Litmus or phenolphthalen is useful in detecting leaks of this nature as a very weak solution of ammonia in water will be shown. Jacket cooling water should be tested frequently with the aid of litmus and if ammonia be present the cover nuts of the jacket cover should be tightened sufficiently to stop any leaks.

It is unnecessary to point out the danger in entering a room full of ammonia fumes, to those who have had any experience with leaking equipment; less than 1 per cent. is fatal. Gas masks should be provided and every man in the plant should learn how to use one. Fortunately accidents from ammonia gas are extremely rare; on the other hand there is always a certain element of danger.

Oil Causes Trouble

Lubrication of the moving parts of a compressor is essential, resulting in the drawing in of minute particles of oil, which, if not removed by some means, will pass into the coils, forming an insulating coating on the inside of the pipes. Oil, being a poor conductor of heat, reduces the capacity of the condenser and materially cuts down the capacity and efficiency of the plant.

To overcome these effects of oil on the system an oil separator is placed between the compressor and the condenser. In principle the oil trap is similar to the steam separator. In some types the gas and oil entering at one side strike a series of baffles, in others a screen is used.

The engineer should drain the oil trap frequently, preventing any large quantity of oil passing into the system where it is sure to emulsify and clog the expansion valve. In draining oil from an ammonia system it is best to draw the oil off through a tube under water, then if any of the gas should escape it will be dissolved in the water. The smallest possible quantity of lubricant should be used in the compression cylinder.

Remove Air

The presence of air in the system is another frequent source of trouble, a small amount causing serious reduction in efficiency and capacity.

The system should be purged whenever the presence of air is suspected or after the head of the compressor has been removed. The packing around the rod should always be kept in the best possible condition, even then a small amount of air is sometimes drawn into the system when pumping out the suction side before shutting down the compressor.

Ammonia gas, being lighter than air, rises to the highest point in the pipes, therefore the air vent should be placed at a low point in the system. Carbon dioxide, being heavier than air, requires to be vented in the upper part of the piping system.

In purging air from the ammonia system it is advisable to blow the air through water. When air is escaping bubbles will rise to the surface. As soon as ammonia escapes a cracking noise is heard, similar to that made by blowing steam into cold water. It is then an indication that the air has been driven out and that ammonia is being wasted. With carbon dioxide it is more difficult to tell when the air is removed, a simple method however is to hold a large milk bottle to the vent, when, if a lighted match is extinguished the instant it is dropped into the bottle, carbon dioxide is escaping and the vent should then be closed.

Care of Brine

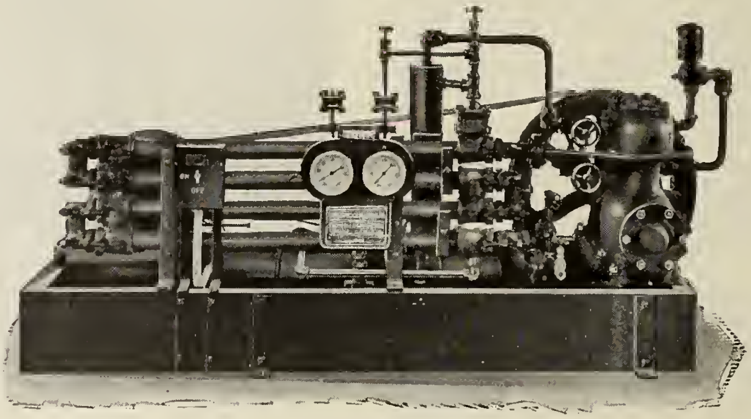
Engineers in charge of refrigerating plants are usually careful about proper lubrication, cooling water, and the prevention of leaks, but pay little attention to the condition of the brine. The tendency is to make the brine too strong, on the other hand sufficient salt must be used so that the freezing point will be low enough to prevent a freeze-up in case of failure of the brine pump for a short time and a consequent lowering of the temperature in parts of the system.

The thermal capacity of brine decreases as its density increases, or in other words, a weak brine can carry more heat than a strong brine, as the following table for calcium will show:

Deg. on Salomiter at 60° F.	Deg. Baume at 60° F.	Per Cent. Calcium Chloride	Freezing Point Deg. F.	Specific Heat
4	1	1	31.10	.996
72	18	16	10	.854
88	22	20	—1.4	.834
108	27	25	/—21.8	.790

Small pieces of cork, fibres, and other small particles commonly get into the

(Turn to page 46)



Self-contained Unit

Disposing of Condensation in the Power Plant

Little Steam Find its Way to the Atmosphere in Modern Practice and Equipment Must Have Capacity Nearly Equal to That of Boiler Feed

IN ONE way or another all the water evaporated in the boilers of a steam plant must be disposed of after it has performed its work in the generation of power and the furnishing of heat for various purposes.

In the old-time plant, where the exhaust from the engine was discharged outbound, and condensation within the piping blown out through open drips, without the use of traps, the matter of damage was a comparatively simple matter.

At the present time very little steam finds its way to the atmosphere, and the equipment for handling the condensation must have a capacity very nearly equal to that of the boiler feed.

System Complicated

In many ways the drainage system is much more complicated than the feed system, because, in the latter case, the water is usually taken from a single source and fed to the boilers by a single pump or pair of pumps working together.

On the other hand, the condensation must be collected from a large number of points, some of it being pure water which may be returned directly to the boilers, while other portions contain oil which must either be renewed or the water drained into the sewer.

Instead of flowing directly to a common receiving tank, the condensation must be discharged through traps to avoid the waste of steam, and again great care must be taken in the arrangement of the piping to prevent the accumulation of water at different points, and also any interference in the action of traps or pumps discharging into the same system of piping.

In order to simplify matters, let us first follow the steam from the boiler and collect the condensation in groups, and then see how these are best disposed of. The sources of condensation will, of course, vary in different plants according to local conditions, and it will be necessary in the present connection to include a considerable number to cover ordinary cases in a variety of plants in Canada.

When condensing engines or turbines are used, the disposal of the condensate will depend upon the type of equipment employed. If a surface condenser is used, the condensed steam is discharged into a hot-well by a suitable pump and returned to the boilers with the make-up water.

With reciprocating engines the exhaust should pass through an oil separator on its way to the condenser, and in some cases it may be necessary to filter the condensate also before discharging it into the hot-well. If there are other oily drips to be cared for it is sometimes more convenient to place the filter between the hot-well and feed-pump.

In a non-condensing plant the exhaust, in ranging proportions, is usually employed for heating the buildings, for process work, and in warming water for domestic purposes or for feeding the boilers, so that a variety of apparatus must be made use of in handling the water of condensation from these different sources. In addition to the above there is condensation which takes place in the distributing pipes of a steam plant, both in the power, heating, and industrial systems, which must be taken care of.

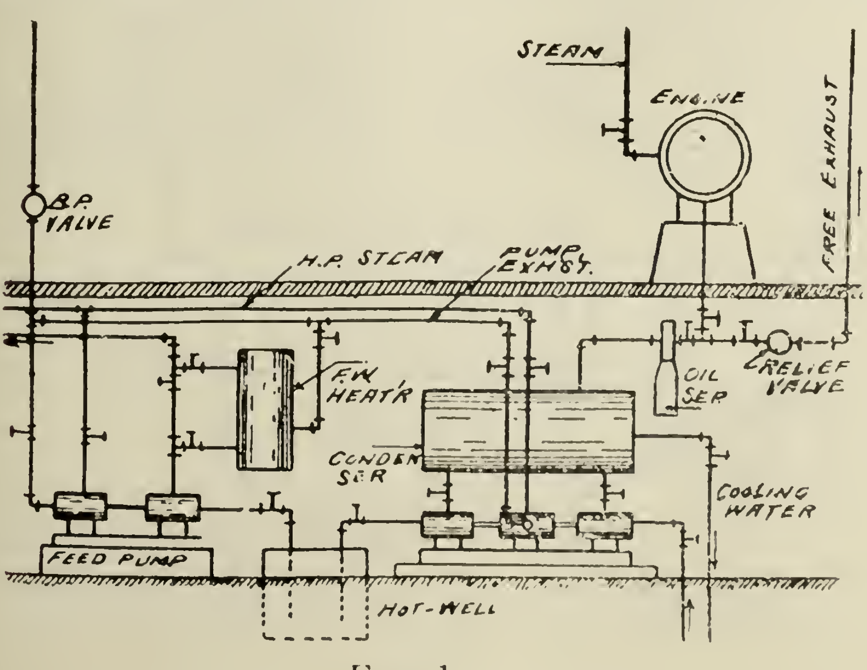


FIG. 1.

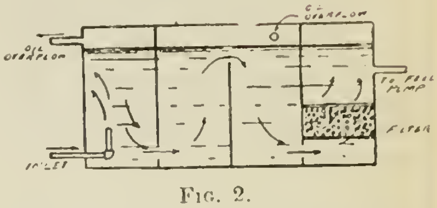


FIG. 2.

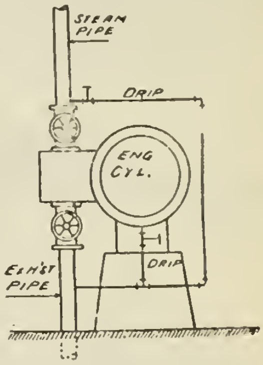


FIG. 3.

Having roughly divided the sources of condensation into groups let us now see how it may best be handled and what equipment is required under different conditions.

A typical layout for disposing of the condensate from a reciprocating engine connected with a surface condenser is shown diagrammatically in Fig. 1. The exhaust from the engine passes through an oil separator into the condensing chamber from which the condensate is removed and discharged into a hot-well as previously described. If special precautions are required or there are other oily drips to be cared for, the hot-well may be separating tank and filter of the general type shown in Fig. 2. The exhaust steam from the condenser pump and feed-pump is utilized in a feed-water heater the drip from which is usually trapped to the sewer on account of the oil.

In large plants where the heat in this water would amount to considerable proportions and where water is valuable, an oil separator may be placed in the pump exhaust, as shown in the illustration and the condensation trapped to the hot-well from which it may be returned to the boilers with that from the main engine.

In case a jet or barometric condenser is used, and the cooling water is suitable for boiler feeding, an oil separator may be placed in the main exhaust pipe, as in Fig. 1, and the feed-water drawn directly from the discharge from the condenser, a portion being diverted to a hot-well or receiver for this purpose. In this case it will not usually be necessary to filter the water if an efficient oil separator is employed, as the condensate will be diluted with thirty to fifty times its weight of cooling water. When a turbine is employed instead of a reciprocating engine, the general arrangement will be the same, except for the oil separator in the exhaust line, which is not needed.

In the case of non-condensing engines the exhaust steam passes on to other pieces of apparatus, except for any surplus which is discharged outbound, and the disposal of the condensation will be taken up later. There are, however, two or three details of drainage at the engine which may well be mentioned at this point, and which are common to both condensing and non-condensing machines.

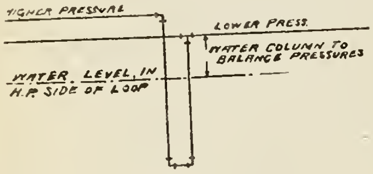

HIGHER PRESSURE
LOWER PRESS.
WATER COLUMN TO BALANCE PRESSURES
WATER LEVEL, IN H.P. SIDE OF LOOP

FIG. 7.

The first of these is shown in Fig. 3, and applies to cases where the steam separator is located some distance away from the engine or where a single separator in the main steam line is made to serve several units. This is for draining away the water which collects above the throttle valve, and is to be used only a short time before starting up the machine. Although water at this point contains no oil, it is usually discharged into the exhaust pipe with the drip from the cylinder cocks, as the quantity is small.

The throttle and cylinder drip pipes are commonly given a uniform diameter of ½ in. except in the case of large machines, as they are not expected to take care of any large rush of water, and there is no advantage in increasing the size to any extent.

A typical method of draining the jacket and receiver of a compound engine is illustrated in Fig. 4, in which case steam at boiler pressure is supplied to the jacket of the high-pressure cylinder and passes from here, with any condensation which has been formed, into the receiver, then through the tubes to the jacket of the low-pressure cylinder, as indicated. The condensation from the high-pressure steam chamber of the receiver, and from the jacket of the low-pressure cylinder, is trapped into the shell of the receiver, and, being at a high temperature, breaks into steam when discharged into a lower pressure and mixes with the steam passing through the receiver from the high- to the low-pressure cylinder. Condensation from the low-pressure chamber of the receiver, together with any unevaporated water from the discharge of the high-pressure traps A and B, is drained to the hot-well through trap C.

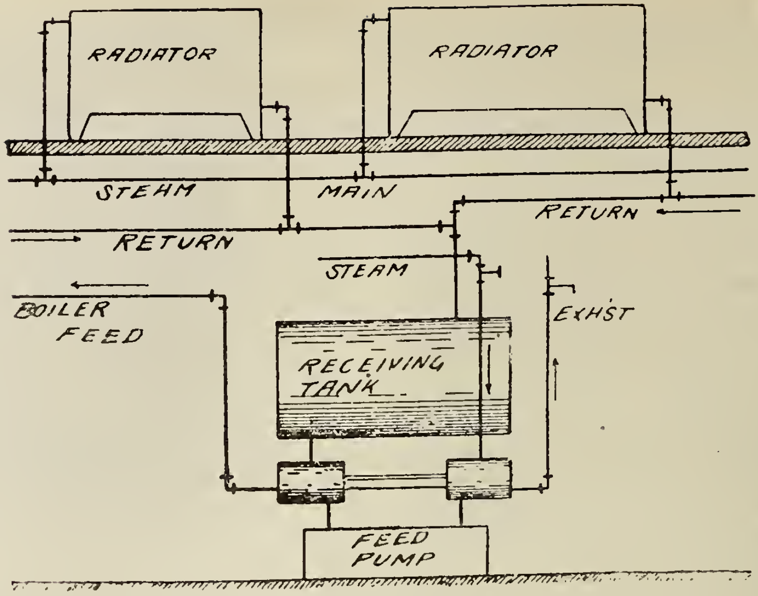


FIG. 5.

The disposal of the water of condensation from a heating system is of great importance, as the successful operation of the plant is as dependent upon this as upon a supply of steam to the radiation.

In the gravity arrangement, shown in Fig. 5, the water flows by gravity from the radiators through properly graded return pipes to a receiving tank, from which it is pumped back to the boilers. When exhaust steam is used for heating, in the average industrial plant, office building, or institution, it should, of course, be passed through an oil separator before entering the heating system, and the same precautions taken for filtering the return water as already described in connection with condensing engines.

When there are various drips to be taken care of, coming from systems or apparatus under different pressures, the tank should be vented to the atmosphere and the return from each system discharged into it through a trap. If the condensation all comes back under practically the same pressure the traps may be dispensed with and a closed receiver used.

In this case each separate return line

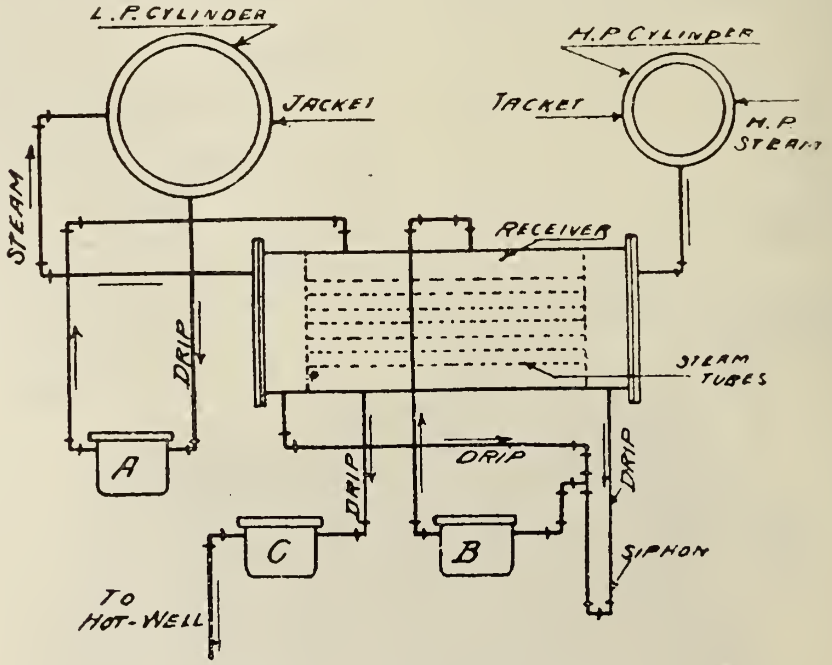


FIG. 4.

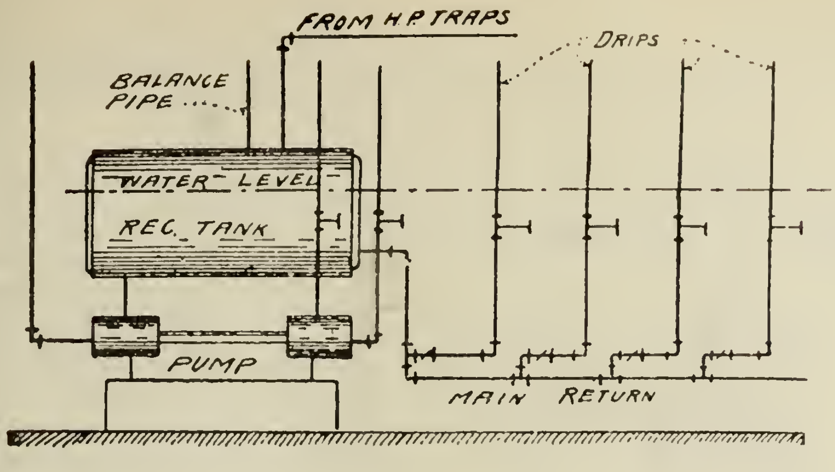


Fig. 6.

should be sealed and provided with a check-valve, as shown in Fig. 6, to prevent any "backing-up," or water-hammer, due to slight variations in pressure which are always present in different return lines, even though under the same initial steam pressure.

It is not good practice to allow a high-pressure trap to discharge into a sealed return or into a receiving tank below the water line, if these are under a lower pressure, as water-hammer and snapping will nearly always result. When water under a high pressure and temperature is discharged into a lower pressure it first breaks into steam, and if this action takes place under water the sudden condensation which follows will produce considerable disturbance of the kind mentioned above.

If the discharge from the high-pressure traps is brought into the receiving tank above the water line, as in Fig. 6, any steam which is formed will pass into the low-pressure system through the balance pipe. If the quantity of steam thus formed is small, and the balance pipe of good size and connecting with a large return, it will do no harm; but if a considerable quantity of steam is liberated in the tank at a somewhat higher pressure it will tend to unbalance the pressures existing in the return system and hold back the condensation in some of the connecting pipes.

Under conditions of this kind it is best to insert a trap in the main return line and vent the receiver to the atmosphere. Care must always be taken to equalize the pressure in the return lines of a heating system by water-seals where two pipes join, either by syphon loops or by carrying the return mains below the water line in the tank or trap. Arrangements for this purpose are shown diagrammatically in Fig. 7, in which case any difference in pressure due to inequality and length of run will be balanced by the water-seal in the loop or drop pipe.

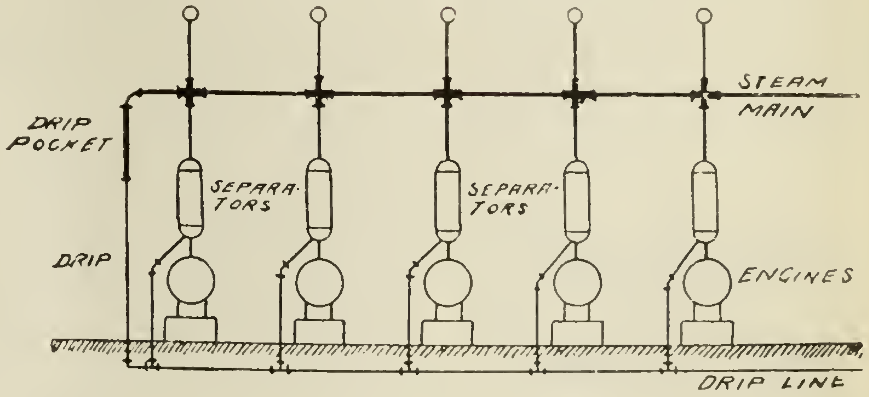


Fig. 11.

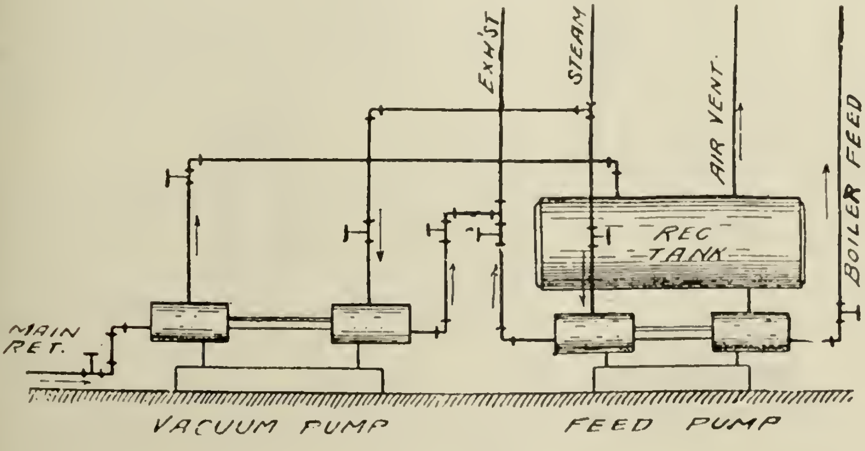


Fig. 8.

The return connections and disposal of the condensation in an "air-line" vacuum system will be the same as for the ordinary gravity system just described, as only the air-valves are connected with the vacuum pump. When the "return-line" vacuum system is employed, the general arrangement is similar to that shown in Fig. 8, although details may vary in different cases. In this system loops and water-seals are not required, as the entire return system of piping is under a suction which takes care of all minor differences of pressure.

In the ordinary arrangement, shown in Fig. 8, the mixture of air and water from the heating system is discharged by the vacuum pump into a vented receiver, where separation takes place, and from which the condensation is pumped back to the boilers, the same as in the other two systems previously described. In special cases, with certain types of vacuum pumps, the feed-pumps are omitted and the water discharged directly into the boilers, air separation taking place in a special receiving tank before the water reaches the pumps.

The return of condensation from process work, domestic water heaters, etc., is combined with that from the main heating system, and usually consists in discharging it by means of traps into the main receiver or hot-well to be returned to the boilers with that from other sources. If the condensation from some special piece of apparatus is small, and the machine remote from the receiving tank, it may not be worth while to save it, but in general all hot water should be returned to the boilers and its heat utilized.

The drainage of high pressure piping has been touched upon indirectly in connection with the low-pressure work, but requires special mention in regard to certain points of drainage in the boiler- and engine-rooms. One of the most important details of this kind is the drainage of the main header.

Water in high-pressure piping is par-

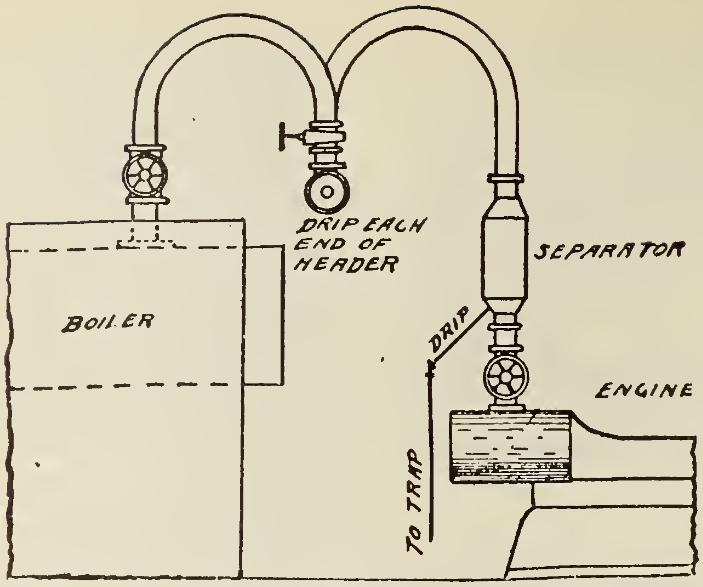


Fig. 9.

ticularly dangerous, for if carried into the engine cylinders in considerable quantity it is liable to wreck the engine or at least rupture the cylinder heads; and condensation in the mains is likely to produce water-hammer, which in turn causes vibrations tending to loosen the joints.

Water in sufficient quantities to produce slugs the full size of the pipe is capable of serious damage when steam is first turned on or sudden changes in pressure occur in the system. The presence of moisture also reduces the efficiency of an engine as it increases the rate of heat transfer from the steam to the cylinder walls. Water finds its way into the piping in two ways: first, by condensation; and, second, by being carried over in the form of spray. The first may be reduced by suitable insulation, and the second by improvements in boiler design.

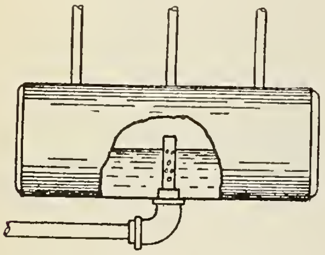


Fig. 1

Under the most favorable conditions a certain amount will collect in the piping, and must be removed by a drainage system of a form adapted to the existing arrangement of piping as found in each individual plant. While there are certain general rules to be followed, it is not always easy to tell what changes are taking place inside the piping, and each case must be studied separately. One point which applies to all plants is that maximum conditions must always be provided for. A drainage system may have ample capacity for normal conditions, but prove inadequate when steam is first turned into the cold piping, when water is carried over from a foaming boiler or when an additional unit is cut in too rapidly. Conditions at such times not only throw an extra load upon the drainage system, but, owing to the unbalanced pressure, slugs of water are liable to be driven through the pipes with sufficient force to fracture fittings where changes of direction take place.

Separators are relied upon to prevent water from reaching the engine cylinders, but these should be supplemented by a sufficient number of drips to remove the condensation from all unavoidable pockets or low points in the piping between the boilers and engines. When the piping is arranged as shown in Fig. 9 each end of the main should be drained in addition to the drips at the separators. In general, a separate trap should be provided at each end discharging into the receiving tank.

When the engine-room is at some distance from the boilers, and the flow of steam through the main is in one direction, the scheme illustrated in Fig. 10 may be employed with satisfactory results. In this case the main should be kept full size for its entire length and end with a pocket or reservoir to catch any sudden rush of water. The drainage from this pocket and the various separators may enter a common drip line leading to a trap discharging into the main receiver or to a system which returns the water directly to the boilers.

Trade Catalogs

A new style of centrifugal pump called a "series pump" is described in a catalog just issued by the De Laval Steam Turbine Co. In this pump double suction impellers and volute diffusers are used, as in single-stage centrifugal pumps. The connecting passages from stage to stage, however, are included in the pump case castings, as in the ordinary multi-stage pump. The advantages claimed are, perfect hydraulic axial balance and high efficiency under varying loads, as is characteristic of the single-stage pump. These series pumps are made with two or three stages. Where more than three stages are required, the use of two independent pumps operating in series and mounted on a single base plate is recommended in order to keep down the length of shaft between bearings.

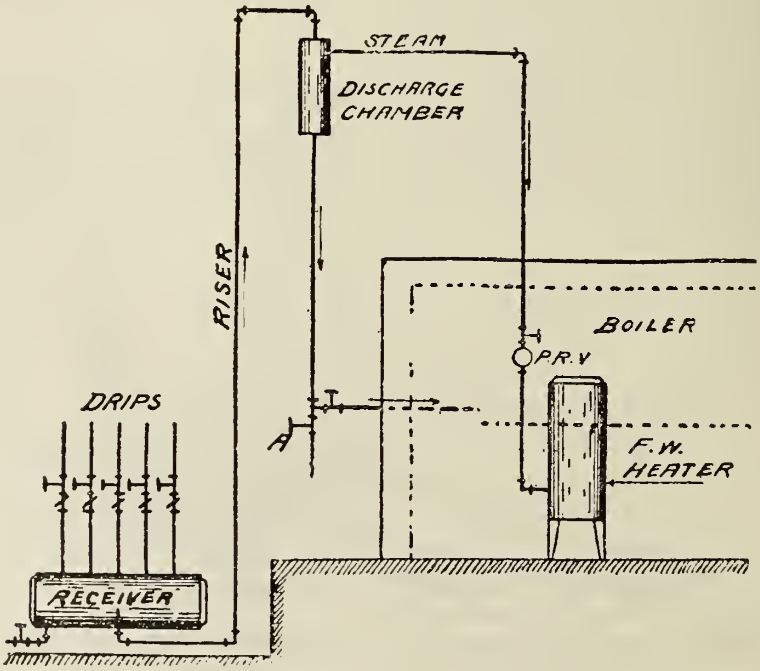


Fig. 10.

Excess Air Costly Factor in Boiler Operations

Experts See Increase in Efficiency of Steam Generation When Accurate Measurements of Air and Fuel Supplied as Well as Water Evaporated Can be Obtained

THE introduction of practical instruments for the measurement of very large volumes of gases has at last rendered possible the ideal for efficient steam generation—the continuous measurement of the air consumption.

A boiler plant is essentially a factory or process equipment for the production of steam at a given temperature and pressure, and the main raw products or ingredients are fuel, water, air, and labor.

If we are going to produce steam in the most economical and scientific manner, that is, work the boiler plant at the highest efficiency, it is necessary to keep a continuous and complete record of the labor costs, the amount and analysis of the fuel burnt, the amount and analysis of the water evaporated to steam—that is the production of the plant— and last, but not least, the amount of air used.

Labor Costing Simple

Labor costing is, of course, a simple matter, although most firms do not even do this properly. The continuous record of the coal or other fuel consumption is also quite easy, various automatic coal-weighing machines being on the market.

As regards the output of the plant, there are over twenty different feedwater meters and about ten steam meters available, so that here again no difficulty is experienced by anyone who desires to generate steam on efficient lines. As is of course well known, however, hardly any steam user adopts these obvious methods, even in electricity generating stations, and probably something like at least 90 to 95 per cent. of steam users in Canada have no accurate method of determining the output and true performance figures of the boiler plant. The consequence is that the average net working efficiency of boiler plants is only about 58 per cent.

Excess Cold Air

One of the great difficulties of maintaining a high figure is the trouble in connection with the prevention of excess of cold air passing through the fires, and boiler plants in general are at present being worked with an average of 75 to 100 per cent. excess air, that is, 20 lb. or over of air, or, say, 250 cubic feet at N. T. P. per pound of average semi-bituminous coal as compared with the theoretical figures of, roughly, 11.5 lb. air per pound of steam coal, or, say, 142.5 cubic feet at N. T. P.

This state of affairs is also indicated by the CO_2 figures in the flue gases. The table following is the result of over 400,000 determinations of CO_2 taken in nearly 400* power plants, giving an average percentage of CO_2 of 7½ per cent. corresponding to 27 per cent. theoretical loss in the coal bill from excess air.

CO2	Number of plants	Figure expressed as a percentage
12 per cent. and over..........	10	2.5
11 per cent	10	2.5
10 per cent.	39	9.75
9 per cent.	48	12.0
8 per cent.	60	15.0
7 per cent.	91	22.75
6 per cent.......	58	14.5
5 per cent.	51	12.75
Less than 5 per cent.	27	6.75
	394*	98.5

*Six plants in which figures were not reliable.

Assuming 12 per cent. CO_2 as a reasonably correct figure in practice, corresponding to 17½ per cent. theoretical loss, the actual saving to be obtained in the coal bill by increasing the percentage of CO_2 from 7½ to 12 per cent. would be about 9½ per cent.

> **The greatest enemy of progress is the closed mind. The engineer, the manufacturer or any one else who says, "This is my work," and will not learn and think beyond the day's need, is not only refusing to permit his own development, but is restricting his capacity for usefulness. The work that carries civilization forward in the service of mankind will ever be done by the individual. The leaders will be those not born but self-developed to a superior usefulness. And, happily, development comes to any man who permits himself to "grow."**

As we gradually reduce the excess air in the furnace, the percentage of CO_2 is increased in some corresponding proportion until we get to a point where CO and unburnt gases appear in spite of the presence of actual excess air. This point depends in practice on various conditions, chiefly the quality of the coal, but roughly it is about 14 per cent CO_2, which is equivalent to a 15½ per cent. theoretical loss in the coal bill owing to excess air.

Net Result a Loss

If now this figure for CO_2 is put up to 15 per cent. the net result is a loss. The theoretical saving obtained by raising the CO_2 from 14 to 15 per cent. is 1 per cent. of the coal bill (15½ per cent. theoretical loss—14½ per cent. theoretical loss) but there is at the same time a serious loss of about 7½ per cent. due to CO and unburnt gas, so that the net result is a loss of 6 per cent. in the coal bill in spite of the reduction in the amount of excess air, whilst a further increase to 16 per cent. CO_2 would give an enormous loss, and 17 per cent. CO_2 is equal to the excess air loss of only 5 per cent. CO_2—33 per cent. theoretical loss.

The "critical point of efficient combustion" is given by the highest CO_2 with absence of CO and unburnt gas, and it is obtained with roughly 12 to 17½ per cent. excess air for ordinary coal with mechanical stokers or hand firing.

The use of modern automatic flue gas analysing machines, therefore—either machines for determining both CO_2 and CO and unburnt gases continuously and giving a record of the results side by side on the same chart, or for determining both CO_2 and oxygen—are invaluable. But even duplex instruments in themselves are not sufficient, and what is really required is to enclose the whole boiler plant and admit the air under just as good control and measurement as the fuel and the water.

There is no practical objection to this plan from the point of view of the building, especially in the modern power station plant, for the whole installation can be enclosed so that all the air required enters through one central trunk or shaft. The doors can be of the double variety so as to be absolutely air-tight when the attendants pass in and out for the coal when entering, and for the ash and clinker when leaving.

In this trunk may be placed a modern type of large volume metering appliance. The average gas meter type of apparatus through which all the air would pass, is, of course, hopeless because of the size and expense.

Principle Gains Favor

The principle now gaining favor in Great Britain is that of the "Pitot" tube or "Venturi" disc, according to circumstances, as in steam meters. The slight difference in pressure, proportional to the volume of air flowing in the "Pitot" tube circuit, or in the neighborhood of the disc of slightly reduced internal diameter, is recorded by a suitable recording mechanism in terms of cubic feet of air, which must be corrected for temperature and barometer.

There is no difficulty about this correction, as the volume of air to be measured is not particularly great in com-

(Turn to page 46)

Practical Ideas From Practical Men

WATER COOLING

Here is a kink that may prove to be worth many dollars to the person who considers it safe to make a water cooler along the lines indicated in Fig. 1.

The writer was once connected with a company that made some water coolers in this way. The method was the first one that entered the head of the chief engineer and it looked perfectly logical to the rest of us. No doubt it has been used many times and perhaps it has been used successfully. I saw the method recommended in a refrigerating paper not long ago as being a good, dependable method,—but, Beware!

As shown, an ammonia coil is placed inside of a closed cylindrical tank for cooling the water. The water is supposed to be kept in continual motion, and if a sufficient quantity of water is circulated the method may be perfectly safe. But there is danger that circulation will not be maintained or that the temperature of the water will reach such a low point that the water begins to freeze, and when it begins to freeze —look out. The tank will burst due to the freezing and it will be found very difficult and costly to repair.

Fig. 2 illustrates a much better method —a method that is practically foolproof. The ammonia coils are placed in an open tank, as indicated, close to the top of the water level. Please note that the liquid in the open tank is not brine but is plain ordinary water. This water can freeze if it wishes to but of course it will freeze only at the top. The tank is made large enough so that it is not likely that the water will freeze clear over to the walls of the tank, consequently there will be no rupture. The coil being close to the top of the water where the water is always warmest, proper circulation is maintained. That is, as soon as the water cools it moves downward and the warmer water comes upward. The cold water therefore surrounds the lower coil, which is the water coil.

The temperature of this surrounding water will never be lower than 32 deg., consequently the water in the lower coil will not freeze and of course the water surrounding the lower coil will not freeze, as all of the freezing takes place at the top. In this way, circulation of water through the lower coil is always possible and there will be no clogging. In Fig. 1, in case the water should freeze solid, there would be no circulation of water.

Since the cylinder tanks shown in Fig. 1 were taken out and the open tanks similar to Fig. 2 installed, no difficulty from freezing has been experienced. Freezing of the water in the lower coils is impossible under regular working conditions.

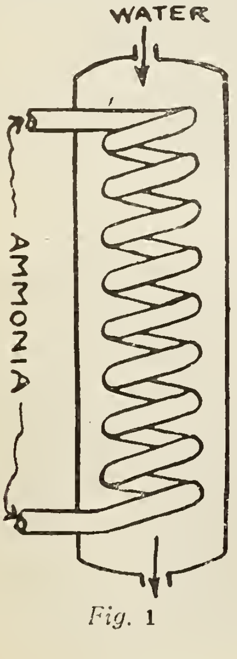


Fig. 1

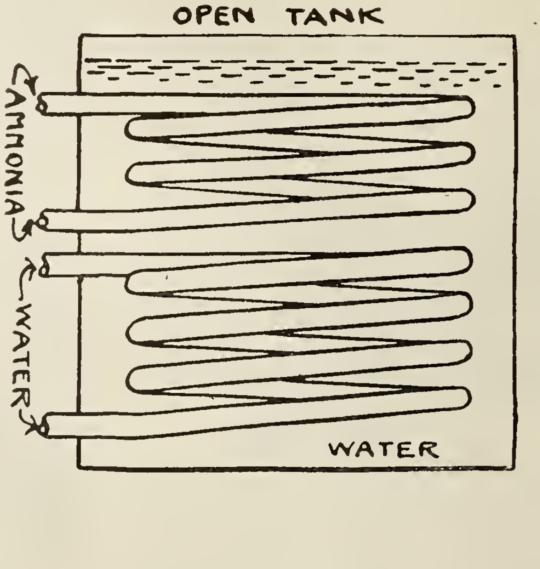


Fig. 2

REMOVING PIPE SCALE

I have read with interest recently various articles on the use of muriatic acid in removing scale from pipes, water jackets, etc.

It is perfectly true that under certain conditions muriatic acid will remove scale, especially when it is of a calcium-carbonate formation, since muriatic acid will combine chemically with this salt with the liberation of gas and the formation of a soluble salt, calcium chloride.

It must be borne in mind, however, that muriatic acid and other acids, which would have a like effect, are extremely powerful corrosive agents so far as iron, steel, brass, etc., are concerned, and even though extreme precautions are taken in employing it for removal of incrustation, the acid will exert its corrosive action on the metal in various places throughout the apparatus or lines to be treated. The acid, therefore, removes not only the incrustation, but also a certain amount of metal, depending on how long the metal is exposed to the action of the acid. The amount of metal removed is not such a serious factor unless the treatment is frequently employed, but it is a well-known fact that the corrosion that is started by acid has the ability to continue even after the original cause has been removed.

In other words, the use of powerful corrosive acids naturally starts up local seats of corrosion, which, while not evident to any appreciable extent at the completion of the acid treatment, are a source of future trouble unless extreme care is taken that every trace of acid be thoroughly removed by use of strong alkalies; even then there exists a possibility of future trouble due to the acid getting into small cracks and crevices, where it will continue its action.

The use of acid, therefore, for scale removal in expensive engine installations and pipe lines, is in my opinion poor practice. I remember that over twenty years ago certain engineers made a practice of putting hydrochloric, or as commonly termed "muriatic acid," directly into steam boilers for the purpose of clearing out the injector, piping, and the boilers themselves. Needless to state, this resulted disastrously in many instances.

The removal of scale from boilers, pipe lines, engine jackets, condensers, etc., can be accomplished efficiently and safely with certain treatments which have been developed after careful study and research, and therefore it is not necessary to resort to methods that involve the use of reagents having a powerful, destructive action on the metal.

ROBERT JONES.

BELT TRANSMISSION

A simple belt transmission rule that does not seem to be well known is this: "A single belt running one foot per minute will safely transmit one watt of electrical energy per inch of width of belt."

Thus, if a single leather belt one inch wide runs 5,000 per minute it will transmit 5,000 watts. If the belt is 10 in. wide it will transmit 50 000 watts at the same speed of 5,000 ft. per min.

5,000 watts is equal to 5 kilowatts.
50 000 watts is equal to 50 kilowatts.

Should it be desired to convert the watts into horsepower, multiply the number of kilowatts by 1.34. Or multiply the number of watts by .00134.

Thus, 5 Kw × 1.34 = 6.7 h.p. or 5,000 W. × .00134 = 6.7 h.p.

The above also applies to solid woven cotton belting of the same thickness as leather belting. For light double leather belts add 25 per cent. For heavy double leather belts add 60 per cent.

TWO CYCLE ENGINE

Below is a formula developed by the writer for fitting the average two-cycle engine.

Of course, formulas of this kind are not absolutely accurate but they fit most cases, and that is what we want, in any case, much depends upon the workmanship, age, tightness, looseness, etc. of the engine and its parts.

My formula is:—Multiply the bore of the cylinder in inches by itself, then by the length of stroke in inches, then by the number of revolutions per minute, then by the number of cylinders, and divide by 10,800. The result will be the horsepower of the engine.

Expressed algebraically the formula is:—

$$\frac{D^2 S R N}{10,800} = \text{H.P.}$$

where D = Dia. of cylinder in inches.
S = Length of stroke in inches.
R = Revolutions per minute.
N = Number of cylinders.

W. F. SCHAPHORST.

CARING FOR CATALOGS

It is usual for power plant engineers to collect countless catalogs on different types of equipment, and after giving them the once over, to lay them aside carelessly instead of having them properly filed for future reference.

Some time ago I called at a plant to make an inspection of a large engine. This engine was equipped with an automatic stop, and as I had never seen one of that particular make, I asked the engineer if he had an instruction book on this device. He replied that he did have one, but did not know just where it was, and I soon found out that he was in no way interested in the device, and knew absolutely nothing about it.

To me this made the risk a poor one, as the care an engine gets is of great consideration in insurance. In talking further with me the engineer said that he had found it practically impossible to keep track of catalogs, so I outlined for him a system I have used for several years with good results.

I first had some boxes of convenient size made of light wood, and divided into five compartments by tin slides, and in the compartments, which are numbered A, B, etc., I filed my catalogs. I then made up a list of what was in each division and pasted it on the front side of the box over the compartment. I also keep a book on my desk in which I have a duplicate list (as shown in the cut) of what is in each compartment. With this system I have a record of each catalog on hand and can readily find any one desired.

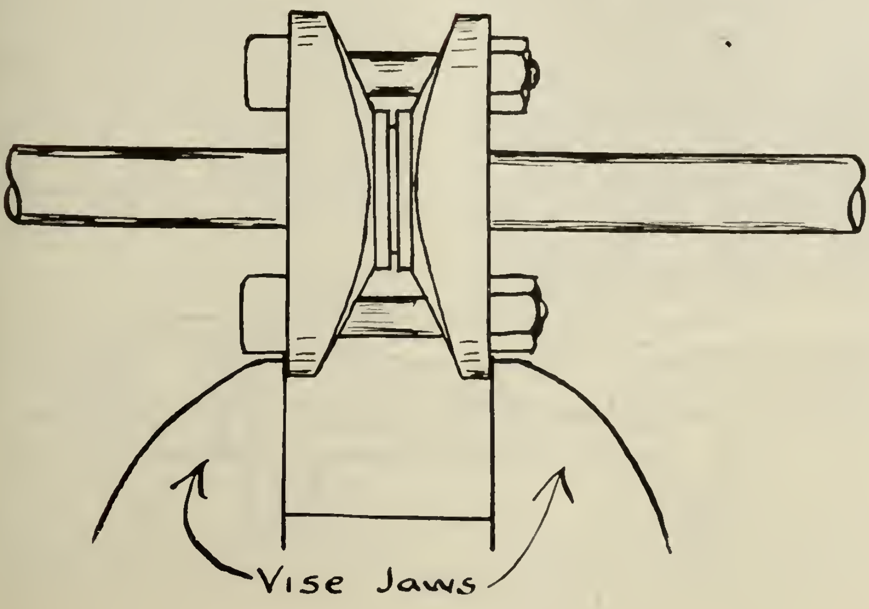
INSPECTOR.

REPLACING A BOLT

The sketch shows how I tightened a leaky joint in a liquid ammonia pipe line without first emptying the pipe to make the repair.

The lower bolt, shown in the sketch, was too short in the threads. That is, it was not threaded enough so that I could turn the nut on farther. Test with a sulphur candle showed the joint to be leaking on the lower side. I did not know what was the matter with the bolt at the time but I learned afterwards.

To replace the bolt I took a small vise off the bench and blocked it up under the pipe, as indicated, so that the jaws would just catch the flanges. I then tightened the vise jaws and relieved the bolt of its stress. I took off the nut from the bolt, removed the bolt and replaced it with another which was sufficiently threaded. The leak disappeared. The plant continued to operate without any hold-up.

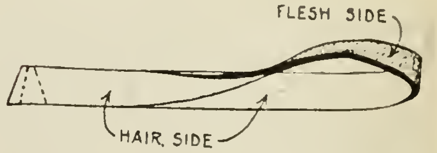


KINK IN CUTTING BELTS

Several years ago the writer was taught a valuable kink for cutting belts, as illustrated in the sketch herewith. This kink so far as I know has never before been published.

We are usually instructed, when cutting a belt, to use a square and make the cut "absolutely square" with the sides of the belt. However, if done in the manner illustrated here, it is not necessary to make the cut square. The important thing is to simply make the cut "straight."

This is done by giving the belt one turn as shown in the sketch and laying the ends one exactly over the other, both in perfect alignment. Then by making the cut "straight" even though not square with the sides, it will be found that the ends will make a perfect fit. The cut may make an angle of 45 degrees or even more with the sides. it makes no difference.



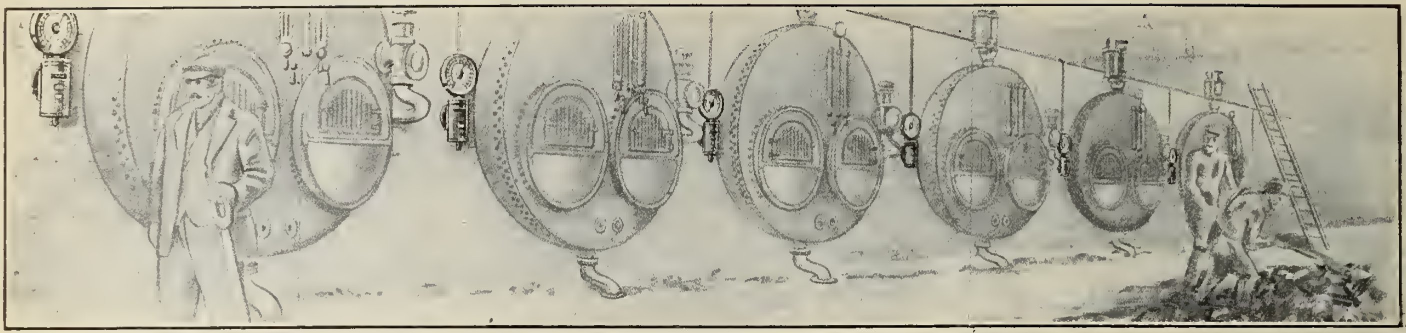
Of course, it is usually best to cut the belt square, or as nearly square as possible. By cutting it square, belting material is more likely to be saved than where the cut is made on an angle. But to be doubly sure, even if a square is used, it is a good plan to give the belt one turn as explained here and then if the square itself is not true, or if an error has been made in some way or other, the cut will automatically rectify itself.—W. F. SCHAPHORST, M.E.

The power plant at Redcliff, Alta., was struck by lightning and totally destroyed during a heavy storm on July 11. The damage is estimated at $15 000.

Harry Baker of the Provincial Hydro Commission is reported to have invented a listening device by which breaks in underground transmission lines can be located within six inches of the actual rupture.

The Underfeed Stoker Co. of Canada, Toronto, will supply stokers, and Goldie-McCulloch Co., Galt, Ont., will supply boilers, superheaters and economizers for the $58,300 addition to the power house at the University of Saskatchewan.

Gordon Perry, president of the English Electric Co., of Canada, leaves shortly for England, anticipating an absence of about six weeks largely on business connected with the company. His return may be followed by the announcement of a distinct broadening out of the activities of the company.



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.,
Director of Engineering, Central Technical School, Toronto.

The Injector—How It Works—Why Steam Forces Water to Move Against a Pressure Equal to or Greater Than the Pressure of the Steam

PRACTICALLY all steam engineers have at some time used an injector to feed water into a boiler, using steam from the same boiler, or even at a lower pressure than the boiler into which the water was being forced. They all know that this result can be accomplished; but very few engineers know why steam will force water to move against a pressure equal to or even greater than the pressure of the steam.

Records show that as early as the year 1570 a crude type of injecting apparatus was used to pump water. The earliest patent office records respecting injectors show that in 1818 Mannoury d'Ectot patented a device somewhat similar to the modern injector. In 1857 Bourdon, after whom the modern pressure gauge is named, and in 1858 Giffard, patented various features in connection with injectors. The instrument as improved by Giffard was, however, the one to which various modifications have been made in the development of the modern types of injectors.

Behavior of Fluids

Before going into the action of the injector, it is necessary for us to understand something of the behavior of fluids in flowing through various shaped nozzles. When water is forced into a boiler by an injector, work is done which necessitates the expenditure of energy. The only source of available energy is the steam. Energy may be in various forms, of which the more common are heat, motion, pressure, electricity, etc.

Steam contains energy in the form of heat, and when in a high pressure boiler, it contains available pressure energy. Energy can be converted from one form to another, for example: If high pressure steam escapes to the atmosphere, its pressure energy is changed to velocity or kinetic energy, except for the little that is used up in friction in the orifice.

Must Move Faster

Let us imagine a pipe of the shape shown in Figure 1. If there is some fluid flowing through it, it is obvious that the same amount of fluid must pass through section B as passes through sections A or C; but since the area of the pipe is much smaller at B than at A or C, the fluid must move faster through B than through A or C. The faster a body is moving, the greater is its kinetic energy.

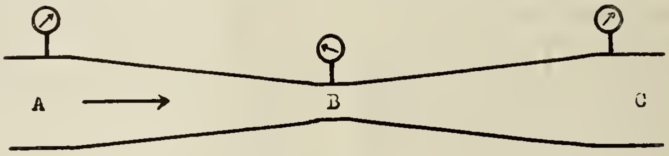


Figure I.

Therefore the kinetic energy, or the energy due to motion, of the fluid at B is greater than that at A or C. But the total energy at B can not be any greater than at A, because there is nothing to add energy to it, therefore, it must have less of some other form of energy at B than it has at A. On the other hand the kinetic energy at C is less than at B, therefore the fluid must have more of some other form of energy at C than at B.

The above deductions are borne out in practice. If we connect a water or steam pipe of this shape with pressure gauges as shown in Figure 1, we will find that when there is a flow through the pipe, the pressure at B is less than at either A or C. Thus we find out three things. 1st—That a fluid will flow from a low to a higher pressure under certain conditions. 2nd—That when a fluid flows through a converging nozzle, such as from A to B, Figure 1, the pressure decreases, but the velocity increases. 3rd—When a fluid flows through a diverging or expanding nozzle, such as from B to C, the pressure increases as the velocity decreases.

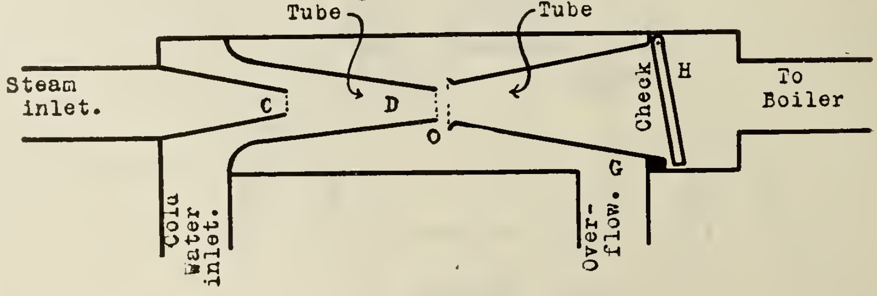


Figure II.

In its simplest form the injector is something the form shown in Figure 2. The action of the steam and water in it is as follows: High pressure steam from the boiler passes through the converging nozzle C where its pressure is reduced but its velocity increased. This steam passes on through the converging nozzle D where its pressure drops below atmospheric pressure. The steam can not open the check valve H because there is boiler water pressure behind the flap, so the steam escapes through O to the overflow G.

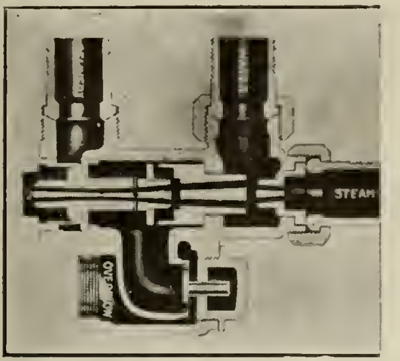


Figure 3.

The rapid flow of steam through D carries with it, or entrains, any air there may be in the cold water supply line, causing the pressure therein to drop below atmospheric. Water will then rise in the supply pipe until it comes in contact with the steam jet in the combining tube, as nozzle D is called; here it condenses the steam at the same time absorbing any energy it contained.

The kinetic energy that was in the steam is sufficient to give the water speed or velocity enough through the jet D, that it enters the delivery tube, which, being a diverging nozzle, causes an increase in the pressure of the water as the velocity decreases. This increase in pressure, as will be proven later, is more than sufficient to overcome the pressure of the boiler water on the back of the check valve, and the water passes through into the boiler.

High Vacuum at O

Because of the high vacuum at O. usually a vacuum up to 25 inches of mercury. air would be drawn in through the overflow G and forced into the boiler with the water. To prevent this action, the overflow is usually provided with a check valve, though sometimes a hand operated valve is used, which should be closed as soon as the water starts to come through the injector.

A modern type of automatic injector is shown in Figure 3, while Figure 4 shows a positive injector commonly known as the locomotive type.

To prove that the principles stated above will accomplish the stated object, it is necessary to study the relative amounts of energy imparted to the feed water by the steam, and required by the water in order to enter the boiler against pressure. Before going into this question, it may make the operation of the injector appear more simple if we consider the volumes of steam and water drawn from and put into the boiler by the injector.

As a general thing an injector will feed from 10 to 25 pounds of water into the boiler for every pound of steam used. Let us assume for sake of an example a large amount of water such as 20 pounds per pound of steam, because if we can prove that one pound of steam will put twenty pounds of water into the boiler, it is obvious that it will easily put in less than that amount. While inside the boiler the steam used and the water fed will be at the same pressure.

At 100 pounds pressure per square inch by the gauge the volume of one pound of steam is about 3.83 cubic feet. The volume of the water put into the boiler will be that of the 20 lbs. of water and the 1 lb. of condensed steam, which will make just over 1/3 of a cubic foot. Thus we see that the volume of steam taken out of the boiler is about 11½ times as much as the volume of the water put in. This looks as if there ought to be energy to spare, which we will find to be so.

Energy Used Up

Let us now consider the energy used in the injector. Consider one unit of mass, or weight, of steam. In a large steam supply pipe leading to the injector this unit mass of steam has large pressure energy and practically no kinetic energy. It has been found experimentally that steam issuing through a jet from 100 pounds per square inch gauge pressure has a velocity of 1,466 feet per second. The kinetic energy of the steam escaping through a steam nozzle is given by the formula $E = \frac{1}{2}MV^2$ when M is the mass or weight and V is the velocity of the steam in feet per second. Thus one unit mass of steam has energy equal to ½x1x1.466 = 1,074,578 foot pounds, or in round numbers says 1,075,000 foot pounds.

If this one unit weight of steam is condensed by and mixes with 20 units by weight of water, the total kinetic energy is transferred by impact to the mixture. By reversing the above formula we get

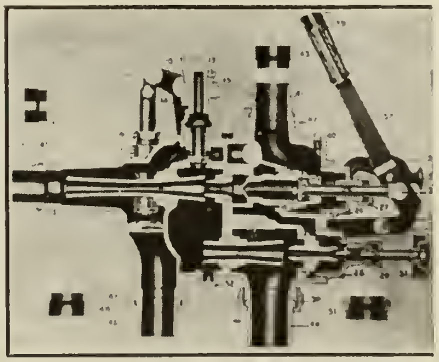


Figure 4.

$$V^2 = \frac{E}{\frac{1}{2}M} = \frac{2E}{M} \text{ or } V = \sqrt{\frac{2E}{M}}$$

Thus the velocity of the mixture at the end of the combining tube in the injector will be

$$V = \sqrt{\frac{2 \times 1{,}075{,}000}{21}} = \sqrt{102{,}381}$$

or about 320 feet per second. We shall now see how much pressure we could develop by passing this water through a diverging nozzle such as B-C in Figure 1 or the delivery tube in an injector.

Experiment has shown that the velocity of water in a jet is found by the formula $V = \sqrt{2gH}$, or $V = 12.03\sqrt{P}$, where V is the velocity in feet per second, and P is the pressure back of the jet in pounds per square inch. Reversing this formula we get

$$\sqrt{P} = \frac{V}{12.03}, \text{ or } P = \frac{V^2}{144.7}$$

Thus the pressure increase, if our jet keeps on expanding until the velocity is negligible, or all the kinetic energy is converted into pressure energy, will be

$$\frac{320^2}{144.7} = \frac{102{,}400}{144.7} = \text{about } 709,$$

or over 700 pounds per square inch. It is thus seen that the water moving with this velocity could be made to produce any pressure up to this limit. In practical injectors, however, the discharge nozzle is not expanded so large as to reduce the velocity to a negligible amount, but just enough to insure the pressure of the water being well above boiler pressure.

In closing, the author might answer a question which large numbers of engineers have asked him. "What is the difference between an inspirator and an injector?" The word "inspirator" is the trade-mark of the Hancock Co., who make injectors under this name.

Joseph E. Michaud, member of the provincial government of New Brunswick without portfolio, has been appointed a member of the New Brunswick Electric Power Commission.

The Quebec Power Co. directorate met in Montreal on July 13, to arrange final plans for taking over the Quebec Railway Light, Heat and Power Co.

W. R. Clubb, Minister of Public Works, Winnipeg, will receive tenders up to August 2, 1923, for the supplying and erecting of one water tube boiler at the power house, Hospital for Mental Diseases, Selkirk, Man.

George Kidd, general manager of the British Columbia Electric Railway Co., Vancouver, B. C., was appointed president of the company by the board of directors at a recent meeting in London, England. W. G. Murrin has been appointed vice-president, and A. T. Goward manager of the Vancouver Island System.

Rules for Routine Operation of Power Boilers

A.S.M.E. Sub-Committee Suggests Best Methods of Obtaining Maximum Efficiency at a Steam Pressure Exceeding 15 Lbs. Per Sq. In. Above Atmospheric Pressure

IN STARTING a new boiler or one that has been out of service for an extended period, see that the combustion chamber and gas passages are clean and in good repair. See that all clean-out doors are closed tight.

Operate and see that both inlet and outlet dampers are free and in good condition. Leave the back dampers open. Operate the stoker and draft fan to see that they are ready for service. Make sure that the grates are satisfactory and in place.

Examine the inside of the boiler and make sure that it is free from tools and foreign matter and that there is no one in the boiler; then close manhole openings.

See that blow-off valves, water column and water-glass drains, try cocks and feed valves are in good working condition and closed. Open vent valves.

By means of auxiliary feedwater connections, fill the boiler with water to a level a little above the surface blow-off and then close the auxiliary feed connections. Open and close try cocks and blow-down valves on water column and water glass in order to make sure that these connections are not stopped up.

Draw off water through surface and bottom blow-off valves until the level of the water in the boiler is at the bottom of the water glass and then raise the level of the water to a point about half inch below the normal water line by opening the stop valve in the main feed line.

Ease Up on Stem

Ease up on the stem of the main stop valve without lifting the valve off the seat in order to make sure that the valve is not stuck.

Open valves to steam pressure gage.

If coal is used as a fuel, cover the grate with a thin layer of coal and start a light fire. Where pulverized coal, gas or oil is used as a fuel, make sure that the back damper is wide open, create light draft, with fan if necessary, place torch or fire near burner to insure quick ignition and start light fire by admitting fuel slowly.

If the boilers use oil as a fuel and the system is new or has been out of service for a considerable period, first clean and examine the strainers and remove, clean and examine tips and burners. If compressed air is available, blow out the oil supply lines with air. Place and adjust burners and tips and work the air register to see that they are in good working condition. Close individual burner throttle valves.

Remove any spilled oil about burners, fronts and floor and see that there is no oil on the floor of the combustion chamber. Ventilate the boiler by opening draft gates and dampers.

If no steam is available for oil pump and burners, raise steam in boiler by wood fire. Remove any excess accumulation of water in oil tank. Have oil pumps warmed up ready for use. Open suction-line valves and pump oil to burners. If oil lines are equipped with air chambers, charge them with compressed air. Examine oil lines and equipment for leaks.

Light Center Burner

Light the center burner by holding hand torch near and just under tip or burner standing well clear to avoid possible flare back. If torch is snuffed out before oil is lighted shut off the oil and relight the torch. Always use the torch for lighting burners until the brickwork is intensely hot and even then if all burners are out. Next light the adjacent burners but be sure that there is an excess of draft before lighting additional burners. Do not permit the oil to impinge on the brickwork or parts of the boiler.

Enclosed find $2 subscription to Power House for one year. Mail the paper to Daniel Fenton, P. O. Box 271, Drumheller, Alta. Mr. Fenton is a friend of mine and I have shown him how much good he can get out of your paper, so he asked me to mail his subscription at once. I have been a subscriber for about eight years and I would not be without one now.

Gilbert D. Barchyn,
P. O. Box 209
Drumheller, Alta.

Test the steam coils in the heater for oil.

After starting a light fire and if the entire setting is new, the fire should continue until the brickwork is dried out thoroughly which in the average case takes several days; if the combustion chamber only has been renewed keep the fire going about 48 hours. After the usual week-end shut down, a light fire should be carried for about one hour. Only in extreme emergency should steam be raised in less than a half hour. Do not permit the fire to generate a steam pressure until about thirty minutes before cutting the boiler into the line.

In case of a new setting, ease up on buck stays and tie rods to allow for possible expansion of the brickwork. After water becomes heated, check the level of the water in the glass with try cocks and examine blow-offs for leaks. After steam has escaped through the vent valves for a few minutes, close the valves.

After brickwork is dried out and the boiler heated, begin raising the steam pressure slowly, especially in internally fired boilers where the circulation is sluggish. Keep the water level constant. When the steam pressure approaches the working pressure, examine the boiler for leaks, blow out the pressure gage connections and test the safety valve by hand. Blow down boiler to remove sediment.

Protect Before Lighting

If the boiler is equipped with a superheater of the indirectly fired type not constructed to withstand the intense heat during the firing up period, see that it is protected before lighting the fire by flooding or by closing dampers installed for the purpose.

Drain very thoroughly the steam connections between the boiler and the header or steam main. Where a non-return check valve or stop and check valve is not installed, the stop valve shall be opened very slowly and only when the pressure in the boiler is exactly the same as the pressure in the header. If the main stop valve has a by-pass, the by-pass should be used until the pressures are equalized. In any case the stop valve shall be opened very slowly and the operator should stand by for a few minutes after the stop valve has been opened wide; if any disturbance or hammer occurs in the boiler or in the pipe line, close the stop valve at once.

If a non-return check valve or stop and check valve, as the case may be, is installed, open the stop valve when the pressure in the boiler is 10 or 15 lb. less than the pressure in the header, and let the non-return check operate automatically.

Firing Boilers

Aside from the standpoint of economy, the fire should be maintained as uniformly as possible in order to avoid excess combustion, undesirable variations in temperature and possible gas explosions.

Fires should be cleaned at stated periods, if possible, and when boilers are operating at low rating as at noontime and just before peak loads. Avoid holes in fire and excessive draft while burning out the fire. Clean fires as rapidly as possible to minimize cold air in the boiler. Do not fire too heavily immediately after cleaning. Do not pile hot ashes and clinkers against boiler front, use care in quenching and remove ashes as soon as possible.

Do not bank fires any more than necessary. When fires are banked, make sure that a continuous light current of air is passed through the boiler. This is usually accomplished by having the ashpit doors closed, the firing doors slightly opened and the back damper perforated or nearly closed.

Handling Boilers

The most important rule in the safe operation of boilers is to keep water in the boiler and as constantly at the proper level as conditions will permit. Never depend upon automatic alarms or feedwater regulators. Any inattention, other duties or reliance upon automatic devices cannot be accepted as an excuse for a boiler damaged by low water level.

The first duty on entering the boiler room is to ascertain whether the valves and connections between the boiler and water column are free and open especially when starting up in the morning after the fires have been banked over night. Then blow down the water column, noting the return of the water in the glass, and try the gage cocks until sure of the water level. This should be done at the beginning and end of each shift and also several times during the shift. Have the water column well lighted and keep the water glass clean. Do not allow steam to leak from the water column or its connections, as this will cause the water glass to show a false level.

Try Gage Cocks

If the level of the water is not visible in the water glass, try the gage cocks to determine whether the level of the water is above or below the water glass. If the level is below the water glass, stop the supply of fuel immediately and then the supply of air; close the dampers and ashpit doors. Close the feedwater valve and under no circumstances feed water into the boiler. Haul the fire and, in the case of stokers or chain grates, keep them in motion with the fire doors open. Do not throw water on the fire with fire or other hose. Do not open the safety valve or change the steam outlet valves or make any changes that will cause a sudden change in the stresses acting upon the boiler. Examine the bottom blow-off valves and repair them if they are found defective. Find the cause of the failure of the supply of water.

If foaming occurs check the fuel supply and close the steam outlet valve long enough to determine the true level of the water in the glass. If the level of the water in the water glass is sufficiently high, blow down some of the water in the boiler and feed in fresh water. Use surface blow-off if any are installed. Repeat the alternate blowing-off and feeding several times, and if the foaming does not stop, draw the fire and continue the alternate blowing-off and feeding. When the boiler is sufficiently cooled off, empty the boiler and look for the cause of the foaming which may be caused by oil or other foreign matter in the feedwater or by scale solvent. Test safety valve and connections of water column and water glass for any choking or sticking. Determine positively the cause of foaming and adopt measures to prevent its recurrence.

Beware of Oil

Watch carefully for any signs of oil in the feedwater heaters, water glasses and blowdowns. If a boiler becomes coated with oil or grease, shut down the boiler and clean it thoroughly.

Execute carefully all instructions given for the treatment of feed water in your particular boiler room. Do not experiment with "home made" treatments or boiler compounds, unless advised to do so by a chemist experienced in feedwater treatment.

Except where the amount and frequency of blowing down is determined by chemical analysis, blow down at least one gage every twenty-four hours. The amount of blowdown depends upon the number of hours per day the boiler is in service, the rate at which it operates and the kind of feedwater used. Blow down the boilers at a period in the day when the circulation of water in the boiler is slowest. Always open the cock first and the valve second; in closing, close the valve first and the cock second.

Always open and close the blow-off valves carefully and slowly; if unusual effort is necessary to close the valve or cock, do not try to force them shut but empty the boiler and find the cause. In blowing down, open the cock or valve until it is half open and leave in that position until the water is blown down about half an inch in the water glass; then open the cock or valve wide open until the blowing off is completed. See that the valve shuts tight and remains tight. Repair all leaky blow-offs as soon as discovered. Use the surface blow-off frequently for a short period of time.

Lubricating oil used on the main and crankpin bearings will pick up minute particles of carbon if the engine is of the trunk piston design. This carbon will not settle out of the oil, and a first class filter or filter press is necessary. The loss in oil should be made up at least once a week and it should be remembered it does not pay to use cheap oil. All reputable oil companies have an oil suitable for Diesel engines and the engine builder is in a position to advise as to the best oil.

To Signal Operator

Where the water glass is not in view of operator blowing down a boiler, another operator shall be stationed where he can see the water glass and signal to the operator who is blowing down the boiler.

When small leaks occur, locate their source and repair them as soon as boiler can be removed from service. If a serious leak occurs such as a leak along the longitudinal seams, shut down the boiler immediately by gradually reducing the steam pressure and have the boiler examined by an authorized inspector.

Do not make any repairs upon a boiler, piping or auxiliaries while they are under steam pressure. Calking of pipes and joints and setting up of nuts and bolts under pressure to stop leakage must be prohibited.

Soot should be dusted from the tubes once a day; whether a lance or soot blower is used, drain the steam or air-supply connections so that the steam or air is practically dry. Never use steam for dusting off tubes when the boiler is not under pressure. When a boiler is to be shut down, dust the tubes before the fire has died out and with the draft on after the boiler has been cooled, brush or scrape any hardened soot or deposit from the tubes.

Remove ashes frequently and do not permit the accumulation of any large amount of ashes in the ash pit, boilers, flues or base of stacks. Do not pile ashes against the furnace front and, when wetting down ashes, make sure that no water is thrown upon hot castings. Do not leave ashes banked about blow-off pipes as a protection.

When ashes are removed by a suction system, an explosion door shall be provided on the storage hopper. Where steam-jet ash conveyors are used, see that all operators are warned against the water which may collect upon the top of the ashes in the hopper and may flow suddenly from the gate when the ashes are being removed. When necessary to bar through the gate to release clogged ashes, the operator shall be warned to stand sufficiently aside to avoid being burned by the hot ashes or water.

Care of Appliances

Test the safety valves at least once a day by gently raising the valve off the seat by hand, or, when practicable, test the valves daily by raising the steam pressure to the blowing pressure of the safety valve. If the valve sticks do not try to release it by hammering; drop the pressure in the boiler and clean the valve seat or correct any other defect that may be found. Repair or replace leaking safety valves as soon as discovered.

When a safety valve blows, note the pressure on the boiler steam gage and, if the stipulated blowing pressure varies more than 5 lb. from the pressure noted on the gage, test the gage. If the gage is found correct, adjust the safety valve.

Do not permit setting or adjustment of safety valves by any one but a competent person. Do not have the water in boiler above the highest gage cock when setting or adjusting the valve. When the spring becomes weak and must be screwed down to secure the stipulated blowing pressure, make sure that the spring is not screwed down so far that there is a restriction of the proper amount of opening of the valve.

Do not open the safety valve to reduce the pressure in the case of low water in the boiler.

Blowing Off Point

Never set the blowing point of a safety valve above the authorized pressure of the boiler.

When making a hydrostatic test do not try to hold the safety valve closed by screwing down the spring; blank the valve, clamp the seat in place or use some other suitable method. Make sure that the safety valve is placed in good working condition after the hydrostatic test has been made.

Keep scale, dirt or other foreign matter from collecting between the coils of the spring. When running a wire in the drain hole in the escape pipe to ascertain if it is clear, be careful that the wire does not move scale that may fall over the drain opening when the wire is removed.

Blow down the gage connections frequently and especially when checking the safety valve, raising steam in a boiler and when foaming occurs.

Broken Water Glass

When a water glass has broken, remove the broken pieces and, with head turned away from the water column, slowly open the bottom valve to blow out any remaining pieces. Before inserting the new glass, see that the glass is of the exact length required and that the connections are in line. Insert the glass and set up the stuffing-box nuts, taking care not to set them up too tight. Then warm the glass by opening the drain cock of the glass and with head turned aside, open the top valve slightly and let a small current of steam flow through the glass. Close the drain cock after the glass is sufficiently warmed, open the bottom valve slightly and when the level of the water in the glass has become stable, open the bottom valve wide and then open the top valve wide, all the while keeping the face turned to one side.

Water glasses must be kept clean. Do not clean a glass with waste or linty cloth; use cloth, free from lint and dirt, wound about a wooden stick. Do not use a metal rod that would scratch the glass and start a crack.

Boilers Out of Service

To cut out a boiler, first cut off the supply of fuel. In a coal-fired boiler close ashpit and fire doors and close dampers. In an oil-fired boiler, continue the air supply until any oil on the floor of the combustion chamber is consumed and the gas passages are well ventilated; then close dampers. After the boiler ceases to require feed water and the non-return check valve, if any, on the steam line has closed, close the main steam stop valve. When possible blow-off the tubes before the fire has died out. Fill the boiler to three-fourths of a glass.

After the fires have died out, close all doors and open dampers. When the pressure has dropped to blowing down pressure clean the furnace of all coal and ashes and permit the brickwork to cool for not less than two hours. When there is much sediment in the boiler, longer time must be allowed.

After cooling off the setting, open the blow-off valves when the pressure in the boiler has been reduced to about 10 lb. if it is not feasible to empty the boiler at atmospheric pressure. When the boiler to be emptied is set in a battery, make sure the blow-off valves that are opened are on the boiler which is to be emptied. As soon as the boiler is empty, remove the manhole plates and covers of other openings.

Examine Boiler Often

Examine boiler frequently to determine how often the boiler should be washed. Wash more frequently when the boiler runs longer hours per day or at higher ratings, when feed water becomes foul or when scale solvents throw down scale.

Remove manhole and handhole plates, close feed valves, steam outlet valves and blow-off valves and hang sign on boiler to indicate that a man is working inside.

Use hose with considerable force or hand tools, if necessary, to remove scale. Disconnect blow-off pipe close to the boiler and run water to waste. Horizontal-tubular boilers should be washed from below as well as from above. See that the water does not get on the brickwork of the combustion chamber.

Pass Light Inside

After washing the boiler pass a light inside and see that the cleaning has been thorough and that no tools are left inside. If the boiler has been treated with kerosene in the feed water, ventilate the boiler; do not use a naked flame to examine the boiler.

Do not remove scale with kerosene if it can be done by any other means. If it is used, see that the boiler is dry and cool. Do not use kerosene in large quantities in a room where other boilers are in service unless special precautions are taken to keep the vapors from escaping into the boiler-room. Keep all lights away from the boiler except incandescent lamps enclosed in moisture-proof globes and guards.

Spray the inside of the boiler and, after allowing it to stand a sufficient length of time, wash thoroughly with hose and copious amount of water. Do not enter the boiler until it has been thoroughly ventilated. Also ventilate the boiler before entering it the next time that it is opened.

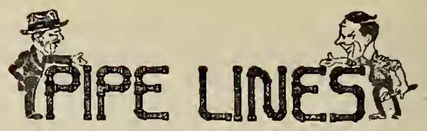
When boiler has been allowed to become heavily scaled or coated with oil it may be cleaned by boiling out with soda ash and kerosene. Fill boiler well above water line with water containing 50 lb. of soda ash and 5 gallons of kerosene to 1000 gallons of water. Close the boiler and start light fire sufficient to carry about 5 lb. pressure in the boiler. Continue boiling for two or three days, empty the boiler, then wash thoroughly and ventilate the boiler. Use the usual precaution against oil and vapors.

Personals

The Dominion Power & Transmission Co., Terminal Sta., Hamilton, has purchased additional power from the Canadian Niagara Power Co., to supplement its own supply from Decew Falls, and plans to install machinery and equipment for changing 25-cycle current to 60-cycle, at Niagara Falls, Ont.

F. W. James, manager of the Union Natural Gas Co., Chatham, Ont., is resigning and his place will be taken by S. A. Morse, at present secretary of the company. R. W. Bevan, formerly of the Canadian Western Natural Gas Co., Calgary, is now associated with the Union Company as superintendent of production.

The Bancroft Light, Heat & Power Co., Bancroft, Ont., is having plans prepared for the development of 2,500 h.p., about 50 ft. head, equipment to include turbines, generators, oil switches, circuit breakers, lightning arresters, insulators, panels, cranes, gates, racks, etc., at High Falls. The cost is estimated at $300,000.



PIPE LINES

No longer little Micky Hare,
Whose ways are mild and meek,
Will keep my clothing in repair
For 50 cents a week.
He now demands a larger sum
Which I esteem too dear
For lately Michael has become
A Pressing Engineer.

* * *

A slight adjustment of speed in a shunt or compound-wound motor may be accomplished by shifting the brushes; movement in a direction against the rotation causes an increase of speed, and *vice versa*. Too great a movement may interfere with good commutation. A greater increase in speed may be accomplished by weakening the field or by increasing the air gap by removing shims under the polepieces.

* * *

The days when Tonio Dorio
Would clip and trim my lawn,
And make my kitchen garden grow,
For ten a month are gone.
He now is making wads of pelf
Takes contracts by the year,
And on his billheads styles himself
A Mowing Engineer.

* * *

A governor is said to be stable when it assumes a definite position for each particular speed and when a change of speed is necessary for a change of position, while a governor which is in equilibrium at but one speed is said to be isochronous. Perfect isochronism would be impractical as the slightest increase in speed above the normal would result in cutting off the steam, accompanied by a sudden decrease of speed, following which the steam valve would open wide thus giving rise to extreme fluctuations.

* * *

The lads from Greece who cleaned my shoes,
Once in a cheaper time,
Now with haughty scowl refuse
My little proffered dime.
One sees them by appointment now,
They're risen, it appears,
And have become, so they avow,
Shoe Surface Engineers.

* * *

Every direct-current generator of regular construction may be operated as a motor, and *vice versa*. The only essential difference is in the controlling apparatus. When used as a dynamo, the machine is provided with a high-resistance rheostat connected in series with the shunt-field windings and when used as a motor it is provided with a low-resistance starting rheostat connected in series with the armature. When run as a dynamo, however, the speed must be somewhat higher than when run as a motor, if the voltage remains the same in both cases; this is due to the voltage drop through the armature circuit.

Editorial Comment

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

N. C. SHATFORD
News Editor

The Sting of "The Puff"

"ONE reason I'm now strong for Power House," said a stoker manufacturer in Toronto last week, "is because the paper no longer gives 'puffs' and over-done write-ups. Its pages are filled with news, ideas and real information of value to the engineer."

That statement merits thought as to the real nature of a "puff"—that relic of the old patent medicine days—when a reader read about a marvelous case which was finally cured with a bottle of Billsby's Bilious Bitters, and when the reader had read to the end, shouted "stung," and threw the paper at the cat.

In Power House to-day advertising is recognized as advertising and editorial matter as editorial matter. And there is a written law that never the two shall be mixed.

Nobody now pays attention to puffs. No, nobody except those who are puffed, and even they don't believe what the puffers say.

The pages of Power House are always wide open for news, ideas, information, anything that will help engineers to cut operating costs with the minimum of labor. Instead of "puffs," which at best had little meaning and still less value, we can all help ourselves by helping to gather really practical ideas in power plant economy.

What everybody is interested in is what engineers are doing, how they are doing it, and what the results are.

High Pressure Steam Values

THE value of steam as a means of transforming heat into work lies, as every Canadian engineer knows, in the comparatively large amount of heat energy which can be transferred from the furnace to the engine by every pound of the working fluid, without involving pressures or temperatures beyond the resistance of ordinary materials.

Practical considerations for many years limited steam pressures to about 200 lb. per sq. in. but with the development of manufacturing methods, a decided tendency is now evident to operate boilers at much higher pressures, indeed, a steam pressure of 350 lbs. per sq. in. is not regarded to-day as exceptionally high.

There are two reasons for this tendency to increase pressures. One is the desire to secure greater thermodynamic efficiency, and the other is the appreciation of the practical benefits of the reduction in the size of steam pipes which high pressures render possible.

The latter reason is of considerable importance, for when a single turbo-generator may require as much as 150 tons of steam an hour, the less the volume of the steam, so long as boiler drums, pipes and joints will stand up, the better.

High pressure generation of steam is bound to give rise to problems in boiler construction and maintenance which may not be easy to solve, and the question obviously arises as to what compensating advantages in efficiency may be hoped for.

The value of a pound of steam is, of course, by no means proportional to its pressure, but only to the amount of heat which can be transformed into work by expansion to some lower pressure.

Taking 0.5 lb. absolute or a vacuum of about 29 in. as the lowest practical exhaust pressure, a pound of dry steam at 500 lb. pressure, if used in a perfect engine, will only do 15 per cent. more work than the same weight of steam at 200 lb. pressure. The proportion of the heat supplied to the steam, which can theoretically be turned into work, is 35.3 per cent. in the former case and 31.96 per cent. in the latter so that the gain, either in work or efficiency due to the higher pressure, is not very great.

If we push the initial pressure still higher, say to 2,400 lb. per sq. in., much the same result is obtained. The available work per pound, calculated from Professor Callendar's tables, is 261.16 pound-centigrade units, or only 27.05 per cent. more than in a pound of steam at 200 lb. pressure, and the thermodynamic efficiency of a perfect engine using steam even at this extremely high pressure would not exceed 41.78 per cent.

In practice, of course, greater efficiency is sought by superheating steam to the highest temperature which practical considerations permit, at present, about 700 deg. Fahr. In order to take advantage of the Centigrade scale we will assume an upper limit of temperature of 380 deg. C., the equivalent of 716 deg. Fahr. With steam at this temperature, at 200 lbs. pressure, in a perfect engine exhausting 0.5 lb. absolute, the available heat will be 251.53 units, which is 33.82 per cent. of the total heat supplied to the engine.

At an initial pressure of 500 lb. the available heat will be 276.58 units, or 37.6 per cent. of the total, and at a pressure of 2,400 lb. the corresponding figures are 295.78 units, or but 43.28 per cent. of the total.

These figures are sufficient to show how slowly the value of steam increases with its pressure, whether superheated or not. Nevertheless every increase in efficiency, however small, is worth obtaining, if it is not counterbalanced by corresponding disadvantages.

The Structure of Society

THE foundation upon which the structure of society is built is as old as society itself. This foundation is confidence. Customs, manners, and usages may change with the centuries, but confidence must endure lest the superstructure tumble. The world views differently from generation to generation the life and the interrelations of men, and draws different conclusions. Laws change as conditions change, and methods of life are constantly changing.

Man of to-day is born with the same instincts, with the same nature as man of a thousand years ago. He has, however, learned to restrain his instincts; to treat his fellows with more respect and consideration; to have confidence in his neighbor; and not to look upon society as a natural enemy.

Confidence is a state of mind or a firm belief in the trustworthiness of others. It manifests itself in our actions; in our behavior towards one another; and in the most common and homely affairs of every day. An executive has confidence in his engineer, his lawyer, his banker; and this confidence is an expression of the development of human nature brought about by education and necessity.

There will alway be pessimists as there always have been. They will tell you that the world has not changed for the better, and that there is no more honesty to-day than in the time of Alexander, Charlemagne, or Napoleon. These are the people who contend that every man has his price. Having no confidence in themselves, they have none in any one or any thing.

Electricity in the Power House

TRANSFORMER TESTS

IF THE utmost service is to be obtained from any transformer it is essential to conduct certain tests at regular intervals and also to make thorough periodic inspections of all the parts comprising the complete apparatus.

Contrary to what might at first be thought, it is infinitely more important to make thorough inspection of all the parts, rectifying any defects which might be found, than to subject the apparatus to certain tests, though these undoubtedly have their value. Tests that can be made on site are usually somewhat limited in extent on account of the lack of suitable testing plant and pressure and current, and only in large power stations and the like can complete tests be made which would be comparable with routine factory tests.

In the average power plant, however, it is not necessary to make anything like the exhaustive tests on site that are conducted in the factory on a new transformer, and the reasons are fairly obvious. For instance, it is unnecessary to test for losses, as any abnormal increase would be indicated by thermometer readings or by contact of the hand with the top of the tank.

Presence of Smoke

A short-circuit between turns of either windings would make itself known by the presence of smoke issuing from the tank and by the tripping of the supply switch, so that over-potential pressure tests are not necessary. Ratio and impedance will not vary, and the no-load current will not increase unless a fault occurs in the magnetic circuit, which would increase the iron loss and, therefore, the temperature rise. Pressure tests to earth should not be indulged in, as, if the transformer is working satisfactorily, such tests only uselessly place excessive dielectric stresses upon the winding insulation. The tests which may advantageously be carried out are:

(a) For the presence of moisture in the oil.

(b) For the presence of acid in the oil.

(c) For the presence of sludge deposits in the oil.

(d) Megger tests to earth on insulated bolts passing through the laminated core structure.

(e) Megger tests of any insulated core clamping structure.

(f) Megger tests to earth of both H. T. and L. T. windings and between windings.

(a) The dielectric pressure test is by far the surest and most delicate test for the detection of the presence of moisture in oil, and this simply consists of applying a gradually increasing electrical pressure across a fixed gap between suitably-shaped electrodes. The electrodes should consist of ½-in. diam. polished metal spheres, set 0.15 in. apart, and they should be mounted in a glass container, for receiving the oil to be tested. The container should be chemically clean and dry before the oil is poured into it, as otherwise fictitious results will be obtained.

Disperse Air Bubbles

After the oil has been poured into the container all air bubbles should be allowed to disperse before pressure is applied across the gap. Electrical pressure is then applied across the gap, say, at about 5,000 volts to commence with, and if breakdown through the oil immediately occurs, moisture is certainly present. If breakdown does not immediately take place, the pressure should be raised gradually until preliminary sparking takes place across the gap and a clean breakdown occurs. Preliminary sparking indicates either the presence of moisture or of fibres in the oil and the determination of which of these is present must be left to the experienced judgment of the engineer in charge.

Several tests should be made on different samples, so as to obtain a reasonable average figure. Each sample should be subjected to one definite breakdown only, and if this is appreciably less than 20,000 volts, the question of drying the oil should seriously be considered. The oil should, of course, be drawn from the bottom of the transformer tank.

It may happen, however, that the necessary testing apparatus is not available, in which case rough-and-ready approximate indications only must be relied upon. Perhaps the best known of these is to plunge an iron wire, heated to a temperature just below red heat, into the oil sample. If the oil be dry, a puff of smoke only will be the result, but, if it is wet, a characteristic crackling sound will be heard. Alternately, a sample of the oil may be heated in a test tube, when, if moisture be present, crackling will be heard. A third method is to pour some of the oil, which has been dried out, into a test tube containing anhydrous copper sulphate, shaking the two up together. If moisture is present in the oil the anhydrous copper sulphate will, to a certain extent, regain its characteristic blue colouring.

Tests for Acidity

(b) Rough tests for acidity may be made by shaking up a sample of the oil in a test tube with a piece of blue litmus paper. If this turns red, acid is present, and the rate at which the colour change takes place gives a qualitative idea of the acid contents.

(c) For this test it is only necessary to filter a sample of the oil and note the deposit upon the filter paper. Unless this is heavy it should not be necessary to filter the oil, and in any case a better indication can doubtless be obtained from an examination of the surfaces of the coils and core structure.

(d) In the larger sizes of circular core type transformers insulated bolts pass through the laminations for the purpose of securing them to prevent vibration. If the insulation on two or more of these breaks down to the core, large circulating currents may be produced in the bolts, and these may cause such intense heating as to distort the core structure and destroy the coil insulation. Before the coils are assembled in the shops upon the cores, these bolts are all pressure-tested to the cores at about 1,500 volts. The bolts through the yokes are treated the same. Megger tests on site will, however, give a clear indication regarding the qualitative condition of the insulation of the bolts, but it should be remembered that the top and bottom yoke bolts only are accessible, as the core bolts are obscured by the coils. If megger tests indicate a breakdown of any bolt insulation the fault should be repaired immediately.

(e) Core and yoke-end plates are usually insulated from the main magnetic circuit, so as to prevent the circulation therein of eddy currents resulting from straying flux. Similarly, coil-clamping structures, provided for taking up coil shrinkage, are also insulated and pressure-tested in the shops at about 1,500 volts. Megger tests should also be applied to these parts and any fault found should be remedied.

The Testing Megger

(f) Megger tests on transformer windings do not necessarily give a true indication of the exact electrical condition of the insulation to earth or between windings, as the case may be. This will be evident when one considers the relative pressures of the testing megger, and that for which the windings are perhaps designed, and no one would expect to be able to determine the true condition of insulation proportioned for a pressure of 20,000 volts, or even for 3,000 volts, by means of a 500-volt testing set. A 500-volt megger will, however, indicate whether the insulation is intact or not, and this fact, taken in conjunction with a knowledge of the immediately preceding operating

(Turn to page 46)

Oil Engine Efficiency Factors in Power Plants

By E. W. BERRY

Notes and Comments on the Selection, Maintenance and Care of Various Classes of Oil Engines for Different Classes of Service in the Power Plant

TO REALIZE the maximum efficiency in oil engine power plant operation, the plant must be properly designed, and the type of engines installed adapted to the class of service they are to be used in.

For instance, oil engine alternator sets supplying power to a cyanide mill or to a concentrator are at all times under peak load, a class of service that lends itself nicely to surface-ignition oil engine installations comprising either two or more sets or one full-power unit.

In the case of fluctuating loads, such as tram lines or large hoists, where the power demand from the one machine reaches from 50% to 60% of the total power of the engine, Diesel motors adapt themselves to that class of service ahead of all other types, because there is no danger of a cylinder going cold on off-peak load and ignition failing, as is the case in multi-cylinder surface-ignition oil engines when the strictest attention is not paid by the engineer.

In the case of municipal lighting and power plants where the difference between off-peak and full peak loading is greater than 30%, a series of power units of like size and type should be installed. In the case, for example, of a plant developing 1.200 k.w at full peak load with the power demand at off-peak being between 650 and 750 k.w., the most efficient installation would be three 450 k.w. units, the plant being laid out for unit installation to care for increased power demands at some future time.

Year-Round Efficiency

It has been found that the greatest all-year-round efficiency is attained by the use of small units in any class of work, and every time the unit size is divided the factor of safety increases 100 per cent. An illustration of the efficiency lost by using a single full-powered unit on some classes of work can be found in a plant the writer visited, where there was a single unit of 300 b.h.p. furnishing power to mine and mill. At the time of my visit the mill was shut down for repairs, and it was found necessary to pump water in all tanks; the pump required only 12 h.p., yet it was necessary to run the 300 h.p. engine for forty-eight hours to furnish that power.

Engines should be grouped as closely as convenient for accessibility. By so grouping it is possible to have a convenient upper runway connecting the valve decks of all units, and the switchboard should be so located that the synchronoscope can be seen from the control station of the incoming Diesel-alternator.

If the crank-pits of the A-frame engine or the crank case of the box-frame type be piped with conduit and wired for electric lights with a carbon filament lamp in each crank-pit it will greatly aid inspection, and the engineer can keep close watch on the condition of the bearings and lubrication. A good overhead crane system should be incorporated in each installation, wtih a capacity equal to the weight of the heaviest part in the engines and its travel should cover all units.

An Important Factor

A very important factor in the successful operation of semi-Diesels is the close regulation of cooling water. On light loads the best efficiency will be had by raising the temperature of the heads by cutting down the flow of the cooling medium. If the flow be allowed to continue after the load drops on a multi-cylinder surface ignition engine, one or two of the cylinders will cool down and ignition will cease for a few revolutions. If the load should come on while that cylinder is cool the governor will give the injectors full stroke, and when the dead cylinders resume firing the heads are apt to crack or other damage be done which can all be avoided by close attention to the regulation of the water.

In the first Diesel engine patented, air was not used to inject the fuel charge. This idea was a later development. It appears that compressed air serves to atomize the fuel particles in a very perfect manner. Outside of the chilling effect no better means can be found to act as the injecting agent. The air pressure carried depends upon the load on the engine, the character of the oil fuel and the design of the atomizer discs and cone.

In engines of the crank case compression type the oil drain compression by-pass should be adjusted so that sufficient air is compressed for complete scavenging of the burnt gases but enough air should be by-passed so the oil will not be forced from out the bearings. The by-pass will carry the used oil to the drain where it can be collected and purified. Care must be taken to see that the by-pass does not become stopped up with falling carbon particles, because then the used oil would collect in the crank pit and be thrown into the cylinder with the scavenging air, causing a run-away and possibly a wreck.

Fuel of 27 deg. Beaumé and above is recommended by the majority of surface-ignition engine builders, but the writer has achieved wonderful results from 24-plus oils. By keeping the engine well adjusted even heavier oil may be used successfully. Heavy fuels necessitate scraping the exhaust ports and cleaning the muffler pots at frequent intervals. On full load plants this should be done every week, though it will depend on the gravity of fuel used and on the load.

Gets Accurate Results

In plants that have no indicator the "time interval by ear method" of adjusting will give fairly accurate results. First with light load (10 per cent. or 15 per cent.) adjust the engine for speed, getting all cylinders as nearly alike as possible. When speed is adjusted, on a four-cylinder engine hang up all injectors and drop back two of them at once, noting mentally the time until these two cylinders have the engine up to speed. Then hang them up and drop the other two, noting time as with the other pair. If both pairs are fairly even, leave one pair hung up and cut in first one cylinder and then the other of the pair that is down. If the time interval between that pair is noticeable, very carefully adjust the slow cylinder until the time interval is no longer noticeable. Then hang that pair up and repeat the operation with the next pair. After adjusting this pair, break pairs. and repeat the operation then under full load test for speed. The torches should be burning slowly during the adjustments to keep the cylinders from going cold. Fairly accurate results may be obtained by this method.

A change from one grade of fuel to another will cause a very noticeable variation in speed with semi-Diesel engines. On a 200 h.p. engine the writer was using 27 plus oil when he received a car of gas oil, the effect of which was an increase in speed of seven revolutions.

Care Must be Taken

In shutting down surface-ignition oil engines care must be taken in closing off the cooling water. If allowed to flow at full amount, it will cool the heads down too rapidly, causing shrinkage stresses to be set up which may allow water to enter the combustion chambers. If the water be cut off immediately the jackets will become very hot, the effect of which will be the precipitation of the lime and salts in the water; the lime depositing on the heated surface of the combustion head and in time causing cracked heads. The best method is to allow a small flow of water through the jackets until the engine has cooled down slightly, and then the flow may be completely stopped.

In power plants where surface-ignition oil engines of the water-injection, or water-drip, type are used, care must be taken in ordering fuel oils. This type of engine is very susceptible to sulphur. If the sulphur content of the fuel be very high, with the water-drip type a series of events will occur as follows: the sulphur injected with the fuel in the form of SO will upon combustion of the oil change into sulphur dioxide gas—SO_2—which, being thoroughly mixed by the turbulence of the burning gases with the H_2O from the water drip, will form H_2SO_4—which immediately attacks the cylinder walls, exhaust passages, etc.

To Obtain Efficiency

To obtain full efficiency from the fuel, the water-drip must be closely adjusted so that under full load a light bluish smoke is obtained instead of a black smoke, which indicates insufficient water feed.

On surface ignition engines of the direct-injection type attention should be paid to the condition of the fuel nozzles, because the economy and efficiency of the engine will be governed by their condition. The nozzles should be removed at frequent intervals, taken apart and cleaned. Inspect carefully the conditions of the check ball, and, if it shows acid pits or is ringed by continued operation in one place, discard it at once. Never attempt to smooth a ball, as it is impossible to keep a worked-over ball from dribbling: If the seat be pitted it may be smoothed by grinding with clover leaf compound on the end of a stick the same size as the ball seat. Care must be taken not to enlarge the seat. If the ball should not seat, the nozzle will dribble and fuel will be wasted. This condition makes itself known by knocks in the cylinder, and unburnt fuel oil will be forced out of the ports, the exhaust from that cylinder showing darker than the others. This condition also causes muffler pot fires.

Low Gravity Oils

Diesel-motors show even better efficiency using low gravity fuel oils than with the lighter gravity fuels, because the heavy fuels burn more slowly, giving more gradual expansion. Less work is required to keep the fuel pumps packed when using heavy oil, though a higher injection pressure is needed for atomization.

The motors should be "indicated" at regular intervals, and any adjustments made that the diagram shows necessary. A diagram book should be kept in which all cards should be entered with full record of conditions indicated. An engine should not be operated with one cylinder showing low compression, but should be immediately shut down and investigated, because trouble may result if the piston rings are stuck with carbon, a piston in this condition scoring the cylinder very rapidly if operated for any length of time.

Lubricate With Care

The multi-stage compressor of atomized-injection motors should receive a large share of attention because it is the heart of the engine, and a very small trouble in it, if overlooked, will develop into a serious breakdown in very little time. This important part should receive careful lubrication with the best quality oil.

An analysis of the cooling water should be made by a competent chemist, and if lime or other scale-forming matter is found a closed system should be used and the water in the system treated with soda-ash or compound. Scale is very troublesome in Diesels, because very little of it forming in the water jackets of the compressor will cause the compressor to overheat, and when precipitated on the power-cylinder heads it will cause faulty heat transfer, ultimately resulting in cracked heads, burnt pistons and scored cylinders.

A 3,600 b.h.p. plant the writer visited used impure water with a straight cooling system. The result was the burning-up of two compressor cylinders and numerous cracked heads on the 1,000 h.p. engines. Upon the installation of a closed circulating system all trouble ceased.

Analyze Scale Samples

In case the engine is badly scaled before being noticed, samples of the scale should be analysed and the cooling water treated with a dilute muriatic acid, compound or soda-ash, as the analysis shows best. A simple field test the chief engineer can make at the plant to get an idea of the scale-forming matter in the cooling water is to take a test tube or water glass and fill nearly to the top with the water to be tested, adding a few drops of ammonia to make the water alkaline and a small amount of phosphate of soda to change the lime, magnesia, etc., into phosphates, which will precipitate and settle to the bottom of the test tube. The amount precipitated will give an idea of the amount of scale-forming matter in the water.

Lubrication of the motors is one of the most important factors in the operation of the plant. The very best oil should be used. It is false economy to use an inferior grade of oil on machinery of any class, and especially on oil engines. By using a good grade of oil, the proper amount, and running the used oil through a purifier very efficient service at a low cost per h.p.hr. will be obtained. It is very nearly impossible to get a gravity filter to clarify the oils properly.

The chief engineer should open up the motors and make an inspection of all parts at regular intervals, making all necessary adjustments, a record of which should be entered in the log book. If any part needing attention is noticed during routine attendance and cannot be adjusted while running, the engineer on throttle watch should make an entry of it in the log for the attention of the chief engineer, so the trouble may be attended to at the first shut-down.

Records of Operation

Complete records of the plant operation should be kept at all times, indicator cards filed with full data of conditions, humidity and temperature records, and a complete record of repairs, adjustments, fuel used, lubricating oil and running time should be entered in the engine-room log book. The chief engineer should plot a monthly and yearly graph from this data. A record of this type will give a check on the monthly and yearly operating efficiency of the plant.

It goes without saying that the deciding factor in the efficiency of the plant is the attendance. A very poor plant will show good results if the engineers know their business, and the best of installations will show poor results if the engineer and crew are inefficient. The most inefficient plants I have visited have been in charge of chief engineers that got the job through pull or politics and are afraid to hire engineers that know their business, for fear they will have their jobs taken away from them.

Their excuse is that they wish to train their own engineers from oilers at the plant. It is the greatest tribute to the Diesels that they run in spite of such inefficient attendance. This type of man is rapidly disappearing, because the power companies are beginning to realize that the engineer who insists on blaming everything that happens as a fault of the engine does not know his business, because hundreds of plants of all types of oil engines are developing full power, year after year.

Power Notes

The Border Cities Hydro Utilities Association, including the Windsor and Walkerville Hydro Commission employees, will hold the annual picnic at Sea Cliff Park, on July 26.

The Hydro-Electric Power Commission have decided to double the capacity of the power station at Acton, Ont., by the installation of three new 100 h.p. transformers.

A report made to the Hydro Commission recently states that in extending power to rural parts of Ontario, 650 miles of transmission lines have been laid. This makes power available in 93 townships.

The Dominion Engineering Works, Ltd., Montreal, have under construction two 58,000 h.p. turbines for the Queenston-Niagara development of the Hydro-Electric Power Commission of Ontario. The same company are also constructing two Johnston penstock valves and two sets of I. P. Morris governors.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

B. C. EXAMINATIONS

To whom should I write for information regarding examinations for British Columbia?—WALTER W. P. SINCLAIR, Medicine Hat.

Answer:—You should get in touch with the Chief Boiler Inspector, Department of Public Works, Victoria, B. C.

WANTS INFORMATION

If the cylinder rings of a steam engine become worn and have a slack fit in the cylinder, is it advisable to place on a smooth surface and tap with a cross peen hammer going all around the inside of the ring, in an endeavor to make it fit the cylinder tight again. If the job is properly done will the spring stay in the ring, and does it fit the cylinder correctly all the way around?

I have tried this several times but the rings soon become slack again after the engine has run but a short time, spots 3 or 4 inches long appearing on the rings, where there seems to be no rubbing against the cylinder walls.

I would like any engineers, who have had any experience in this matter or who can give me some advice on the matter to do so through the question box of Power House.—JOHN T. WOOLMAN, Espanola, Ont.

COMPRESSOR "RUN UNDER"

Should a horizontal motor-driven ammonia compressor be run under or over?
WINNIPEG READER.

In order that the pressure from the crosshead on the guides may be downward, a horizontal motor-driven compressor should be run under. In the case of a compressor the crosshead is driven by the crank, which is the reverse of the condition with an engine, where to bring the pressure of the crosshead downwards, the engine must be run over. By running a motor-driven compressor "under" or an engine "over," the wear is almost entirely on the lower shoe of the crosshead and, to maintain good alignment, this shoe alone will need adjustment.

A CHLORIDE SOLUTION

What is meant by a 2 per cent. chloride of calcium solution, and what quantity of chloride of brine would be obtained from a gallon of water when sufficient chloride of calcium is added to make a 21 per cent. solution?
A. STEVENS, Toronto.

Answer.—A 21 per cent. solution is obtained by dissolving 21 parts by weight of calcium chloride in 79 parts by weight of water. A cubic foot of water at 64 deg. F. weighs 62.3446 lbs., and a gallon of water at that temperature weighs $62.3446 \times 231 \div 1{,}728 = 8.334$ lbs.

The specific gravity of a 21 per cent. calcium chloride solution taken at the same temperature is 1.178, and therefore a gallon of the solution would weigh $8.334 \times 1.178 = 9.8174$ lbs. A 21 per cent. solution made from a gallon of water would contain $8.334 \times 21 \div 79 = 2.215$ lbs. of calcium chloride and 8.334 lbs. of water, making a total weight of 10.549 lbs., and therefore the volume would be $10.549 \div 9.8174 = 1.075$ gals.

KNOCK IN ENGINE

We recently purchased a second-hand slow-speed engine which since placed in use has a peculiar knock that appears to be due to looseness of the crank on the shaft. The shaft is steel 5 in. diameter and the crank is cast iron 4 in. thick. Would it be advisable to attempt electric welding without removing the shaft and crank from the premises?

Answer.—Ordinarily electric welding could not be satisfactorily performed unless at greater loss of time and expense than necessary to remove and rebore the crank, upset and refinish the end of the shaft and replace the crank with a good press fit. However, before deciding on the necessity for such a repair, it should be borne in mind that looseness of the crank would have grown worse so rapidly with continued use of the engine as to render the condition unmistakable in a very short time.

Frequently a creaking noise or peculiar knock existing in an engine for a long time is attributed to looseness of the crank, and later it is discovered that the noise proceeds from some quite remote part of the engine.

BOILER SCALE

Although the vibratory method of scale removal does very well for fire tube boilers, the writer frequently hears complaints about that method when applied to water tube boilers. Some manufacturers claim that it works as well in one kind of tube as in the other.

It is quite logical that when the tube of a fire tube boiler is rapidly tapped on the inside the metal of the tube will move or vibrate slightly, much like the ringing of a bell, and as a result the scale will drop off due both to inertia and to the slight bending effect in the metal scale is inelastic and brittle, while boiler tubes are elastic and tough. This difference in structure and characteristics makes it possible to remove scale very effectively by the vibratory process from tubes that can be set in vibration.

But when it comes to using the vibratory method in the tubes of a water tube boiler, it is not so easy. The same theory does not apply so readily and practice bears out the theory just as it should. In the water tube there is a constant variation in diameter of tube due to the thickness of scale itself within the tube. This makes it difficult and often impossible for the vibrating hammer to "make a good stroke." The strokes are therefore bound to be of variable length.

A high grade turbine cleaner for water tube boilers overcomes these objections. This kind of cleaner may not get ALL the scale out—a very thin scale may remain—but this can be remedied by running a vibrating cleaner through the tube after the turbine cleaner, should it be considered worth while and should it be found that the turbine cleaner is not thorough. It has been demonstrated mathematically and practically that thin scale causes more money loss in proportion to its thickness than does thick scale. This may sound paradoxical but it is the truth nevertheless, as borne out by recent experiments.

—W. F. SCHAPHORST, M. E.

The annual convention of the Northwest Electric Lighting and Power Association was held in Victoria, B. C., June 29 and 30. There were about seven hundred delegates present. The sessions were held in the Empress Hotel.

The employees of the Consumers Gas Co., Mutual St. branch, held their annual picnic on Saturday, June 14, at Wabasso Park. About 500 attended, and an attractive program was enjoyed.

The Dominion Tar & Chemical Co., Ltd., St. Boniface, Man., is in the market for complete equipment for boiler house and distillery, also for three storage tanks.

The Winnipeg Hydro Co., Winnipeg, Man., is in the market for superheaters for boiler and de-aerating open heater. The estimated cost is $20,000 and $10,000 respectively.

The Hydro Electric Co., North Bay, Ont., is in the market for three steam generators to replace those lost by fire at their sub-station at Gormonville.

To Avoid Clinkers While Firing

Practical Experiments at Wesley College, Winnipeg, Results in Cutting Fuel Cost

By C. F. RYE

FIRST it may be best to see what clinkers are; how they are formed, and what can be done to prevent them from forming.

Clinkers are the ash and unburned substances in the coal that have been heated above their melting point and work their way down to the grate where the fused mass is cooled and hardened.

Clinkers are formed in several ways; some of the most common being explained in the following: by sliding the slice-bar under the ash and fire, in so doing raising the ash up to the top of the fire exposing it to the intense heat The melted mass gradually settles back to the grates in the form of a soft putty, and as soon as it comes in contact with the cooler grates, and cold incoming air, it cools forming a hard clinker on the grates.

Heavy Charge of Coal

Another way in which clinkers are formed is by throwing a heavy charge of green or new coal on a bed of melting coal at a white-hot heat which cannot hold up under the load, and therefore, crushes down in a pancake style, stopping the draft at that place. In this compressed mass of coal and ash you have a splendid foundation for a clinker, from which one is sure to form.

A good illustration of compressing the coals and stopping the air is seen when a plumber uses oakum to stop a leaky joint in pipe connections. In its ordinary state it will not stop a leak, but when it is compressed it will be water tight. and likewise the ash and coal will be air tight.

From what we have gone over we have learned three important things:

First.—To keep ashes where they belong: not mixed up with the burning coals.

Second.—Do not throw a heavy charge of coal on the fire, instead of spreading each shovel of coal over at least four square feet of grate.

Third.—Do not burn rubbish or a fuel with a low melting ash.

Now after much experimenting we have come to the conclusion that the following is a splendid method to follow to avoid the formation of clinkers.

In starting the fire whether from kindling or bank, try to remove all clinkers, and start the fire near the front of the grates if you have not enough to spread over the whole of the grates. The first coal you throw on should be "nut and pea" size, which should be used until there is a good bed of coals then you are sure that you have a bed that will allow free passage of the draft, and yet a good solid bed that will not easily break down when new coal is thrown on. Now if you have slack coal, you can use it very sparingly, and in small quantities, well spread over a portion of the grates only. The best way we have found is as follows:

Imagine your grates in four sections lying in the same direction as the grates. If your fire box is four feet wide, then you have four sections each a foot wide.

If you use smoky or dirty coal you should fire only one section at a time of a very thin layer of coal. In this way the hot coals are not broken down with the weight of the new coal.

When you cannot get enough draft through the fire, reduce the thickness of the ash by shaking the grates, if the grates shake. If not, work the ashes through the grates by using the slice bar, but remember, do not raise the ashes in the fire.

In order to bank a fire without causing a clinker, the bank ought to be built up of thin layers of coal. In this way the weight will not crush down the hot coals, and each layer ought to be fired at intervals, so as to allow the smoke to burn off and allow the solid material or carbon in the coal to hold the fire without giving off smoke and soot to dirty your flues. Of course there are other ways to bank a fire, but this is the best method when new coal is used. In this way you will form a coked bank that will give much better results, and offer much less trouble in starting the fire, because you have a clean coked bed of coals that will break up in a form of coke, making a splendid bed on which to start a fire with little smoke, good draft and high economy and efficiency.

See Little Saving in Oil Fuel

Engineers of U. S. Bureau of Mines Oppose Changes Where Computed Economy Over Coal is Small

THE report of the Mechanical Engineering Division of the United States Bureau of Mines, opposing changes from a coal consuming to an oil burning basis in the heating plant of the Federal government institution on the ground of conservation of national resources will prove of interest to Canadian engineers as it leads to the conclusion that oil should not be used in stationary plants which show but small computed savings over using coal.

By a slight change in the furnace the Bureau of Mines engineers pointed the way to fuel economies at the plant in question. The tests showed variations in efficiency among the three shifts in the fireroom.

The report states that the plant could be changed to an oil burner at a cost of $33.500. to be amortized in five years. Assuming that oil could be contracted for at 3.5c. per gal. as contrasted with New River coal at $8.18 per ton. it is estimated the plant could save only $2,400 a year by changing to oil.

"Oil is a national resource which is limited in extent and must be conserved for military, naval, merchant marine and lubricating needs. To use it extensively in stationary plants brings nearer the time when the supply will be exhausted and the above needs for its best use will have to seek supplies in some other other form.

Oil Prices Now Low

"At present oil prices are low and therefore favorable to plants desiring to change from solid to liquid fuels, but no one can predict how long such conditions will exist. It is certainly true that a plant changing from coal to oil now will have to revert to coal again in the not too distant future. It seems advisable from a national resource standpoint that this plant continue on a coal-burning basis and bend their energies toward improvement in coal efficiency rather than seek a change to fuel oil now and later on change back."

The tests disclosed conditions which resulted in shortening the ignition arches 18 in. in consequence of which the over-all efficiency was increased 2 per cent.; the thermal efficiency of the boiler alone increased 4 per cent., while the heat absorbed by the superheater and by the economizer decreased 1 per cent. each; and the temperature of the gases leaving the boiler decreased 108 deg. while the rate of working the boilers decreased 20 per cent.

Previously, the steam pressure tended to fall continuously and to maintain it at the proper point the fuel bed had to be poked frequently. The poking of the fires broke up the caked fuel, which was then carried onward by the stoker.

Cut Ignition Arch

After the ignition arch was shortened, poking was resorted to only one-fourth as frequently, while the steam pressure was held five pounds higher with a maximum fluctuation of five pounds compared with a previous fluctuation of fifteen pounds. Also, it was not necessary after the change to blow the ash from the tubes. which had been done frequently previously in order to avoid complete obstruction, as the accumulation was negligible.

The tests indicated that if the plant is operated as well for the whole year as it was during the the tests. there will be an annual saving of approximately $10 000 in fuel cost.

POWER PLANT EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA
- TUBE CLEANERS
- TUBE CUTTERS
- VALVES, ETC.

BABCOCK & WILCOX, LIMITED

Toronto Office
Bank of Hamilton Building

ST. HENRY—MONTREAL

EXCESS AIR COSTLY

(Continued from page 31) .. ..

parison with the volumes involved when measuring the output of blast-furnace gas or the air currents of an entire colliery. Thus, for example, in a large power station plant of, say, ten boilers of 60,000 lbs. evaporation per hour each, the total volume of air passing into the station would be about 250,000 cubic feet per minute. The advantage claimed for the "Pitot" tube or the "Venturi" disc principle is that the size of the recording mechanism is dependent of the volume to be measured.

In this way, for the first time we should get a boiler plant completely under scientific control, with a record of air and the fuel supplied and the water evaporated. It is tolerably certain that when this is done, many valuable facts will be discovered with regard to the air question, the relations between volume of air, composition of fuel, furnace temperature, complete analysis of the flue gases, and the net working efficiency of the plant, the result of which will be to increase the efficiency of steam generation. There is no reason also why the whole of the exit gases passing up the chimney should not be measured in the same way, if only as a test of the air leakage on the plant. One can only hope that further work of this character will be undertaken in Canada, especially since many engineers claim the United States is now ahead of us in boiler and power plant control.

Typical New Plant

At present little is definitely known about excess air, but it is generally believed that the latest type of mechanical forced draught and mechanical stoker for water-tube boilers will operate with 35 to 40 per cent. excess air, although presumably this figure is based largely on calculation, and not on actual determination. As typical of the latest practice in this respect, there is a new boiler plant projected in Great Britain with water-tube boilers of 8619 square feet heating surface. Each boiler is to evaporate 60,000 lbs. per hour at 210 lbs. pressure, and the steam is to be superheated to 677 deg. Fah. in a superheater of 3190 square feet heating surface.

The plant will include a special "tri-tube" cast iron economiser of 4620 sq. ft. heating surface—with entering feedwater at 180 deg. Fah.— and an air heater. The stokers are to be of the underfeed travelling grate design.

The guaranteed efficiency of this plant is 85 per cent. on the lower heating value of the coal, or deducting the power used for the mechanical draught—forced and induced draught fans—and mechanical stoker, about 88 to 88½ per cent., according to ordinary methods of calculation.

Apart from the fact that the whole question of boiler plant testing is in hopeless confusion and no proper test code exists, so that it is difficult to say what these figures actually mean, it is obvious that the above is a very high guarantee and involves the use of only about 37 per cent. excess air. This figure corresponds to 1,273,000 cubic feet of air at N. T. P. per hour, or 162.8 cu. ft. per pound of coal burnt, as the coal consumption is to be 7816 lbs. per hour. The coal, it may be stated, is of somewhat moderate quality, giving 10,800 B. T. U. on the lower heating value—whatever that means exactly—for the method of expressing the heating value of fuel is part of the general confusion.

The best results with regard to excess air are, of course, obtained with pulverised fuel, because of the intimate mixture obtained with the air and the fuel owing to the fine state of division of the latter.

Elaborate tests have been carried out in a plant which consists of eight water-tube boilers with superheaters and economisers working at 300 lb. pressure and fired by pulverised fuel, supplying 40,000 kilowatts. The figures of this boiler plant represent one of the most remarkable performances for steam generation in the world, averaging 85 to 86 per cent. efficiency, and the air figures—which were determined only with great time and trouble— are as follows for five typical tests at different loads on the boiler:—

Tests on One Boiler, Normal Duty 85/90,000 lb. per Hour.

Duty of boiler, evaporation in pounds per hour, average	53,390	83,953	81,121	57,572	92,202
Air—					
(a) Temperature entering furnace, deg. Fah.	86	89	91	104	93
(b) Pressure of air at pulverised fuel feeders, inchese W.G.	11.0	12.2	13.6	12.2	13.6
(c) Excess air in flue gases, per cent.	13.3	21.9	21.2	10.7	25.2
Flue gas—					
(a) CO2 in fourth pass, per cent.	15.8	14.6	14.7	16.0	14.1
(b) O2 in fourth pass, per cent.	3.3	4.6	4.6	3.3	5.2
(c) CO in fourth pass, per cent.	0.05	0.00	0.03	0.00	0.09
(d) Pounds dry gas pound coal, per cent.	11.04	11.63	11.37	10.06	11.56
(e) Temperature leaving boiler, deg. Fah.	434	475	482	430	496
(f) Temperature entering economiser, deg. Fah.	338	400	424	400	431
(g) Temperature leaving economiser, deg. Fah.	168	196	205	204	251
Draught—					
(a) At furnace, inches W.G.	0.017	0.19	0.16	0.045	0.206
(b) At fourth pass, inches W. G.	0.314	1.11	1.185	0.39	1.40
(c) Entering economiser, inches W.G.	0.424	1.23	1.28	0.40	1.66
(d) Leaving economiser, inches W.G.	0.525	1.67	1.72	0.51	2.38
Pounds water evaporated per pound of coal	8.92	8.62	8.49	8.66	8.12

The figures, therefore, for excess air vary from 10.7 to 25.5 per cent. excess over the theoretical, rising as the plant is forced. a very fair average for pulverised fuel being 20 per cent. excess, corresponding to 16 to 17 per cent. CO_2 at the actual point of combustion, although here again the methods used are not very clear.

TRANSFORMER TESTS

(Continued from page 40)

conditions, should be sufficient for the purpose. It is decidedly an advantage to carry out such megger tests. If the windings on either side have an earthed neutral, the earth should, of course, be removed before testing. If the phases on each side are connected (either in star or delta) one megger test only is necessary for each side, though if a fault be found it will be necessary to disconnect the phases to locate it.

Inspection of the different parts is, however, much more important, and for this purpose a transformer should, on the average, be lifted from its tank and examined thoroughly every six months.

It is not very likely that dust or any other foreign matter will have entered the tanks of transformers, if they are the modern products of a reputable firm, and no particular attention need be paid to this point.

REFRIGERATION ECONOMIES

(Continued from page 26)

brine, causing trouble with pump valves and pipes. Brine should be strained. A small strainer on the suction side of the pump will in a short time pay for itself in saving time and the annoyance caused by plugged pipes. The strainer should be kept clean and free from sludge, or the friction loss through it will be excessive.

A fine sediment will invariably collect on the inside of all brine piping, decreasing the velocity of the brine and interfering with the transfer of heat through the walls of the coils. Cleaning at regular intervals may be done readily by using high pressure steam.

Brine should not be wasted. For temperatures around zero 20 per cent. by weight of calcium chloride is required, costing $45 a ton, hence it can readily be seen that any leaks or waste by spilling, will, if continued over a period of time, result in considerable loss.

Save Water

Where city water is used for cooling purposes, the engineer can save money by care in the amount used in the condenser. When large quantities of water are used for boiler feed or other purposes in the plant the water may first be passed through the condenser. The danger then lies in using excess cooling water. Excess water cuts down the suction pressure, a smaller amount of gas then enters the cylinder for each stroke, resulting in a decrease in capacity unless the compressor can be speeded up. Sufficient water, however, must be passed around the condenser to liquefy all the gas.

In general it may be stated that insufficient cooling water results in high pressures on the suction side, an excess in low pressures. and, in consequence, decreased capacity.

The engineer in one plant saved three thousand dollars in a year by cutting down the amount of water passing through the condenser, at the same time increasing the size capacity of the plant.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES — $1 A MONTH
8754 ILLUSTRATIONS — $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes and Aviation*--HOW TO SELECT AN ENGINE, STEAM ENGINE rules and formulas. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you , 1 monthly until $12 is paid.

Signature ____________

Occupation ____________

Employed by ____________

Residence ____________

Reference ____________

POSITIONS WANTED

FACTORY SUPERINTENDENT OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

REFRIGERATING AND MECHANICAL ENgineer with 10 years' operating record, also with experience in heating and lighting work, desires employment in Toronto. Apply Box 108, Power House.

POSITIONS VACANT

STATIONARY STEAM ENGINEER WANTED—familiar with water tube boilers and Turbo Blowers and Generators. Must be an all round competent man, capable of taking charge of plant of about 2,400 B.H.P. Must have first class certificate. State in first letter salary wanted, age, experience, and when you can report. Apply P. O. Box 720, Port Colborne, Ont.

WANTED — SALES ENGINEER—EXperienced in steam specialty lines. University graduated preferred. Write stating experience and salary. Apply Box 109, Power House.

FOR SALE

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St,. Ottawa. When answering this advertisement please mention this paper. P.F.H.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

TAYLOR SAFE FOR SALE

Inside dimensions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110, Power House.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W

Cinders Mean Waste

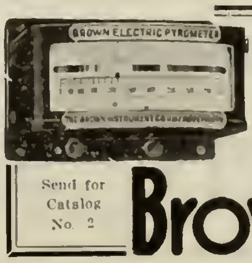
Eliminate cinders and you do away with a big item of production waste. Folder 609 outlines the economies of a Sturtevant Cindervane Fan. Write for this folder to-day.

B. F. Sturtevant Co.
of Canada, Ltd.
Montreal Galt Toronto

GEO. CALLARD
Builder and Contractor
Furnace and Boiler Work a Specialty
Highest References from All the Leading Engineers of the City.
Phone: Uptown 1590
210 Quesnel Street, Montreal

·LIQUID·FUEL·
FOR · HEAT · AND · POWER
·HOW·TO·USE·IT·
SEND FOR IT ··· NO CHARGE
LAUGHLIN'S PRODUCTS LIMITED.
WELLAND · CANADA

OIL BURNING SYSTEMS·
INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.
LAURIE ENGINE CO.
(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.



THE BROWN INSTRUMENT COMPANY
Largest Pyrometer Manufacturers in the World.
PHILADELPHIA, PA., U.S.A.

For Province of Quebec:
LaChapelle Eng. Co.,
414 St. James St.,
Montreal, Que.

For Ontario:
Brown Instrument Co.
1421 Ford Building,
Detroit, Mich., U. S. A.

Send for
Catalog
No. 2

Brown Pyrometers

HINTS TO BUYERS

Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and draft in last pass.

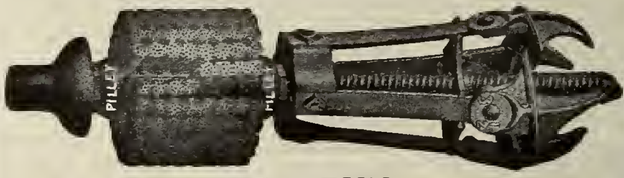
It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

Write for Bulletin CF-131.
THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

FOXBORO
REG. U. S. PAT. OFF.
THE COMPASS OF INDUSTRY

5323

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T. J. CUNERTY** *Company*
9 Richmond St. E. Toronto

AMERICAN
STEAM ASH CONVEYORS

75% of all steam jet ash conveyors in Canada are American. Satisfactory and economical performance guaranteed. Ask for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Calgary, Edmonton, Vancouver.
WM. A. GOOLD, Winnipeg.

CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water

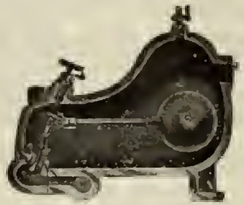
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



BETSON'S
TRADE MARK
PLASTIC FIRE BRICK

IDEAL for repairing furnace linings and arches or laying up complete linings and arches in one solid seamless piece and for making gas-tight baffles at any angle. No special forms, tools or skill required. Any good workman can do it.

Shipped plastic in barrels ready for use or dry ready to add water, from nearest warehouse.

Send for instructive booklet on furnace linings and baffles.

Betson Plastic Fire Brick Co., Inc.,
P. O. Box 386-6, Rome, N. Y.
Canadian Distributors: International Chemical Co.,
2[illegible]-6 Adelaide St. E., Toronto, Ont., Canada.

ENGINEERS!

Remember to Order
GENUINE
"V." PILOT
PACKING FOR ALL PURPOSES
KIRBY & COMPANY

50 LAKE ST. TORONTO MAIN 4443

SPECIALIZING IN
Engine and Boiler Room Supplies of Every Description.
Adamant Gauge Glasses Ideal Tube Cleaners
Kirbyco Boiler Scale Remover
QUALITY SERVICE

GARLOCK

Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS

THE GARLOCK PACKING COMPANY

SUPERHEATERS
ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P Q
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co. Ltd Hamilton
Taylor Instrument Co., Toronto, Ont.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

ASBESTOS SPECIALTIES
Can. Johns-Manville Co., Ltd., Toronto,
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Kirby & Co., Toronto, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELT DRESSING
D K. McLaren Limited. Montreal, Que
Dominion Belting Co., Hamilton, Ont
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que

BELTING, BALATA
D K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que

BELT LACING MACHINES
D K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D K McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd,, Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
W R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Coie Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Soxton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont,

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H, Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd. Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H, Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill
Shell Bar Boico Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co,, Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Branftord

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.
Jeffrey Mfg Co., Montreal, Que.

COILS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach, Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N, Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

Having Any Furnace Trouble

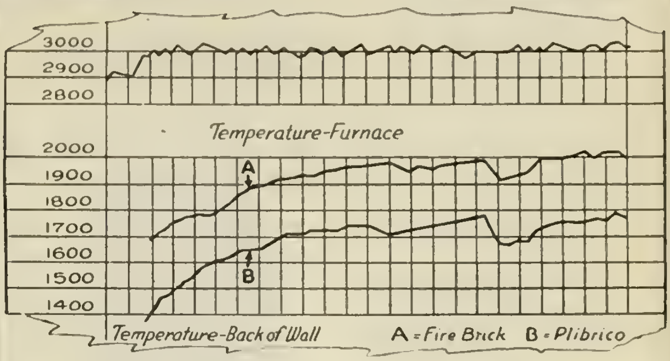
There's bound to be trouble in any furnace or fire-box soon after the edges of the brick start to disintegrate—it's the weakest spot. The only remedy is to eliminate all edges and built a one-piece lining with

STERNSON
No. 40 Monolith

A ceramic mixture of plastic and calcined refractories which can be molded into a jointless, gas-tight furnace or fire-box lining by inexperienced men. It is a positive protection up to 3,000 deg. F. as, when vitrified, it forms one great fire brick. The saving in price alone, compared with brick and mortar, is worth considering.

"Let a Technical Firm Do a Technical Job."

G. F. STERNE & SONS, LIMITED
Chemical Manufacturers,
Consulting Chemical Engineers.
BRANTFORD : : CANADA



Proof that Plibrico reduces heat radiation—

PLIBRICO far outlasts fire brick. Thousands of furnaces lined with Plibrico are proving this. Now here is proof that Plibrico keeps the heat in the furnace far better than fire brick.

Some time ago half of the back wall of a furnace was lined with Plibrico and the other half with laid-up fire brick. Then a test run was made, the temperature ranging from 2,900 to 3,025 deg. F. as shown by the chart above.

The chart tells the story of how Plibrico kept the heat in the furnace. The temperature of the outside of the Plibrico-lined wall (line B on chart) ranged from 1,400 to 1,770 deg. F.—the temperature outside of the fire-brick-lined wall (line A on chart) from 1,660 to 2,015 deg. F.

Don't you want the 50 page catalog "Modern Furnace Building" that shows how Plibrico cuts fuel costs and furnace maintenance costs? Your copy is waiting.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B. C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's Ltd., Calgary, Alta.

PLIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO.
1142 CLAY ST CHICAGO

Power House
Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

$2.00 PER YEAR — Every Power Plant employee should read Power House

DUNLOP
MECHANICAL PRODUCTS

DUNLOP

Rubber Products to Meet Every Need

Gibraltar RedSpecial Transmission Belting is known for its suitability for all purposes.

Gibraltar Conveyor and **Elevator Belts**—the Belts with the protective covering of Cord Tire Tread Stock that most effectively resists abrasive action.

DUNLOP **Industrial Hose, Packing** and **Mechanical Goods** of all descriptions.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Brantford

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto,
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Jeffrey Mfg. Co., Montreal, Que.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER PURIFIERS
Stephens Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philiadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome. N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati. Ohio
Reading Steel Casting Co., Hartford, Conn.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio
Reading Steel Casting Co., Hartford, Conn.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR. GAS. STEAM. WATER)
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pliley Packing & Flue Brush Mfg. Co St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd. Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co. Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicsgo, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome. N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto,
Canadian Johns-Manville Co., Ltd., Toronto
Can. Steam Boiler Equip. Co., Toronto
Durabla Mfg. Co., New York, N. Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto. Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Lytie Engineering Co., Montreal, Que.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
Kirby & Co., Toronto, Ont.
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div- Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto. land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCullocb Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Ce., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Sheil Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Sheil Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Limited, Brooklyn, N. Y.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstreng Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Scbaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co, Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil. Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

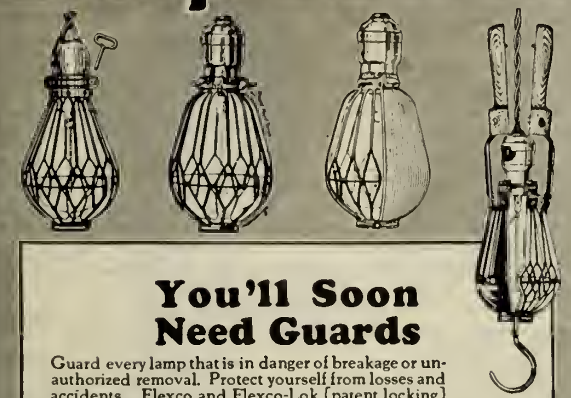
OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

FLEXCO
TRADE MARK

Lamp Guards



You'll Soon Need Guards

Guard every lamp that is in danger of breakage or unauthorized removal. Protect yourself from losses and accidents. Flexco and Flexco-Lok (patent locking) guards cost less than new lamps. Last for years.

Expanded metal reenforced construction. Attractive in appearance. Very rigid and strong. Made with key locking or plain round head screws. A style for every lamp.

Free sample 50 watt guard and complete information sent on letterhead request, mentioning socket size.

FLEXIBLE STEEL LACING COMPANY
469 Lexington St., Chicago, Ill.

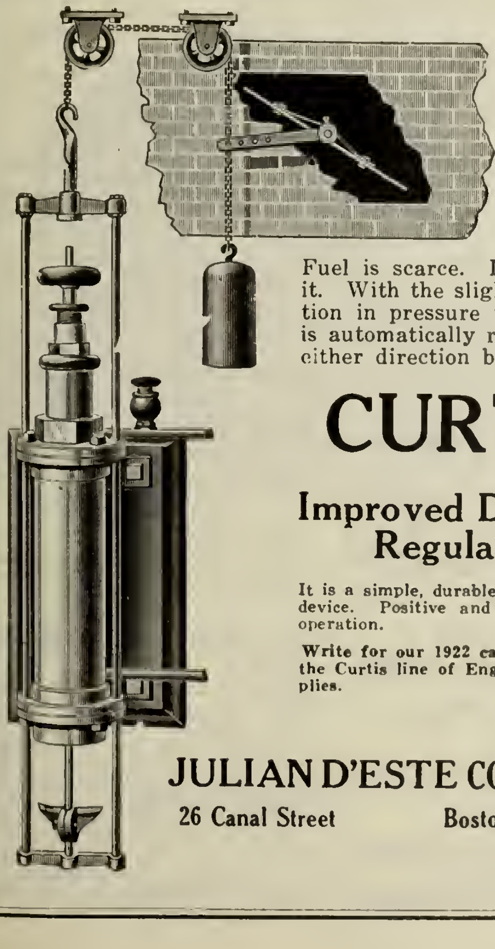
"Maple Leaf"
Brand

Stitched Cotton Duck Belting *and* Dressing

It is water-proof and economical; also more efficient than other belting. The standard of quality, "Maple Leaf" Brand, is always maintained. That is why the demand for this belting is steadily increasing. "Maple Leaf" Brand Belting and Dressing make a good combination—use both.

Write for prices and further information.

Dominion Belting Co., Ltd.
HAMILTON, CANADA
Quebec Branch: 51 Duluth Building, Montreal



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1922 catalog showing the Curtis line of Engineering Supplies.

JULIAN D'ESTE COMPANY
26 Canal Street Boston, 14, Mass

A COMPLETE SERVICE IN
"John Crane"
FLEXIBLE METALLIC PACKING
"MADE IN CANADA"

Style 100. Babbitt foil, spirally wound and impregnated with purest graphite.

Steam and Air Rods

Every new steam pump or air compressor or centrifugal pump should be packed with Style 100 immediately upon placing it in service, if you desire to keep these rods in perfect condition. Friction will be greatly reduced and long, uninterrupted service will be the result.

Style 100 is a splendid packing for oil rods. It does not become saturated or deteriorate.

Use Style 100 on hand valves, header valves and Corliss valve stems.

Specify "JOHN CRANE" Packing on new equipment. Our book "METALLIC PACKING" (88 pages, illustrated) is free to all engineers.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, B. C.

PACKING, AMMONIA, STEAM AND WATER

Beveridge Suppy Co., Montreal.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can Johns-Manville Co., Ltd., Toronto
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto

PACKING, OIL

Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor Ont.

PACKING, COMPRESSED ASBESTOS SHEETS

Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Kirby & Co., Toronto, Ont.

PAINTS

Shell Bar Boico Supply Ltd., Toronto, Ont

PIPE COILS

Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER

Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED

Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS

Crane's Limited, Montreal.

PIPING AND FITTINGS

Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
York Manufacturing Co., York, Pa.

PIPING, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUMBING SUPPLIES

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS

Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

POWER PUMPS (OIL, GASOLINE)

Pratt & Cady, Hartford, Conn

PRESSURE REGULATORS

C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES

C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC

Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES

C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL

D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH

Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID

Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX

The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE

Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY

Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO

Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co. Cincinnati, Ohio.

PUMPS, STEAM

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX

Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING

Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL

Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS

Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS

Crane's, Limited, Montreal.

RADIATOR TRAPS

C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS

Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES

C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS

Shell Bar Boico Supply Ltd., Toronto.

REBOILERS

Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS

Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2

Sarco Company, Inc., New York.

REFRACTORY MATERIALS

Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE

Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER

Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE

Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS

The Superheater Co., Ltd., Montreal.

REGULATING VALVES

H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co, of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS

Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING

Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES

Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER

Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)

Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY

Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS

Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM

V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS

W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE

C. A. Dunham, Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

SOOT CLEANERS

Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET

Conveyors Corp. of America, Chicago, Ill

SPROCKET CHAIN ATTACHMENTS

Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Brantford

SPUR WHEELS

Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q

STEAM TRAPS

Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS

Smart-Turner Machine Co., Hamilton.

STEEL DRUMS

Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL

Can. Fairbanks-Morse Co., Ltd., Montreal

STRAINERS

Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd

STRUCTURAL STEEL WORK

Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal

SWITCH AND SWITCH BOXES

Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS

Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF

Waterous Engine Works, Co., Brantford

TANKS, BRINE

Frick Co., Waynesboro, Franklin Co., Pa
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE

Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING

Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa

TANKS, GASOLINE

Imperial Oil, Ltd., Toronto.

TANKS, OIL

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co. Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada

TRANSFORMERS

Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES

Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING

Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.
Kirby & Co., Toronto, Ont.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER

Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS

Engineering and Machine Works of Can Ltd., St. Catharines, Ont.

TURBINES, STEAM

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

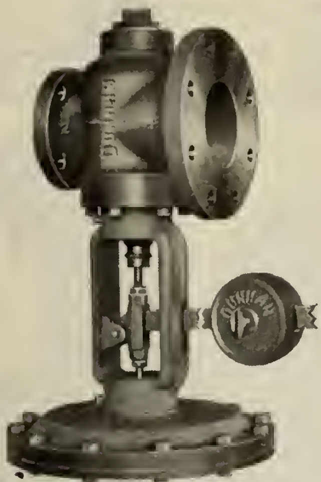
VALVES

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Edward Valve & Mfg. Co., East Chicago, Ind.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lytle Engineering Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont
Reading Steel Casting Co., Hartford, Conn
Shell Bar Boico Supply, Ld., Toronto.
Valve Engineering Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa,
Underfeed Stoker Co., Toronto, Ont.

WALKWAYS, (Irving Subway)

Irving Iron Works Co., Long Island City N. Y.

Dunham Reducing Pressure Valves Insure Constant Pressure Control



Dunham Reducing Pressure Valve, TYPE 310.
This valve has expanded outlet, facilitating quick reduction from high initial pressure to as low as atmospheric pressure. Also other types.

Dunham Reducing Pressure Valves reduce the pressure of steam, air, water or oil to any desired low pressure and hold it at that point, even if there is considerable variation on the high pressure side of the valve. They reduce in one step without chattering and are unusually capable in meeting sudden demands. They are applicable to a wide range of initial pressures and are made in straight as well as expanded outlet types.

Write for further information.

C. A. DUNHAM CO., Ltd., Toronto, Ont.
Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary.
London, Eng.: 18 St. Thomas St., S.E. 1.

The DUNHAM REG. TRADE-MARK
HEATING SERVICE
(MADE IN CANADA)

Specialists in the production of—
PUBLICATIONS, CATALOGUES
BOOKLETS, HOUSE ORGANS, FOLDERS
ADVERTISING LITERATURE

PRINTING

FORTY YEARS' experience—backed by one of the largest and best-equipped printing plants in Canada and the men who know how—enables us to offer you a complete printing service.

Send us samples of your catalogue or other printed matter, and write us fully as to your requirements. We will give your proposition thorough consideration and advise you intelligently. This will incur no obligation on your part, and may mean greatly increased effectiveness of your printing.

Commercial Printing Division

The MacLean Publishing Company, Limited
143-153 University Avenue, Toronto, Ontario

Established 1907 **POWER HOUSE** Member A.B.C.

B. G. NEWTON, Manager
CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740. Montreal: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. Winnipeg: 810 Confederation Life Bldg., Tel. Main 3449.

S. S. MOORE, Advertising Manager
UNITED STATES—New York: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. Chicago: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. Boston: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

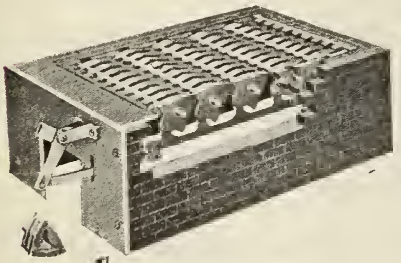
GREAT BRITAIN—London: The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A
Audel, Theo. 47
Allen Feed Water Purifier Co... 14
Albany Pump Co. 19
American Steam Pump Co...... 24
B
Babcock & Wilcox, Ltd......... 45
Betson Plastic Fire Brick Co., Inc. 49
Brown Instrument Co. 47
Bristol Co. 4
Buyers' Directory 50, 52, 54
Business Newspapers of Can... 16
C
Callard, Geo. 47
Canadian Fairbanks-Morse Co., Ltd. 6
Conveyors Corp. of America... 48
Cory & Sons, Inc., Chas........ 2
Combustion Engineering Co.... 13
Cunerty Co., T. J.......... 48
Can. Allis Chalmers Co.....Inside Back Cover
Can. Ingersoll-Rand Co.......... 20
D
Dart Union Co. 2
D'Este Co., Julian.......... 53
De Laval Steam Turbine Co.... 14
Detroit Stoker Co. 10
Dominion Belting Co.......... 53
Dominion Engineering Agency.. 17
Dunham Co., C. A. 55
Durabla Mfg. Co. 6
Dunlop Tire & Rubber Co., Ltd. 51
E
Engineering and Mach. Works of Canada 4
Edward Valve & Mfg. Co...... 21
F
Fisher Governor Co. 8
Foxboro Co., Inc. 48
Flexible Steel Lacing Co........ 53
Flexible Metallic Packing Co.... 53
Frick Refrigeration Co. 21
G
Garlock Packing Co. 49
Garth Co., The 49
Gates Engineering Co., Inside Front Cover
Goldie & McCulloch 22
Gutta Percha & Rubber Co..... 3
H
Hays Corp., Jos. W.......... 14
I
Imperial Oil Co. 15
Irving Iron Works 12
J
Jeffrey Mfg. Co. 5
Jamieson Cold Storage Door Co. 17
Jenkins Bros. ....Front Cover
Jointless Fire Brick Co........ 51
K
Kirby & Co. 49
L
Laurie Engine Co. 47
Linde Can. Refrig. Co. 17
Laughlin's Products, Ltd....... 47
M
Magnolia Metal Co. 12
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncrieff, Ltd. 49
Mueller Mfg. Co. 11
McLean Underfeed Stoker Co... 57
N
Northern Equipment Co. 12
P
Pilley Packing & Flue Brush Mfg. Co. 48
R
Refinite Co. of Canada....... 48
Refrigerating Engineers, Ltd... 18
S
Superheater Co., Ltd.......... 49
Sterne & Sons, G. F.......... 51
Sarco Co., Inc. 8
Sanford Riley Stoker Co........ 7
Shell Bar Boico Supply Co...... 56
Sterling Engine Co. 9
Sturtevant Co. 47
Stephen Chemical & Mfg. Co., Limited 49
T
Taylor Instrument Co., The.... 18
Thomson-Gordon, Ltd. 48
U
Underfeed Stoker Co. of Canada 7
W
Wall, W. J. 49
Waterous Engine Works Co..... 1
Watson & McDaniel Co........ 48
Watson, M. Barry, M.E....... 47
Wilson, J. L. 17
Y
York Mfg. Co. 17
Young Pump Co. of Canada... 9



Anti-Clinker
SHELL-BAR GRATE BARS

Designed and built by men with practical experience, the Shell-Bar Anti-Clinker Grate Bars are built to

Get the last bit of heat out of the last bit of fuel

Write for full particulars

Maximum air space permits perfect combustion even of low-grade fuel. Nothing is burnt to waste—nothing is wasted in clinkers. Wherever they are used they are giving more heat with less fuel.

SHELL-BAR BOICO SUPPLY, Limited 1-15 Saunders Ave. **TORONTO**

SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

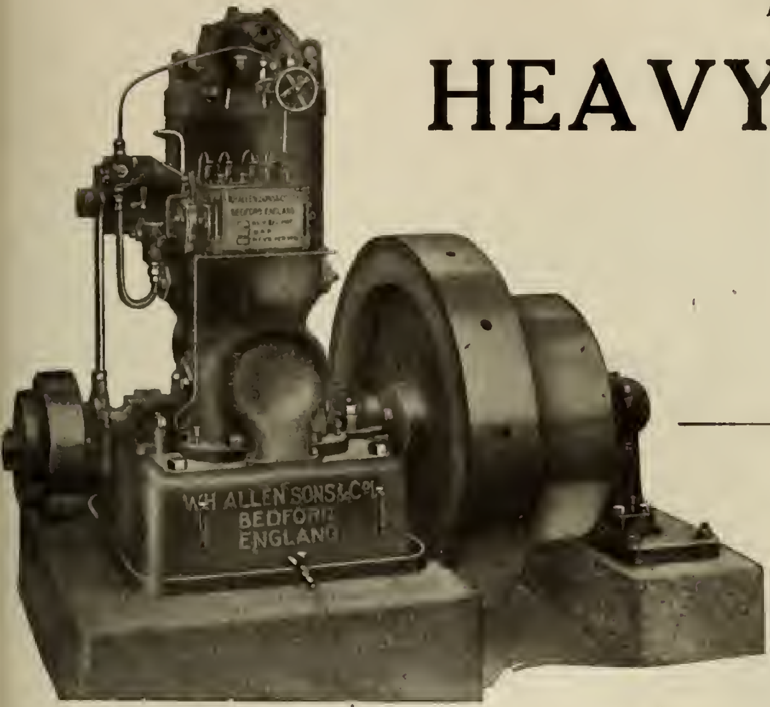
When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*

Power at Minimum Cost

BY USING OUR

HEAVY FUEL-OIL ENGINE

SEMI-DIESEL TYPE



One, Two and Four Cylinders

For Driving--

DYNAMOS, PUMPS,
COMPRESSORS, Etc.

Features--

SIMPLICITY—Easy to Operate
RELIABILITY—Maximum Life
ECONOMY—Minimum Running Cost
DURABILITY—Rigid Construction

SIZES
15 H. P.
to
200 H. P.
Write for
Particulars

CANADIAN
ALLIS-CHALMERS
PRODUCTS
Hydraulic Turbines
Centrifugal and Steam Pumps
Steam Power Plant Equipment
Mining Machinery
Crushing and Cement Machinery
Flour and Saw Mill Machinery

CANADIAN ALLIS-CHALMERS LIMITED

Head Office—KING AND SIMCOE STREETS, TORONTO

BRANCH OFFICES: HALIFAX, SYDNEY, ST. JOHN, MONTREAL
QUEBEC, OTTAWA, HAMILTON, LONDON, WINDSOR, COBALT, SOUTH PORCUPINE
WINNIPEG, CALGARY, EDMONTON, VANCOUVER, NELSON AND VICTORIA

TRADE MARK
J.M.T.
REGISTERED
A
GUARANTEE
OF
QUALITY

REDUCING VALVE PERFECTION

J.M.T.

A watchman who spends half his time sleeping is a poor asset to any plant. You wouldn't hire him for five minutes. Can you afford to be less particular of your Pressure Reducing Valves?

The importance of using valves which maintain correct reduced pressure at low maintenance costs cannot be over-estimated.

Morrison Valves are furnished for pressures from 5 to 300 lbs. They are the result of over 50 years' engineering experience.

Morrison Products include Valves for every service, Gauges, Injectors, Ejectors, Whistles, Bells, Steam Traps, etc.

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Co.
LIMITED
93-97 ADELAIDE STREET WEST
Toronto, Ontario

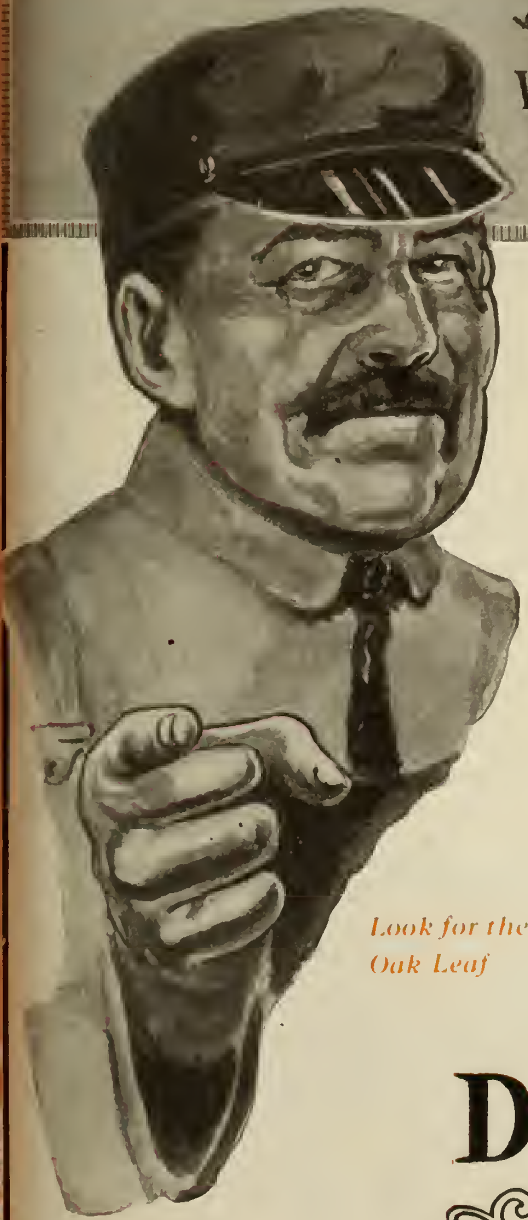
POWER HOUSE

Fostering Economy in the Development of Power for All Industries

ol. XVI—No. 15

Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.

August 5, 1923



"Belting trouble ends where D.K. McLaren's Belting begins"

YOUR GUARANTEE OF

GENUINE OAK

LONGER BELTING SERVICE

There are good reasons behind our claim that D. K. McLaren's belting reduces your transmission costs. In the first place only the toughest parts of hides, selected by experts, are used. These **Backs** are subjected to the **genuine British Oak Tanning,** a process that not only adds to their toughness but imparts a wonderful flexibility to the leather. It is this combination of toughness and pliability that gives to D. K. McLaren's Belting that gripping quality that prevents slippage and other troubles.

Look for the Oak Leaf

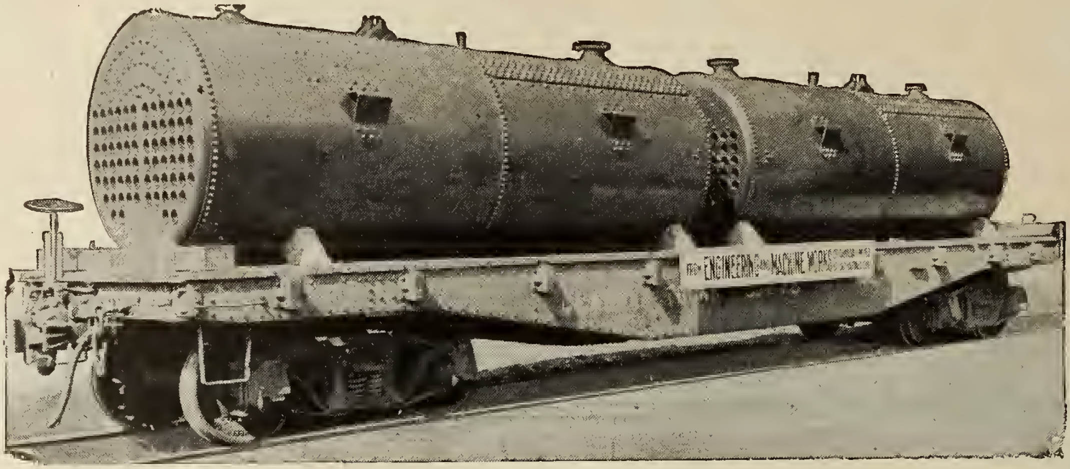
D·K McLAREN LIMITED

Head Office and Factory: 351 St. James Street, Montreal, P.Q.

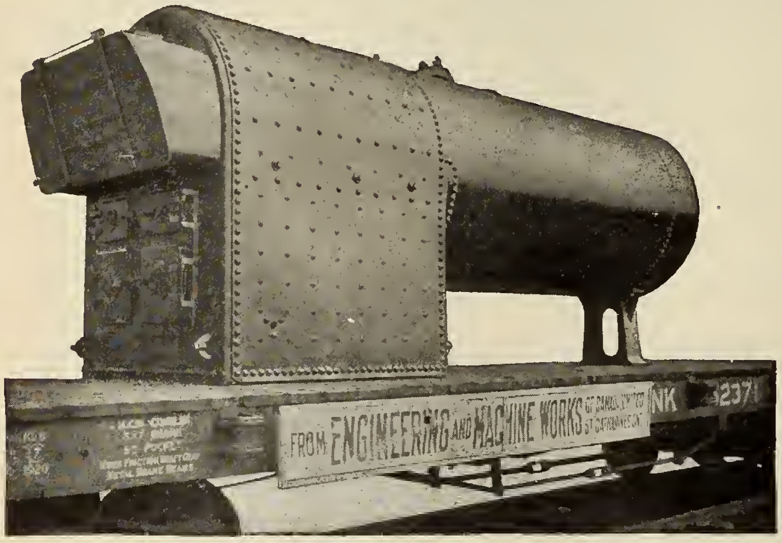
BRANCHES: Toronto, Ont., 194 King St. W.; St. John, N.B., 90 Germain St.
STOCK DEPOTS: Calgary, Alta., Gorman's, Limited; Edmonton, Alta., Gorman's, Limited; Vancouver, B.C., T. M. Grindley Company, 1158 Homer St..

Cents a Copy

$2.00 a Year



Boilers for Power or Heat


FROM ENGINEERING AND MACHINE WORKS OF CANADA LIMITED ST. CATHARINES ONT.
NK 32371

E. & M. W. Heating Boiler—Smoke Consuming Device can be added if desired.

Remember, a good Boiler is a real money saver.

Remember the old adage "any fool can make money but it takes a wise man to keep it."

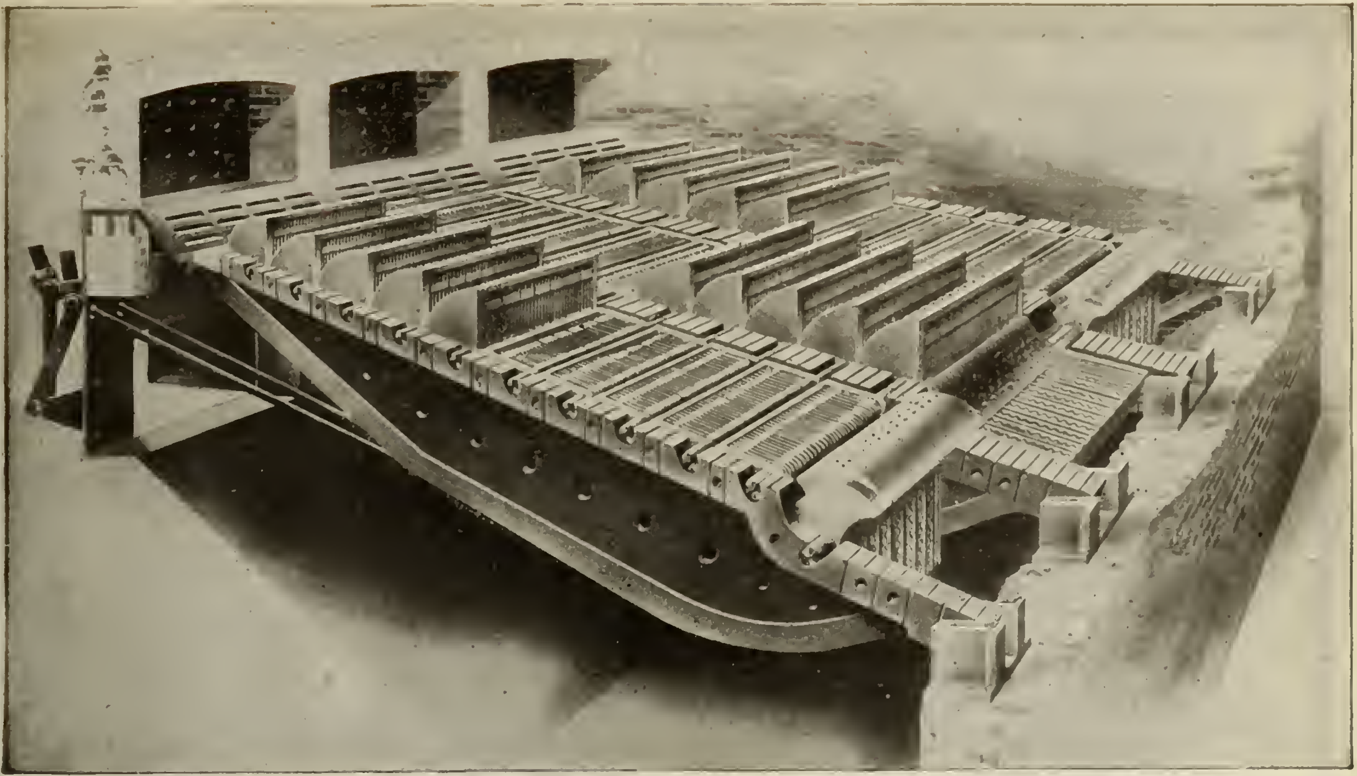
Many a business firm to-day is losing a tidy little annual dividend because they cling to old-fashioned, leaky, coal-devouring Boilers, always "out for repairs."

We can equip you with a thoroughly high grade modern Boiler, for any duty, at a price so moderate that it will surprise you.

ENGINEERING & MACHINE WORKS OF CANADA LTD.

Engineering & Machine Works of Canada, Limited
ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal



Users Testify to the Saving Power of Files Stokers

ONE user of Files Stokers says a single installation (3,600 H.P.) saved enough coal to pay for the stoker investment in five months.

The average rating for this period was 223%.

Another user has written to say "While we have not made an actual test we would judge the saving in coal to be 10% to 15% as our load increased 25%. We are now able to obtain required steam without difficulty, which we could not do with down-draft furnaces."

Quoting from the letter of a third user the fuel-saving merits of Files Stokers is attested as follows: "Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel."

Files Stokers Achieve Results because:

1. **They give correct distribution and proper proportion of air according to load carried.**
2. **The fuel bed is at all times kept clean and uniform.**

You will be interested in the details of design of the Files Stoker. Write for complete information.

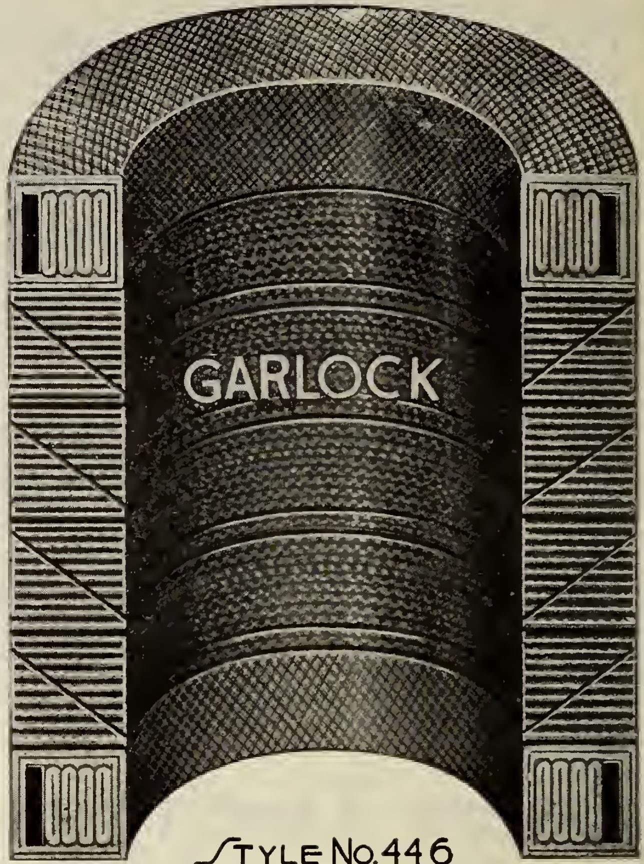
Waterous
BRANTFORD, ONTARIO, CANADA

The Polished Rod

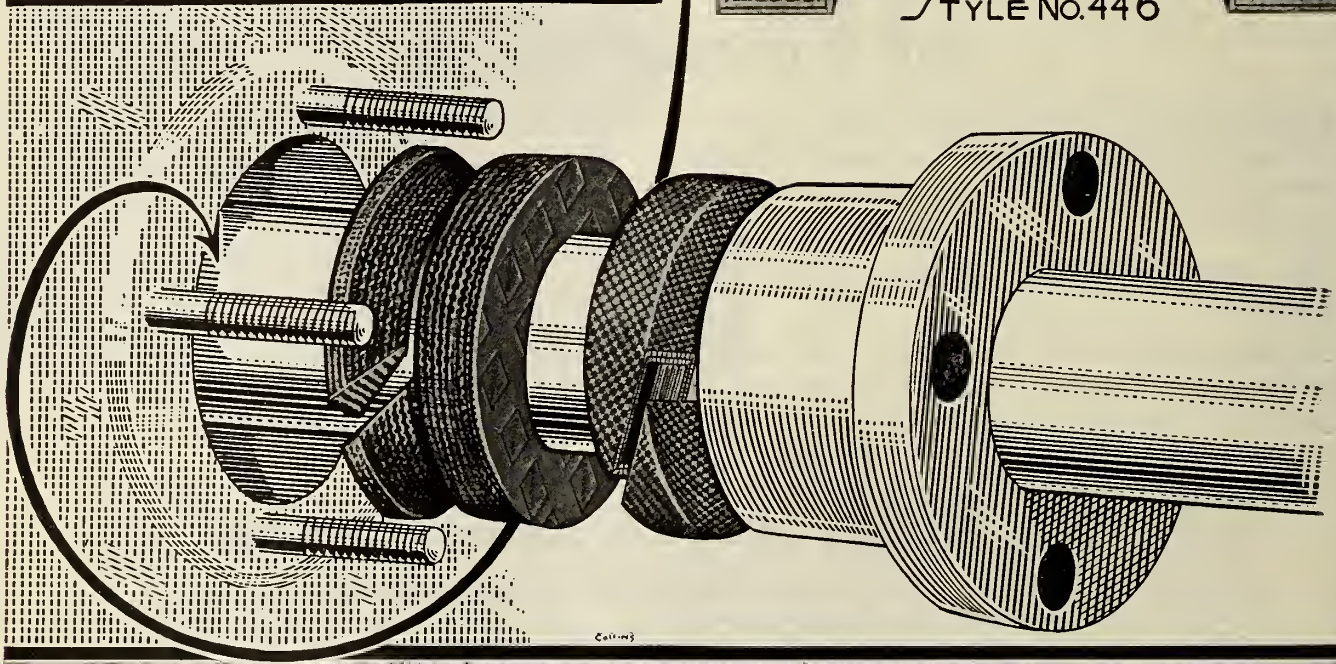
The much desired "glass-like" polish on piston rods can only be maintained by the use of a packing that retains its elasticity and lubricant—not for a few hours after repacking, but during long service of changing pressures and temperatures. Rings of Garlock High Pressure Packing combined with our Diagonal Ring Packing makes a combination (Style No. 446) particularly adapted for service against medium or high pressure steam.

This combination will retain the polish and

"Spare the Rod"



STYLE No. 446

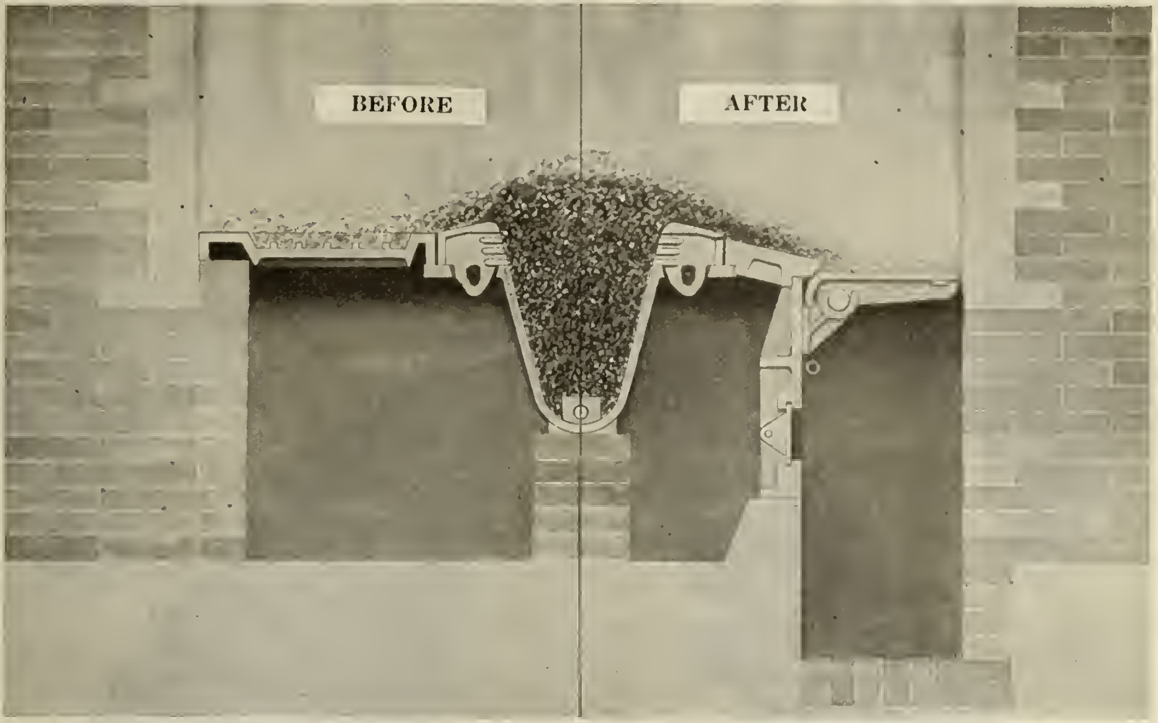


GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY,
HAMILTON, ONTARIO

Branches:

Montreal, Que.	Toronto, Ont.	Winnipeg, Man.
Calgary, Alta.	St. John, N.B.	Vancouver, B.C.



Side dump attachments can be cheaply installed on "Jones Standard" Stokers

"Jones" and "Riley" Stokers
"Murphy" Automatic
Furnaces

Branch Offices:

Alta. & West. Sask.:
Mr. J. Twomey,
Camrose, Alberta.

British Columbia:
E. A. Earle, Ltd.,
Vancouver, B.C.

Man. & East. Sask.:
W. W. Hicks & Co.,
Winnipeg.

Quebec: Cleaton Co.,
(Canada), Ltd.,
Montreal, Que.

RILEY JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

ANY user of "Jones Standard" Stokers can, by adding the side dump attachments, convert his hand cleaned stokers into self-cleaning side dump stokers.

As shown in the illustration above, the change is a simple one. In place of the hand cleaned dead plates (left) sloping combustion grates and hand operated dump plates (right) are used. All of the features which have won fame for the "Standard" Stoker—simplicity, rugged construction, low maintenance, high efficiency and great capacity, to mention only a few—are retained.

The cost of the change is very low. No expensive ash pit construction is needed; an excavation of only a few inches is necessary.

Here is an opportunity for every "Jones Standard" Stoker user to get an ultra-modern side cleaning stoker for practically nothing. Don't pass it up. Send the coupon below to the Under-Feed Stoker Co. of Canada, Limited, 146 King Street, Toronto, for the cost of converting your hand cleaned stokers into self cleaning ones.

Under-Feed Stoker Co. of Canada, Ltd.,
146 King Street, Toronto

Gentlemen: Please give me the cost of equipping my "Jones Standard" Stokers with side dump plates, per specifications herewith:

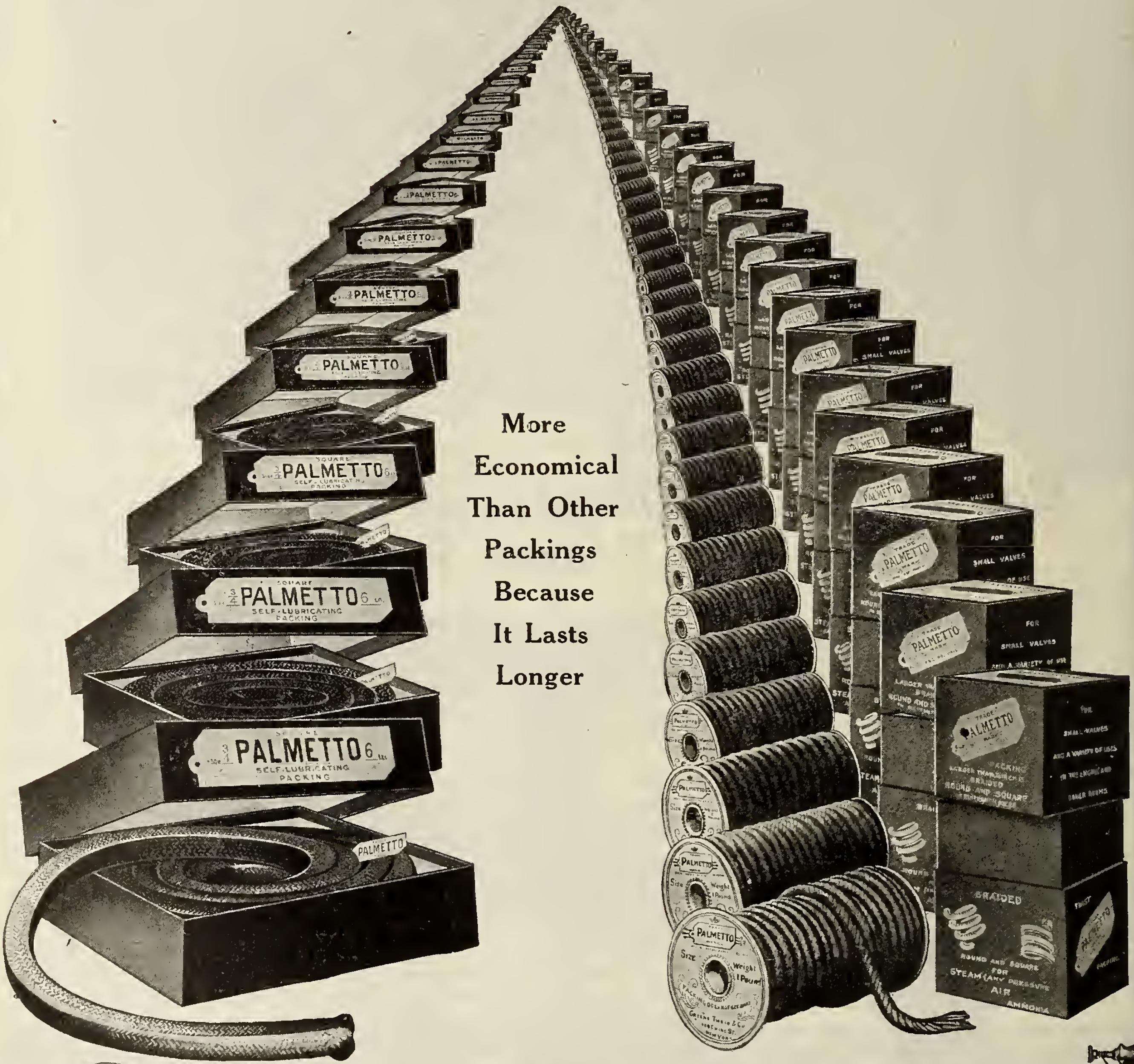
P.H. 8-5-23

No. of stokers....................H.P. of boilers....................
Make of boilers................Stokers purchased in................
Firm ....
Address ....
My name.................................. Title................

"PALMETTO"

REG. TRADE MARK

PACKING

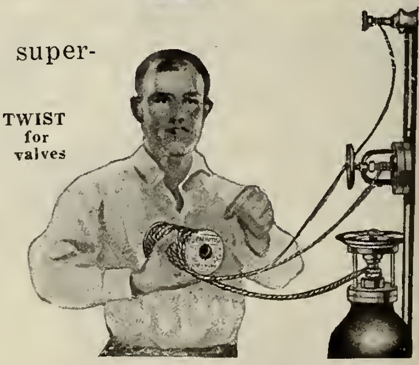


More
Economical
Than Other
Packings
Because
It Lasts
Longer

"Palmetto" has no equal under high pressure superheated steam and compressed air pressures.

BRAIDED
for rods

TWIST
for
valves



If you don't know "Palmetto" let us send you working samples to test—no charge.

GREENE, TWEED & CO.

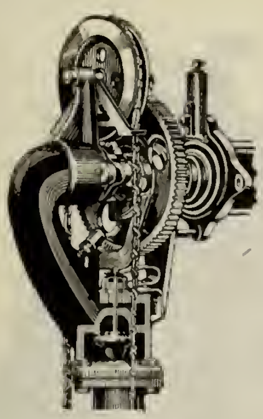
Sole Manufacturers

109 Duane St., New York

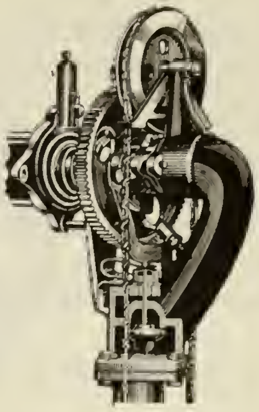
CANADIAN AGENTS:

The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

Diamond "VALV-IN-HEAD" Soot Blowers as compared to independent valve soot blowers



Save 50 percent of steam
Save 50 percent of labor
Eliminate condensate, reducing blower maintenance 35 to 50 percent, besides insuring greatly increased cleaning efficiency



They cost ⅓ less per year to operate. It will pay you to write for complete information

Diamond Specialty Limited
Windsor - Ontario

Diamond
VALV ~ IN ~ HEAD SOOT BLOWERS

A Worth-While Compressor

—a heavy, substantial machine, liberally proportioned, and accurately built. It is self-contained, and may be set on light foundations or strong floor.

Compact and Strong

This type is built both single and double cylinder, and develops pressures up to 125 pounds. Both the head and cylinders are water-cooled; giving approximately 80% more cooling surface than in double-acting machines.

Unloading Governor may be set to operate at different pressures. The suction valves are automatically held open when desired pressure is obtained.

This illustrates our No. 225
SINGLE ACTING AIR COMPRESSOR

What type of air-compressor do you need? Write us.

The Smart-Turner Machine Co., Ltd.
Hamilton Canada

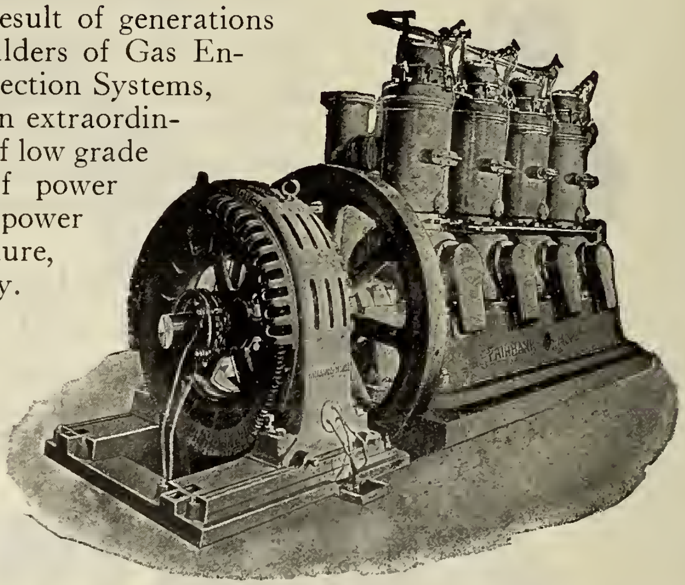
For Thoroughly Dependable Low Cost Power
Fairbanks-Morse "Y" Type Oil Engines

These simple rugged power plants are the result of generations of study and experiment by the pioneer builders of Gas Engines. Their entire freedom from Water Injection Systems, Hot Bulbs, Igniters and Timers guarantees an extraordinary low upkeep cost, while their efficient use of low grade fuel oils ensures a dependable supply of power at minimum expense. And they develop power day-in-and-day-out independent of temperature, weather, coal shortage or failing electric supply.

Write our nearest branch for catalogues and prices.

The Canadian
Fairbanks-Morse Co. Limited

Montreal Toronto St. John Winnipeg Quebec
Ottawa Windsor Vancouver Calgary
Regina Victoria



35

Tight Joints

On Steam, Water, Air, Oil, Ammonia and Acids at All Temperatures

Place Durabla Packing in the next joints you make and be insured against costly shutdown.

Durabla Compressed Asbestos Fibre Gasket material is not affected by vibration or condensation. It will not burn out, blow out, or pulp at the joints.

Made in Canada in stock sizes 36″ wide x 150″ long in thicknesses of 1|64, 1|32, 1|16 and 1|8″.

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast

Plibrico puts an end to falling bricks

When furnaces are lined with fire brick, it is not long before the flame attacks the joints, causing the bricks to crack and spall. Soon they crumble and fall out, and the entire lining goes bad and allows heat to escape — just like the lining in the photo opposite.

Plibrico Furnace Lining eliminates this. Plibrico is pounded into place while plastic, and forms a **jointless** lining—a lining that lasts two to four times longer than fire brick, that resists heat to 3,100 deg. F.. and that cuts down heat radiation.

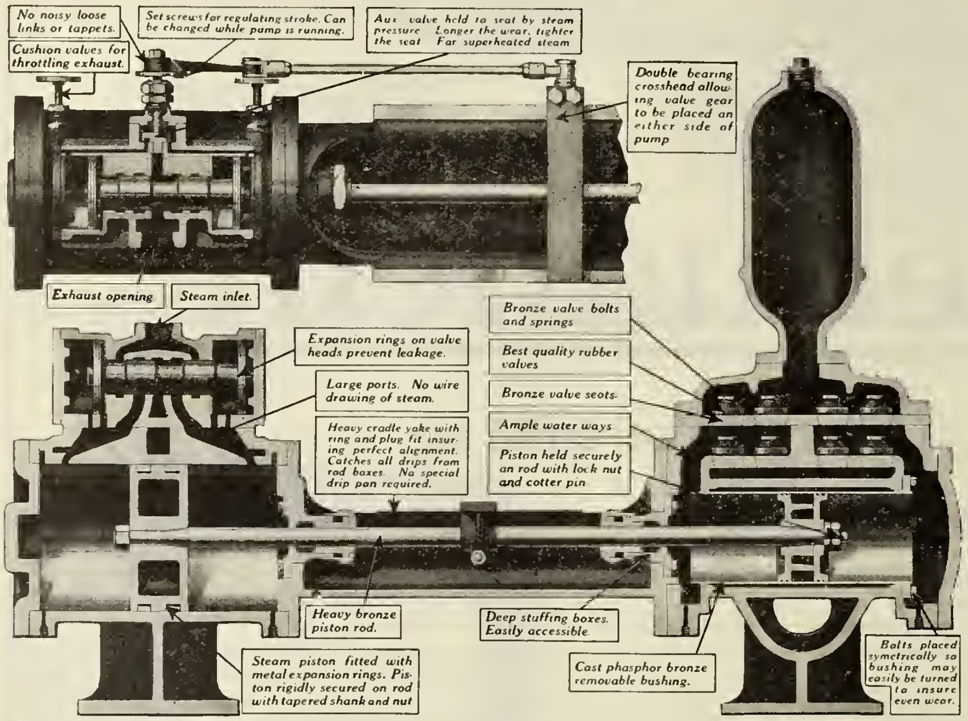
PLIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO.
1142 CLAY ST., CHICAGO

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Gorman's, Ltd. Calgary, Alta.

Plibrico is delivered only in steel containers of distinctive appearance, as shown below.

Book Free.
Ask for the 50 page "Modern Furnace Building." It will point the way to lower furnace costs —and greater profits.

AMERICAN--MARSH PUMPS


No noisy loose links or tappets.
Set screws for regulating stroke. Can be changed while pump is running.
Aux valve held to seat by steam pressure Longer the wear, tighter the seat For superheated steam
Cushion values for throttling exhaust.
Double bearing crosshead allowing value gear to be placed on either side of pump
Exhaust opening
Steam inlet.
Expansion rings on valve heads prevent leakage.
Large ports. No wire drawing of steam.
Heavy cradle yoke with ring and plug fit insuring perfect alignment. Catches all drips from rod boxes. No special drip pan required.
Bronze valve bolts and springs
Best quality rubber valves
Bronze valve seats.
Ample water ways
Piston held securely on rod with lock nut and cotter pin
Heavy bronze piston rod.
Deep stuffing boxes. Easily accessible.
Steam piston fitted with metal expansion rings. Piston rigidly secured on rod with tapered shank and nut
Cast phosphor bronze removable bushing.
Bolts placed symetrically so bushing may easily be turned to insure even wear.

THE illustration tells its own story. Why the American-Marsh are the most reliable, trouble-proof and efficient pumps on the market.

Less than one-half the wearing parts found in the duplex type while a saving of 25% in steam consumption is guaranteed.

Over 160,000 in successful operation.

Ask for catalog.

Canadian Agents: A. R. Williams Machinery Co., Ltd., Toronto and Winnipeg; Williams & Wilson, Ltd., Montreal. Bissett Pinder & Co., Edmonton. Stephens & Boyle, Vancouver. London Engine Supplies Co., London.

American Steam Pump Co., Battle Creek, Mich.

Bronze to Bronze **DART** **At the Joints**

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

BOILER CHEMICALS

Made in Canada for You

Do it Now

Not a hit-and-miss ready-made compound, but made for you on scientific principles.

Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal **Factory: Cobourg**

How Do You Know Instructions Are Being Followed?

From a study of Bristol's chart records, it has been possible to establish a process that is most resultful. By a continued study of the records of

TRADE MARK
BRISTOL'S
REG. U. S. PAT OFFICE.

Recording Pressure Gauges

you can tell whether this efficiency is being maintained — whether your instructions are being followed.

The marked simplicity of Bristol's instruments, is the chief reason why our recording gauges

operate continuously for years, with little attention and few repairs. Catalog 1006-A is waiting for your request.

The Bristol Company

Waterbury, Conn.

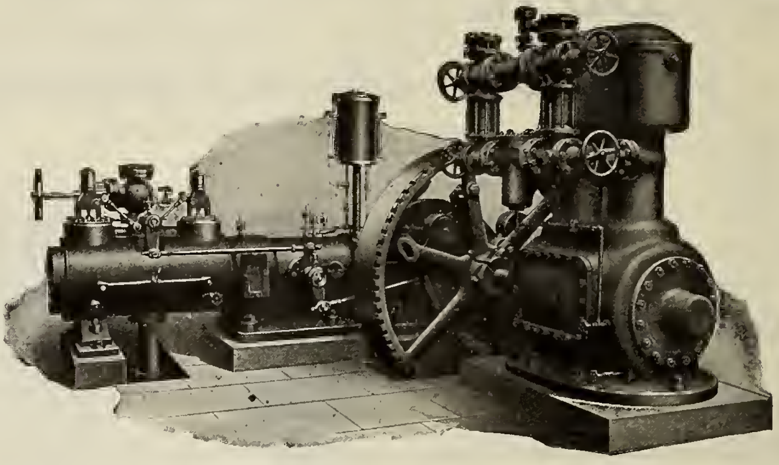
Canadian Distributors:
Eastern Territory—POWERLITE DEVICES, LTD., Toronto and Montreal.
Western Territory—GORMAN'S LTD., Edmonton.

REFRIGERATION DEPARTMENT

FRICK COMPANY, INC. TRADE FRICK MARK WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical



Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

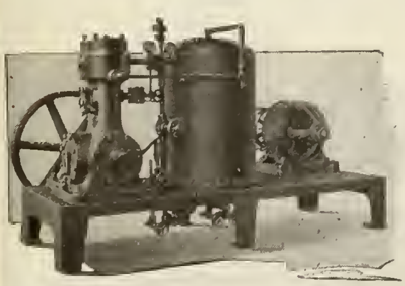
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

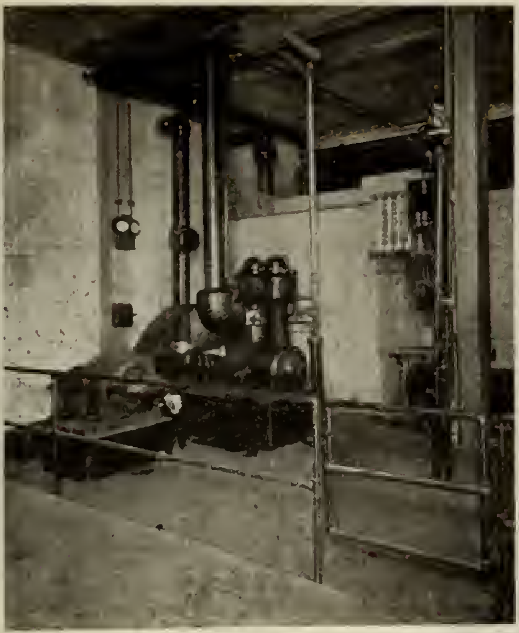
VILTER

ICE MAKING AND REFRIGERATING MACHINERY



A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada



A typical plant of medium size showing Nonpareil Cork Covering on the brine and ammonia lines. S. E. Lux, Jr., Mercantile Company, Topeka, Kansas

Have You Short Lines like These?

SHORT runs of brine and ammonia lines need Nonpareil Cork Covering just as much as long ones. In proportion to size, the saving is just as great on 20 feet of 2-inch line as on 200 feet of 8-inch. It pays for itself in less than a year.

Take an installation like that shown above, which is typical of thousands of small plants. It is surprising how quickly you can put on 40 or 50 feet of Nonpareil Covering with 10 or 12 fitting covers. It all comes in sections ready to apply — no wrapping or trowelling or waterproofing.

And best of all, it is there for good. Nonpareil Cork Covering, applied properly, is permanent insulation. No drip, no frost, no repairs. Keep the wires tight and paint it once a year and Nonpareil Cork Covering will last as long as the pipes.

Write for the new booklet, "Permanent Covering for Refrigerated Lines and Tanks"—Sent free on request

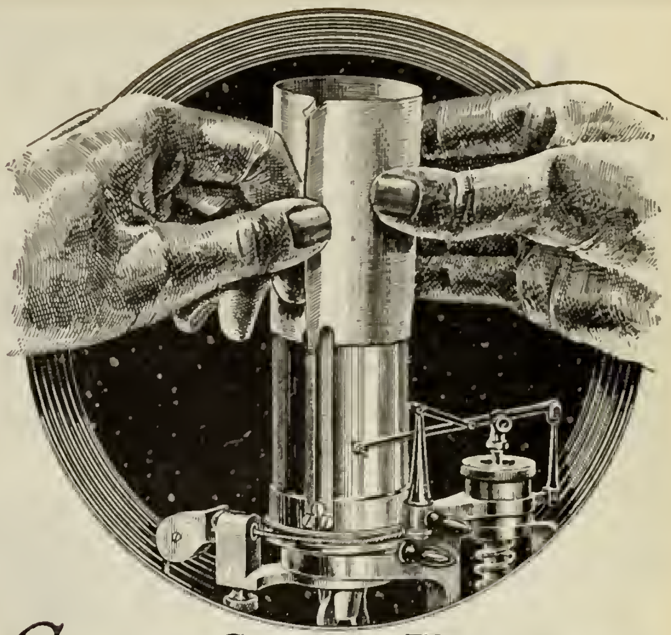
Armstrong Cork & Insulation Co., Ltd.

902 McGill Bldg., Montreal, Que. 11 Brant St., Toronto, Ont. Can.

Also manufacturers of Nonpareil Corkboard Insulation for cold storage and ice storage rooms; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc., Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Cork Covering

For Brine and Ammonia Lines



Changing Cards at High Speed Without Unhooking Cord

While your engine is running at top speed you can change cards on an American Thompson Improved Indicator in less time than it takes to talk about it.

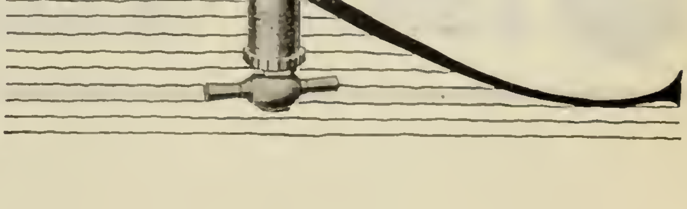
With our patented design of Detent Motion two or more cards can be taken in the time ordinarily required for one. You don't have to unhook cord, and the cord will remain at same tension.

AMERICAN
THOMPSON
IMPROVED INDICATOR

is the only make with this Improved Detent Motion. And without this device it is a slow, disagreeable and often difficult task to take off one card and put on another.

The American is also the most accurate Indicator. Because of its limited pencil motion, it is impossible to make the errors in vertical lines which usually exist in the diagrams taken with other Indicators.

This, and other features of the American are clearly explained in our booklet T-33, sent free on request.



**The Schaeffer & Budenberg Mfg. Co.
and
American Steam Gauge & Valve
Mfg. Co. Division**
BROOKLYN, N.Y.

Canadian Agency
The Canadian Fairbanks-Morse Co., Ltd.
Montreal - Toronto

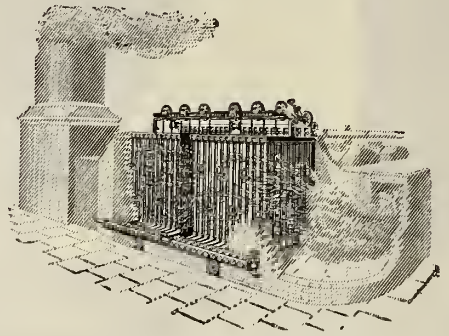
More Steam -- Less Coal

Up-to-date Boiler plants are saving thousands of tons of coal annually by the installation in the main flue between the boilers and the chimney stack of a

Green's Fuel Economiser

which by utilising high temperature flue gases

SAVES 15-20%



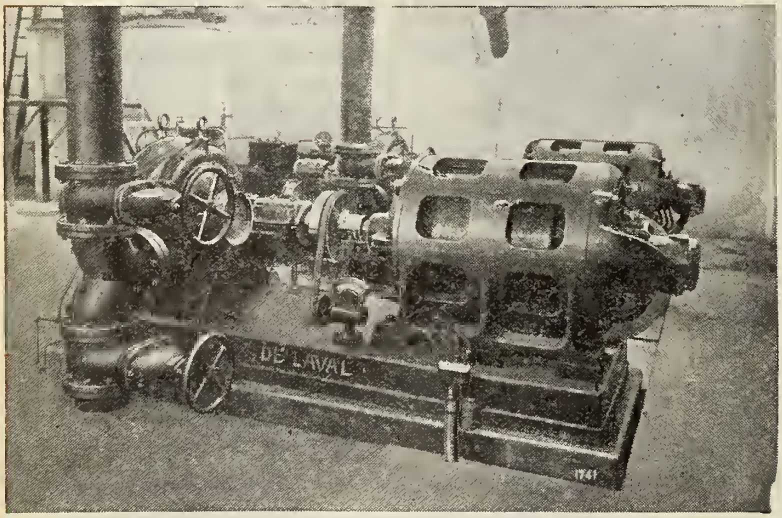
OF COAL

Write for illustrated and descriptive Catalogue D.J. to—

E. GREEN & SON, Ltd., Wakefield, England

Codes: A.B.C., 5th Edition; Bentley's Phrase; A1; Lieber's; Engineering; Western Union.

Pressure Easily Regulated



THE two De Laval two-stage 8-in. centrifugal pumps, designed for 1440 g.p.m. each against a maximum head of 325 ft., shown in the photograph, are installed in the water works pumping plant of Orillia, Ont. They are driven by variable speed motors, by means of which the pressure upon the system can easily be varied. Upon each base plate is mounted a tachometer driven by belt from the motor coupling, also suction and pressure gages, so that the operator can at all times know the speed and the pressure developed, from which it is possible to determine approximately the amount of water being delivered.

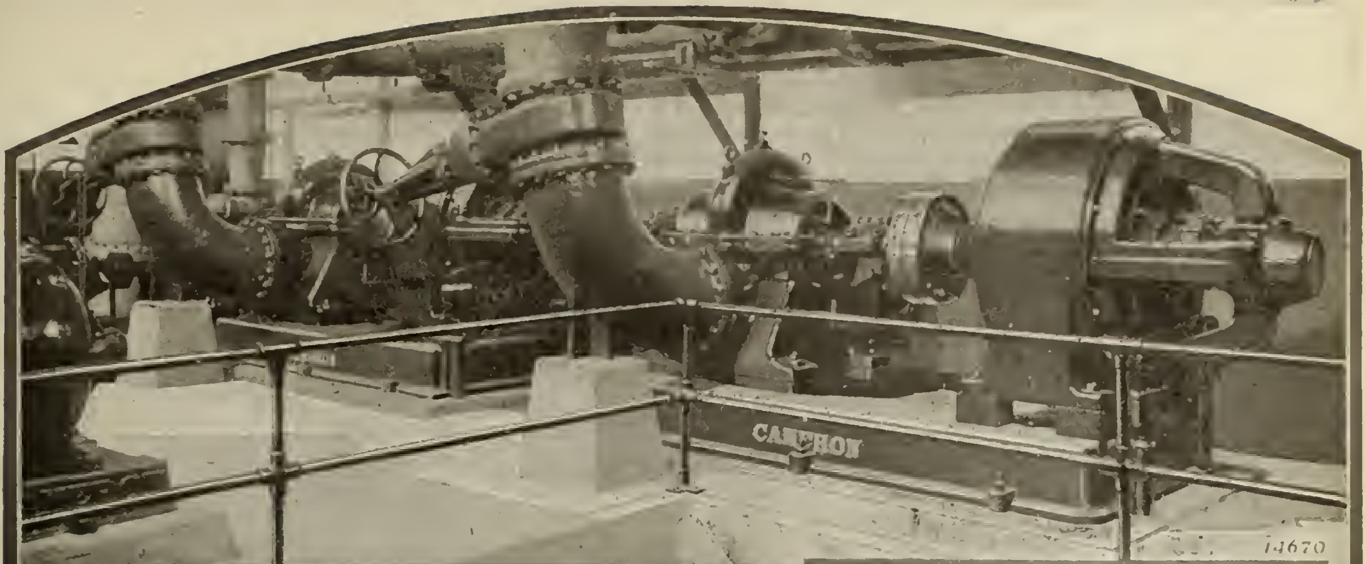
Describe your pumping requirements and our engineers will be glad to make suggestions. Ask for special publication B-100.

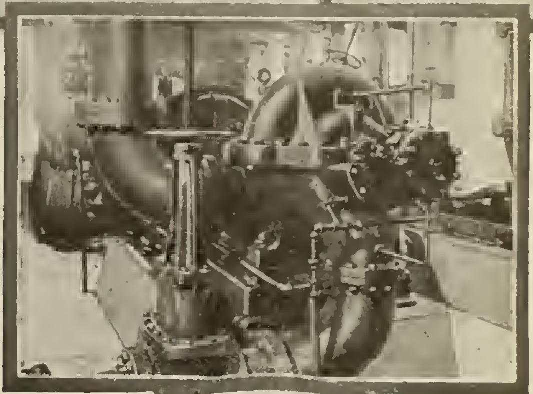
DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

245





Every Pump a Cameron

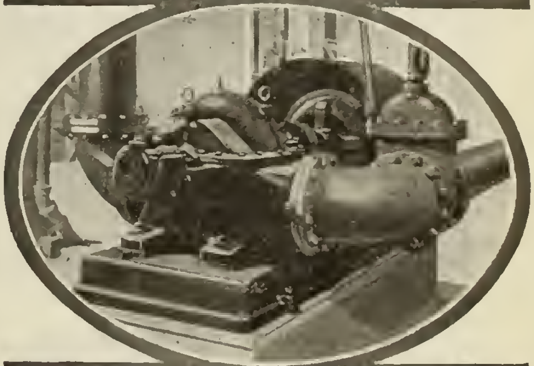
At a Large Paper Mill Three Rivers, Quebec

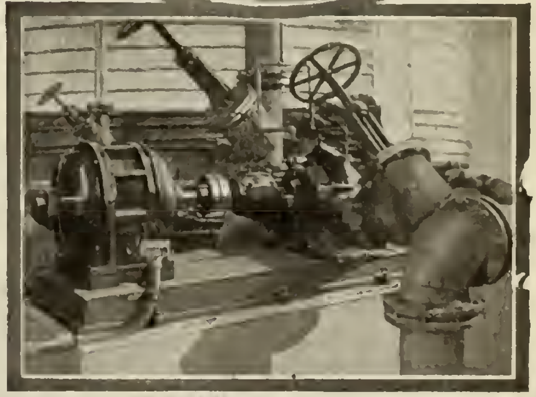
60 CAMERON PUMPS at this mill handle 128,400,000 gallons of liquid every twenty-four hours, requiring 3,973 brake horse power.

These pumps, including stock pumps, acid pumps, circulating pumps, boiler feed pumps and fire pumps, are designed to meet specific operating conditions, resulting in a highly efficient plant.

Many large mills are standardizing on Cameron because there is a pump for every requirement in the industry. Cameron Engineers, after years of experience in every industrial field, are at your service.

Consult our nearest office or write for Complete set of Bulletins.





Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

For the U. S. Refer Ingersoll-Rand Co., 11 Broadway, New York.

Ingersoll-Rand

THE STANDARDS OF PRACTICE

to which

BUSINESS NEWSPAPERS ASSOCIATION
OF CANADA

members are required to conform

B.N.A. Standards of Practice

The members of this Association shall dedicate their best efforts to the cause of business and public service, and to this end shall pledge themselves:

(a) To consider first the interests of the subscriber.
(b) To work for truth and honesty in all departments.
(c) To eliminate, in so far as possible, their personal opinions from their news columns, but be leaders in thought in their editorial columns and make their criticisms constructive.
(d) To refuse to publish puffs, free reading notices, or paid write-ups, to keep their reading columns independent of advertising considerations and to measure all news by the standard "Is it real news?"
(e) To decline any advertisement which has a tendency to mislead, or which does not conform to business integrity.
(f) To solicit subscriptions and advertising upon the merits of the publication.
(g) To supply advertisers with full information regarding character and extent of circulation, including detailed circulation statements, subject to proper authentic verification.
(h) To co-operate with all organizations and individuals engaged in creative advertising work.
(i) To avoid unfair competition.
(j) To determine what is the highest and largest function in the field which they serve and then to strive, in every legitimate way, to promote that function.

It will be conceded that the working principles of the B.N.A. are unsurpassed in the field of advertising and publishing. They are not just a set of "dreamy hopes." Member publications must be dedicated to the true service of industry, must have high editorial standards, and their circulation methods and claims must be audited by the Audit Bureau of Circulations and be like Caesar's wife "above reproach."

Only publications that are willing and able to live up to these high standards are members of the Association.

Adherence to these standards makes B.N.A. publications leaders in their respective fields.

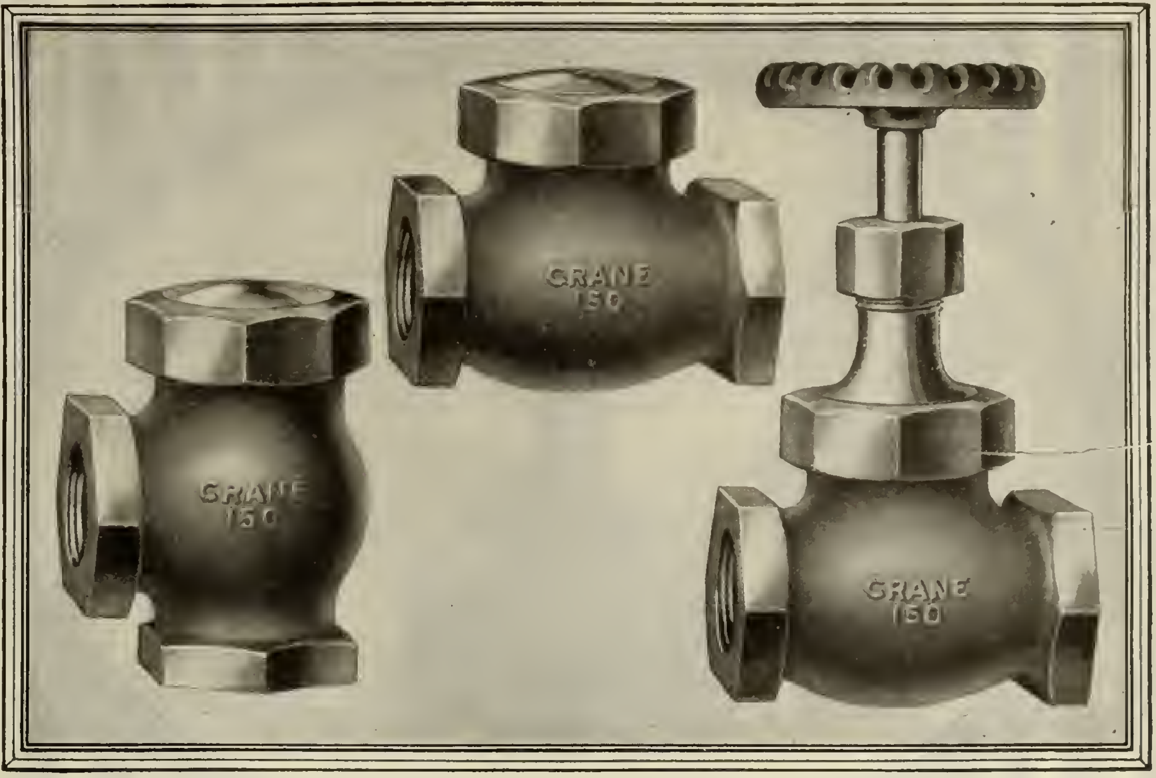
B.N.A. membership to a business paper is what the "Sterling" mark is to silver.

Members of Business Newspapers Association of Canada:

Bookseller and Stationer
Canadian Automotive Trade
Drygoodsman and
  Women's Wear
Canadian Foundryman
Canadian Grocer
Canadian Machinery
  and Manufacturing News
Canadian Railway
  and Marine World
Clothier and Haberdasher
Construction
Contract Record
Dry Goods Review

Druggists' Weekly
Financial Post
Footwear in Canada
Hardware and Metal
Marketing
  and Business Management
Men's Wear Review
Motor Trade
Municipal World
Power House
Le Prix Courant
Printer and Publisher
Sanitary Engineer
Western Lumberman

Association Offices - - 70 Lombard St., Toronto



NO. 7 ANGLE CHECK VALVE, CHECK VALVE AND BRASS GLOBE VALVE

VALVE ENDURANCE TO CUT UPKEEP COSTS

Long life is built into every Crane check valve. Their renewable discs outlast others because the guides of special design confine wire drawing to the metal. True and accurate piping connections make them line up perfectly in an installation.

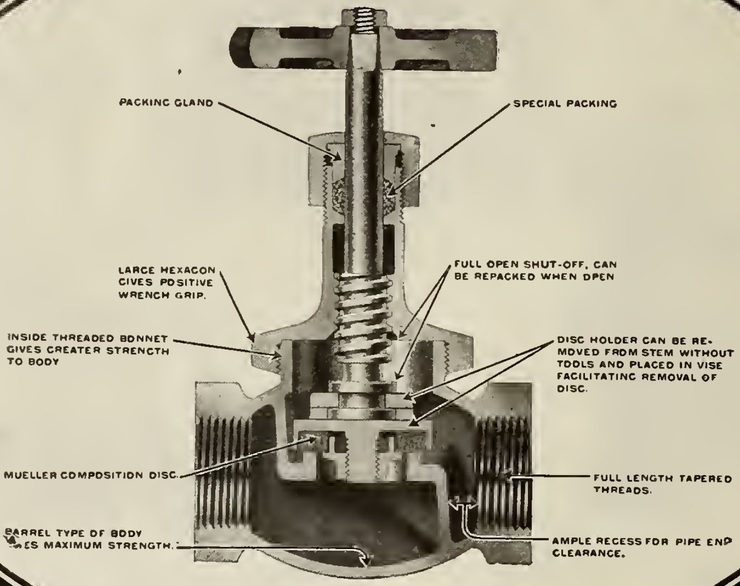
A complete line of Crane check valves is provided, for working pressures up to 2500 pounds. All are of tested strength and match the enduring quality of Crane equipment for every industrial piping and sanitation need.

CRANE

CRANE LIMITED, GENERAL OFFICES: 386 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., HEAD OFFICE: 45-51 LEMAN STREET, LONDON, ENG.
Branches and Sales Offices in 21 Cities in Canada and British Isles
Works: Montreal, Canada, and Ipswich, England

Crane "Barracks" Lavatories

Make
Canada
Prosperous
by
Buying
Canadian
Products


PACKING GLAND
SPECIAL PACKING
LARGE HEXAGON GIVES POSITIVE WRENCH GRIP.
FULL OPEN SHUT-OFF, CAN BE REPACKED WHEN OPEN
INSIDE THREADED BONNET GIVES GREATER STRENGTH TO BODY
DISC HOLDER CAN BE REMOVED FROM STEM WITHOUT TOOLS AND PLACED IN VISE FACILITATING REMOVAL OF DISC.
MUELLER COMPOSITION DISC.
FULL LENGTH TAPERED THREADS.
BARREL TYPE OF BODY GIVES MAXIMUM STRENGTH.
AMPLE RECESS FOR PIPE END CLEARANCE.

VALVES--AND VALVE EFFICIENCY

Maximum Efficiency with Minimum Attention—that's the Service delivered by Mueller Steam Valves. Meeting the full demands of hard service, we know they will suit your requirements.

A full range of Pressure Reducing and Regulating Valves is also among Mueller Products. Acquaint us with your problems—Mueller Engineering Service is ever at your command.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Ill., U. S. A. **Branches, New York and San Francisco**
Mueller Metals Co., Pt. Huron, Mich., makers of "Red Tip" Brass Rod, Brass and Copper Tubing, Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

© 1917 H MM CO

JENKINS

Extra Heavy Iron Body Globe and Angle Valves

Maximum strength and rigidity are rigorously preserved throughout in the design and construction of Jenkins Extra Heavy Iron Body Valves. This reserve strength amply meets the strains and stresses due to expansion and contraction of piping or other causes.

These valves are suitable and guaranteed for 250 pounds working steam pressure, or 400 pounds working water pressure—the margin of safety is wide, for each valve before it leaves the factory is tested to 800 pounds hydraulic pressure.

The bodies of these valves are made of high-grade cast iron; the spindles are manganese bronze, having a tensile strength from 50,000 to 60,000 pounds per square inch. Regrinding discs and seat rings made of durable steam metal.

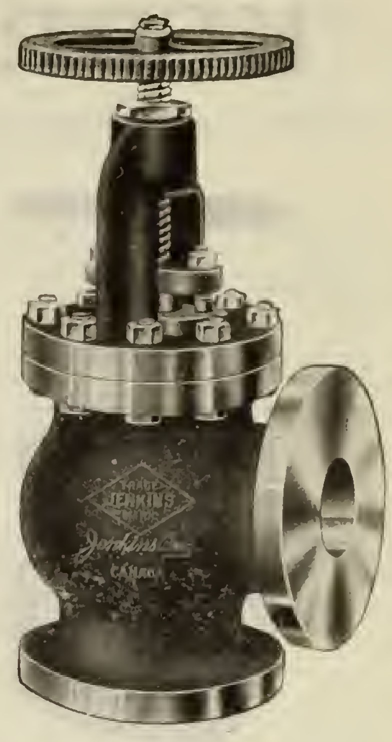


Fig. 163

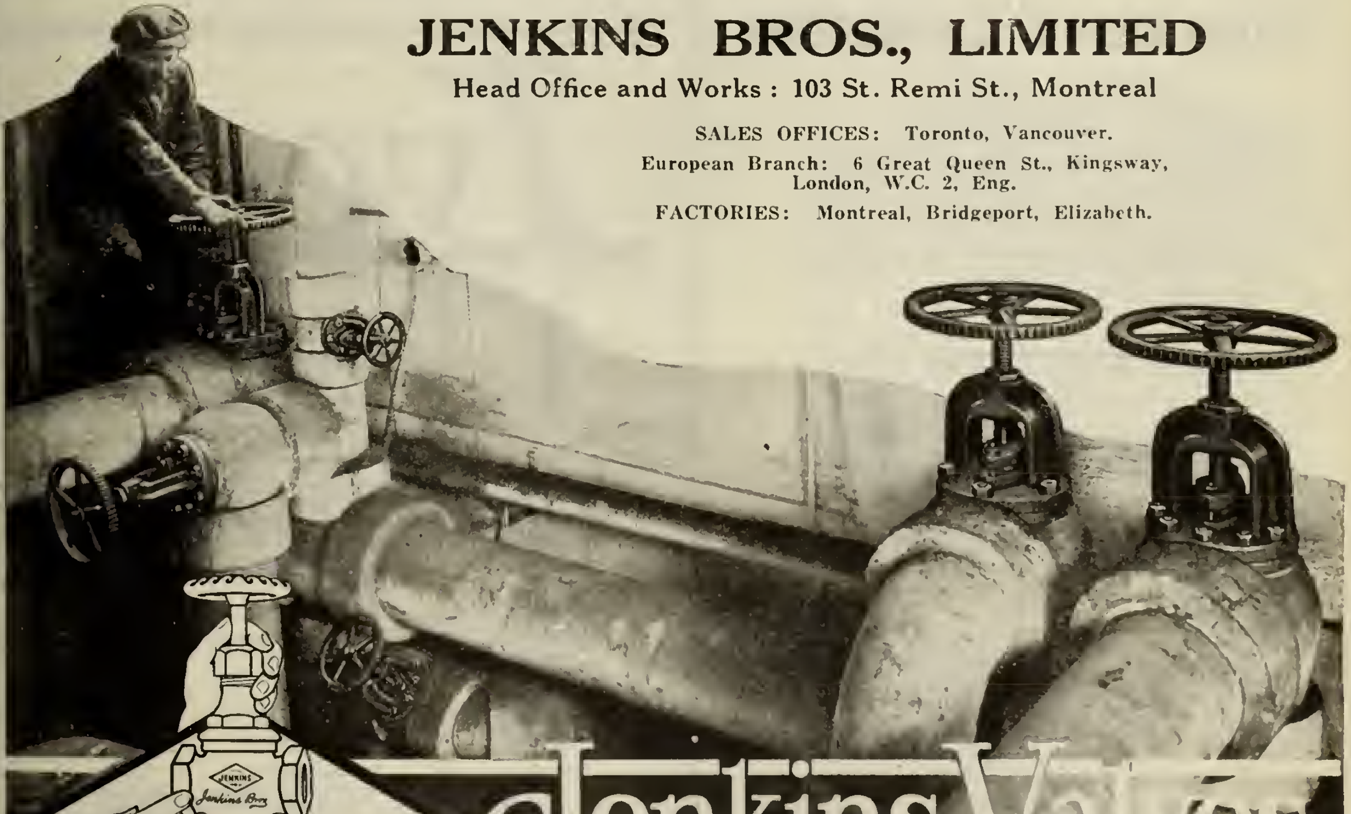
JENKINS BROS., LIMITED

Head Office and Works : 103 St. Remi St., Montreal

SALES OFFICES: Toronto, Vancouver.

European Branch: 6 Great Queen St., Kingsway,
London, W.C. 2, Eng.

FACTORIES: Montreal, Bridgeport, Elizabeth.



KERR

"Guaranteed" Satisfaction

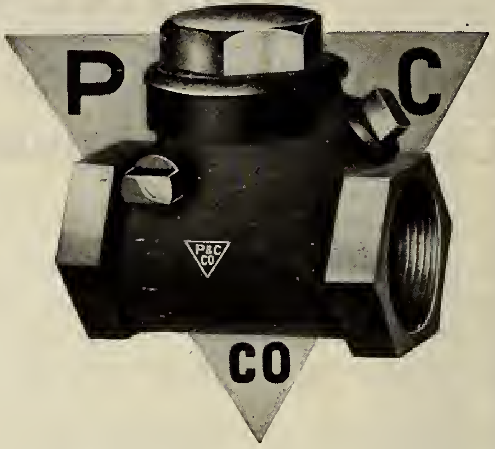
FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville Ontario

PRATT & CADY
VALVES



P. & C. Swing Checks are made in the regrinding type and with renewable asbestos, rubber or leather discs. They have a full port opening and may be used in either the vertical or horizontal position.

The Swing Type of check valve was first patented by Pratt & Cady in 1878.

Reading Steel Casting Co., Inc.
Pratt & Cady Division
General Sales Office: Bridgeport, Conn.
929 Connecticut Avenue
CANADIAN REPRESENTATIVES—CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.

Tycos

temperature instruments

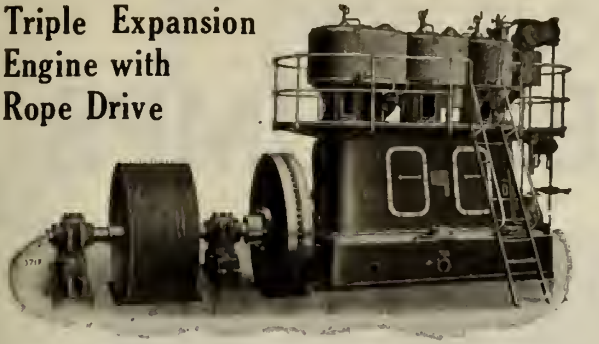
are suited for every particular need in the power house.

Here is a partial list of *Tycos* application. If you have not installed a *Tycos* at these particular points, write for information.

Air Ducts,
Bearing Temperatures,
Blow off lines.
Boilers,
Coal pile temperature and alarms,
Condensers,
Economizers,
Feedwater heaters,
Feedwater lines,
Furnace temperatures,
Furnace drafts,
Generator Temperatures,
Gravity overhead tank heaters, temperature and alarms,
Hot water heaters,
Hot wells,
Pressure lines,
Steam lines,
Superheaters,
Superheated Steam Mains,
Transformer Temperatures and alarms,
Vacuum lines and tanks.

Write for Catalog Part 1.

Taylor Instrument Companies
110-112 Church St., Tycos Bldg., Toronto
There's a *Tycos* and *Taylor* temperature instrument for every purpose.



Triple Expansion Engine with Rope Drive

Belliss & Morcom Ltd.
Birmingham, England

Builders of:

STEAM ENGINES
AIR COMPRESSORS
STEAM TURBINES
CONDENSERS
CRUDE OIL ENGINES

Packing for Centrifugal Pump Spindles will not cut

Maxim Silencers

for Air Compressor Suction, Gas Engine Exhausts, etc.

Welldeck Steam Traps

do not get out of order

AGENTS:

LAURIE & LAMB, Board of Trade Bldg., **MONTREAL**

Save the cost of a shut-down with a Yarway Pipe Clamp

A leaky pipe is a needless expense. Stop the loss in a few minutes' time with a Yarway Pipe Clamp; making either a permanent or temporary repair.

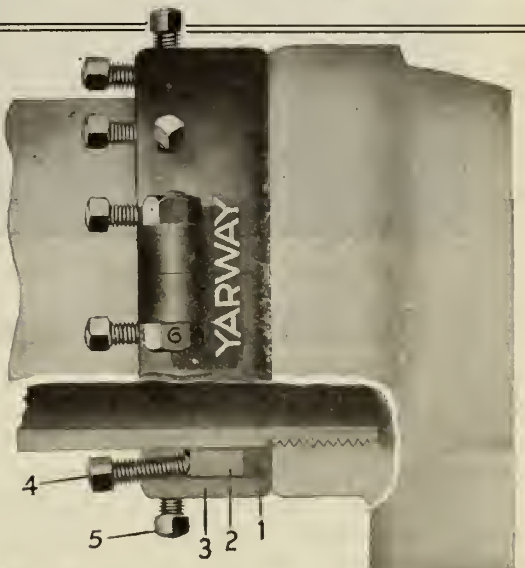
Yarway Holtite Pipe Clamps are for straight pipes. And Yarway Pipe-Joint Clamps are for leaky joints. They are both made in all the usual pipe sizes from ½" to 24" and are stocked by dealers in all principal cities for immediate shipment.

A satisfactory method for temporary or permanent pipe repairs.

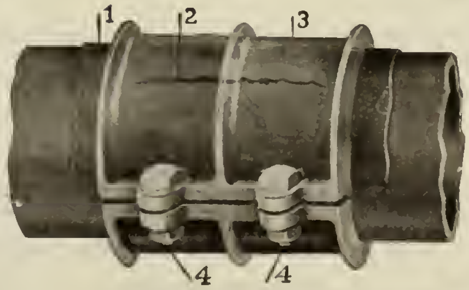
Comments of users are interestingly given, with prices, in Booklet C-805. Send for your copy to-day.

YARNALL-WARING COMPANY

Mermaid Lane and Ardleigh Sts., Philadelphia.
207 St. James St., Montreal.
400 Penobscott Bldg., Detroit.



Yarway Pipe-Joint Clamp. Stops Leaks at Threaded Joints.
1—Square packing ring, forced against leaky joint.
2—Inside ring, forced against packing 1 by screws 4.
3—Outside ring, bolted around pipe by bolts 6, secured by set-screws 5, prevents slipping when adjusting screws 4



Yarway Holtite Pipe Clamp Stops Holes and Splits in Straight Pipe.

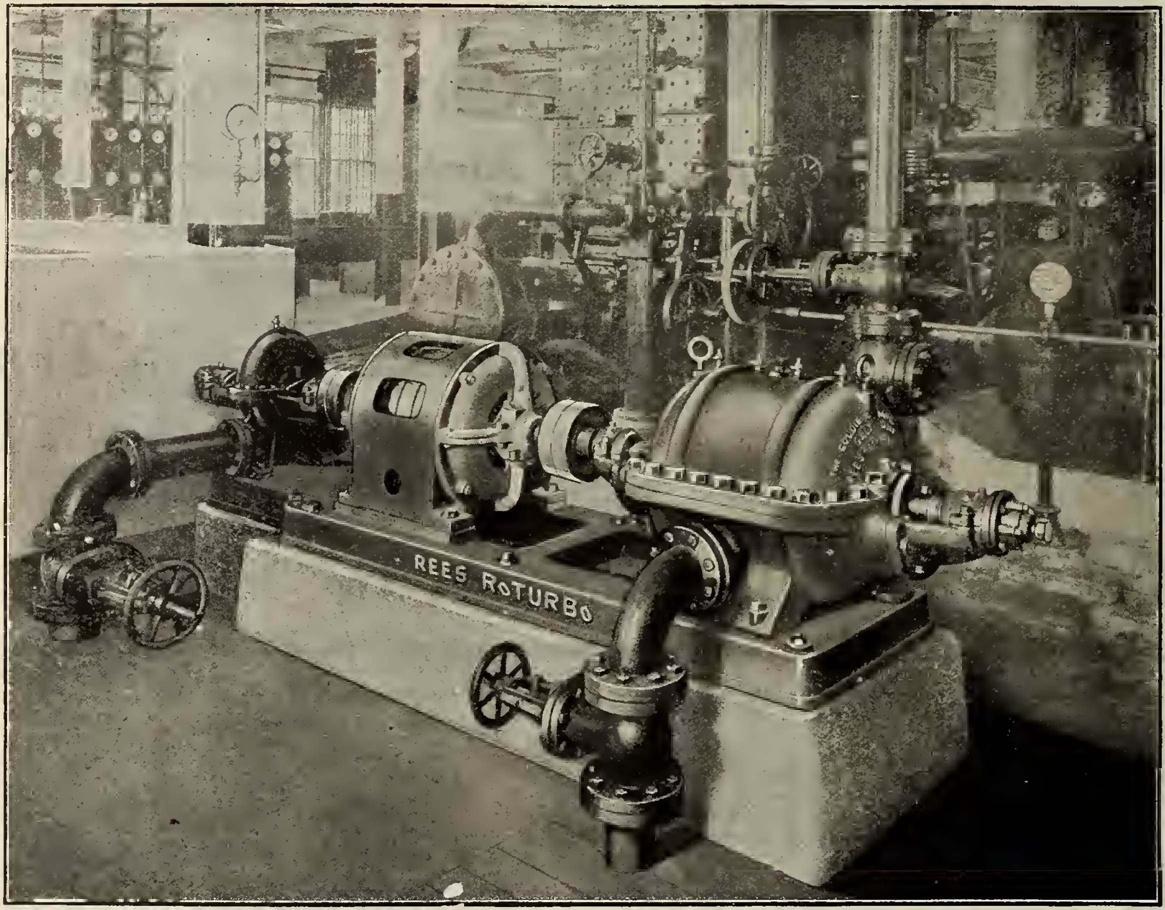
Packing (1) is placed over split or hole (2) in pipe; metal clamp (3) is then fitted around pipe and over packing, and tightened by bolts (4)

YARWAY

POWER PLANT DEVICES *to save fuel*

GOLDIE & McCULLOCH

REES RoTURBo PUMPS



Showing a Rees RoTURBo Two Pressure unit at the plant of the St. Lawrence Paper Co., Three Rivers, Que.

Patent Pressure Chamber Cannot Overload the Prime Mover

The Self-Regulating feature of the RoTURBo PUMP when subjected to variation in boiler pressure cause it to adjust itself to meet the new conditions without danger to the prime mover.

The fluid velocities are low, reducing friction losses to a minimum, and no wear is shown even from gritty waters. High permanent efficiency means that the REES RoTURBo is ideal for multi-stage operation—it is a pump in fact for any service.

REES RoTURBo Patent Pressure Chamber Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Catalog mailed promptly upon request.

SOLE CANADIAN MANUFACTURERS

THE GOLDIE & McCULLOCH CO., LIMITED

Head Office and Works, GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bldg.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig,
400 St. James St.,
Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B. C.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

N. C. SHATFORD
News Editor

Perfect Power Efficiency

IF AN engineer went to a pump manufacturer to obtain a pump with a capacity of one quarter gallon to a gallon a minute, to handle warm salty fluid night and day, without a shutdown, working seventy strokes a minute and guaranteed to operate for seventy years without repairs or attention, would he get a price on such equipment?

If the manufacturer was alone in his office and timid he'd probably tell the engineer that as the job would require a lot of figuring he'd better come around next week, meanwhile edging his prospective customer toward the door before his insanity took violent form. On the other hand, if the manufacturer was made of sterner stuff he might say: "You fool, such a pump never existed or never will except in the brain of a lunatic such as yourself." Which would show how much he knew about it for every engineer carries just such a pump around with him and wouldn't sell it to anyone at any price.

No power plant as yet can boast as efficient a method of converting fuel into energy. It is doubtful if any plant will ever have as well designed a pumping system nor one as perfect for the disposal of waste.

Talk of modern combustion efficiency—the best that science can put into a boiler room is crude indeed compared with that of the human body.

An Analysis of Torque

POWER equipment of the heavier types is so readily rated in horse power that the term torque is seldom used and as a result the ideas of many engineers concerning it lose clarity, although in shafting and gearing problems a thorough grasp of its fundamental implications is of value.

For instance, 5 horse power at 250 r.p.m. can be transmitted by a torque of about 1,260 in.-lb., but the same power at 25 r.p.m. would require 12,600 in.-lb. and a much larger shaft. Indeed it is surprising what a dangerous torque may be produced by little power if the speed be brought very low through gearing or other means; 1 horse power delivered at 1 r.p.m. corresponds to about 63,100 in.-lb., which requires a substantial shaft and gearing.

These effects are generally veiled through the inefficiency of the gearing. If the power output of a motor driving the shafting of chain grate stokers, for example, be compared with the actual power utilized in moving the grates it will generally be found that about three quarters is wasted in speed reducing apparatus.

The torque on the driving axle of a stoker probably corresponds to but a fraction of a horse power, at the crawling speed at which such equipment operates; several times this power may be absorbed in the belts, worm gearing and other means adopted to reduce the speed of the driving motor.

An understanding of torque explains why a high speed electric motor is cheaper than a low speed design, apart from any advantages in production. A given size of motor frame will, within limits, produce a definite torque irrespective of speed. If the speed be halved, the torque remaining constant, only half the power can be produced, since power varies as torque times angular velocity; so that if a given power be required at a speed lower than the normal maximum, a larger frame must be employed, with a larger shaft and other disadvantages.

Torque measurement is best undertaken by some form of torsionmeter, which reads the elastic twisting in a given length of shaft. Previous calibration is necessary as well as means of measuring the speed of the shaft accurately.

The use of some such apparatus is the only convenient method whereby power, developed by turbines which do not drive generators, can be checked in the power house.

Economies of Efficiency

THE man who is interested in his work is always more valuable to an employer than the man who merely "holds" his job; what operating engineer in Canada can maintain his interest in running a plant if he has no idea of the results he is obtaining? He certainly cannot improve upon an unknown result.

The incentive to achieve economy in the operation of a power plant, by the installation of the most reliable equipment obtainable, cannot be calculated in dollars and cents alone, for evidence that efficiency is being attained is apparent in the enthusiasm shown by engineers and firemen who know their results, in striking contrast with the studied indifference of those who simply maintain the supply of steam demanded.

In the latter case the operating force quickly becomes mediocre in every way, waste abounds, and this state of affairs is by no means entirely the fault of the engineer in charge.

The "chief" in a properly equipped plant cannot do other than transmit some of his enthusiasm to those under him, and the result is beneficial in every way. Grievances and waste are noticeably less in boiler rooms where the engineer in charge is imbued with a keen desire to achieve better results. To maintain consistently a high state of efficiency the necessary interest can best be sustained by the provision of apparatus to lessen the labor and appeal to the intelligence of the firemen, to refuse to install such equipment on the grounds of economy is a very short-sighted policy.

Efficiency with economy is quite unattainable under present day operating conditions without accurate information on all the various operations involved in running the modern power plant.

Too Old? Not if He's a Hundred

WHEN an engineer writes a good letter to Power House—the kind every engineer likes to read—why is it that he frequently scribbles "Don't publish my name" at the bottom? It happens every week and it must be assumed that the writer has good reason for the request else he wouldn't be so particular.

The writer of a letter received this week, however, gives his reason for wanting his name kept secret and it's a mighty poor reason.

He says: "If my name is printed some of the members of the association will josh me about being too old to have any opinion worth while on modern power plant operation."

Too old? Not a bit of it—not if he's a hundred—his advice is but the more valuable. The only man who is proof against inspiration obtained in the school of experience is the dead one.

Buying the Right Coal for Power Plant Economy

By ROBERT JUNE, Assoc. Mem. A.S.M.E.*

The Adoption of the Right Fuel to the Right Equipment is a Problem, the Correct Solution of Which Offers Unusual Opportunity to Effect Operating Economies

THE proper selection of coal, the adoption of the right fuel to the right equipment, is a problem, the correct solution of which offers unusual opportunities to effect economies in the operation of the power plant. It is a problem which should ever be taken into consideration in the design of a plant.

The distinctions between the various ranks of coal are not clearly defined. The most satisfactory method for establishing the various classifications is by the use of both mechanical and physical criteria. On this basis the following ranks are arrived at:

The outstanding characteristic of anthracite is its low volatile content. Because of this it burns with very little flame, giving an intense fire free from smoke. Good anthracite is hard, compact, and lustrous, giving a vitreous fracture when broken. The chemical composition and heat value of anthracite is shown in Fig. 1.

Loss in Anthracite

An important source of financial loss in the use of anthracite lies in the fact that no matter how carefully handled, it is liable to break up into very tiny pieces, under the influence of the high temperature of the furnace, when freshly fired, with consequent, large losses of fuel through the grates to the ash pit. As anthracite requires at least 40 per cent. greater combustion space than does bituminous coal, it should never be purchased for use in furnaces not designed for it.

Semi-anthracite reaches the consumer generally under the name of "anthracite," a deception which should not be tolerated. As the name implies it is inferior to anthracite. It has less fixed carbon and somewhat more volatile. Its characteristics are likewise given in Fig. 1.

Super-bituminous fuel is commonly termed "Semi Bituminous"—an unfortunate appellation as it creates the inference that this coal is inferior to bituminous whereas it is markedly superior.

Another trade name for this fuel is "Smokeless" coal. The latter term is a consequence of the relatively high percentage of fixed carbon which renders the coal practically smokeless when properly burned. The heat value of this fuel is very high and as it requires less bunker and storage space per unit of heat than other coals it is in great demand for naval and steam-ship use, as well as for manufacturing plants located in crowded quarters where storage space is at a premium and smoke regulations are enforced.

This is the first in a new series of articles by Robert June, the well known authority on Power Plant Management. The articles are written from the point of view of the executive and deal with the dollars and cents end of power plant operation and maintenance. Succeeding articles will deal with such live topics as Efficient Combustion Practice, Safe and Efficient Boiler Operation, Stoker Operation and other problems of the stationary engineer.

Coal Quite Friable

Super-bituminous coal possesses one characteristic which the public has been prone to regard as a rather serious disadvantage; that is the coal is quite friable, readily breaking into small pieces not only during the process of mining, but also in transportation and handling. This apparent disadvantage is not necessarily existent as the coal can be burned with practically no loss through the grates to the ash pit, when fired with mechanical stokers and grates adapted to the fuel. Reference again is made to Fig. 1 for outstanding characteristics.

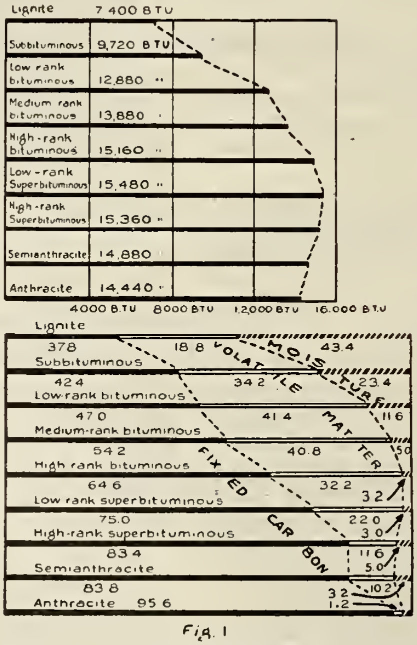


Fig. 1

Comparative heat value, and variations in fixed carbon, volatile and moisture of different coals, computations on ash free basis.

The term bituminous is applied to a wide variety of fuels. The classification "bituminous" is based in particular upon the relation of volatile matter in the coal to fixed carbon, but also and more specially to the factor which distinguishes bituminous coals from those of lower rank. This factor is that true bituminous coal is only slightly affected mechanically by weathering even though it be exposed for a long period of years. This is not true of coals of lower rank, which break up readily under the influence of weather.

Many attempts have been made to divide bituminous coals up into characteristic groups. This is not readily accomplished but the following classifications tell the power plant operator what he ought to know.

(a) Non-Coking, dry bituminous coals are the best for steaming purposes. They closely approach super-bituminous in character, being hard and dense but inclined to be friable, breaking easily in transportation and handling. They ignite readily, and burn freely with short, clean, bluish flame.

Fuse in Burning

(b) Bituminous coking coals as their name implies swell up, becoming pasty and fuse together in burning. They have a higher percentage of volatile and less fixed carbon than the free burning non-coking coals. Being rich in hydro-carbon these coals are particularly adapted to gas making. Certain varieties are commonly sold as "Gas Coal."

(c) Long-Flaming, bituminous coals are notable smoke producers. Some varieties coke, others do not so in using coal of this grade for steam purposes care should be taken to secure a supply at all times from the same source; otherwise uncertain combustion conditions will prevail and financial loss ensue. As a general proposition this coal is preferable for use under dryers, in cement kilns, and so forth, rather than for general steam making purposes.

The distinction between sub-bituminous and bituminous coals lies in the fact that sub-bituminous rapidly loses its moisture and consequently "slacks" to a marked extent when subjected to alternate wetting and drying. As the matters of both size and moisture content are important in buying and shipping coal, there are a number of points to be considered before voluntarily adopting sub-bituminous coal for use in the power plant. For one thing,

---

*Copyrighted, 1923, by Robert June.

unless slacking is to be permitted, it is almost necessary to ship sub-bituminous coal in box cars, thus materially increasing the cost of loading and unloading. Another point is that sub-bituminous coal is extremely liable to spontaneous combustion. On the other hand sub-bituminous is a very clean fuel and ignites with little difficulty.

Brown in Color

As used by the Geological Survey the term "Lignite" is restricted to those coals which are distinctly brown in color and either characteristically "woody" or "clay like" in their appearance. Because of their high moisture content which may run up to 30 or 40 per cent., these coals cannot be shipped far as no one wants to pay freight on so much water. Lignites are even more difficult than sub-bituminous coals to handle because of their rapid loss of moisture and marked tendency to slack and to spontaneous combustion. For economical steam generation lignite should be purchased near the power plant and practically used as rapidly as received.

Comparison of Ranks

Fig. 1 shows proximate analysis of B.t.u. value of the various ranks of coal. This diagram is best on the properties of actual samples of commercial fuels in each rank. Fairly regular increase in fixed carbon from lignite to anthracite will be noted. The rapid increase in the moisture in the lower ranks of coal is of interest as is also the fact that the greatest amount of volatile matter is found in the lower ranks of bituminous,

The diagram shows the B.t.u. value of the coals on an ash free basis. It will be seen that the best coal for steaming purposes is low rank super-bituminous.

Moisture in Coal

Not only is moisture a non-combustible but it absorbs heat because it must be vaporised and discharged at stack temperature. Where the moisture percentage is small this is not such a serious matter, as one per cent. of moisture amounts to only one-tenth of one per cent. of 13.000 B.t.u. coal if we assume somewhat high stack temperature of 700 degrees.

Another point with respect to moisture is important; the usual chemical analyses of coal do not show all of the moisture. The reason for this is that there is considerable amount of water which cannot be driven out of the coal even at 220 degrees F., but remains in chemical combination usually as a carbo-hydrate which can only be driven off with volatile.

In a typical West Virginia coal, 13% of the volatile has been found to be water. In a typical Illinois coal 25% of the volatile itself is non-combustible in the form of water. This means that in making comparative appraisals of coals from different fields or in purchasing coal under specification the moisture content of the volatile as well as the free moisture should be taken into consideration to secure accurate results.

Ash is a complex compound consisting of iron, lime, alumina, magnesia, silica, titanium and various alkalies.

An Inert Material

It is to be considered from two points. First, in buying coal with any appreciable percentage of ash in it you are paying not only the first cost but also freight and handling charges all through your plant for so much inert material. The second, is of utmost importance. It concerns us with the fusing temperature of the ash and the actual temperature to which the ash is subjected in the furnace. There are coals, the ash of which has such high fusing temperature that there are practically no fuel bed conditions which will produce troublesome clinker. Next we find a different type of ash with a lower fusing temperature. This ash will clinker but in doing so it forms a porous spongy mass which does not materially obstruct the flow of air nor prove difficult to remove. The really troublesome ash is that which has a low fusing temperature—say 2100 degrees F. This forms the worst sort of clinker, and the question of the use of coal which contains it should be given the most careful consideration by the power plant operator.

Influence of Size

Bituminous coals are graded and sized as follows:

(a) Run-of-mine — unscreened coal which has been picked over only for removal of larger pieces of foreign material.

(b) Lump—coal which will pass over a bar-screen with 1¼ inch openings.

(c) Nut—coal passing through bar-screen with 1¼ inch openings and over a screen with ¾ inch openings.

(d) Slack—coal which passes through a bar-screen with ¾ inch openings.

Anthracite coal is graded and sized as follows.

(a) Run-of-mine — unscreened coal from which larger pieces of foreign material only have been picked.

(b) Lump—classed as 6 inch, 3 inch, and 1¼ inch according as the coal passes through circular openings of the larger diameter and over openings of the smaller diameter.

(c) Nut—classed as follows:

Three inch—smaller than 3 inches and larger than 1¼ inch in diameter. One and quarter inch—smaller than 1¼ inch and larger than ¾ inch. Three quarter inch—smaller than ¾ inch diameter and larger than five-eighths inch.

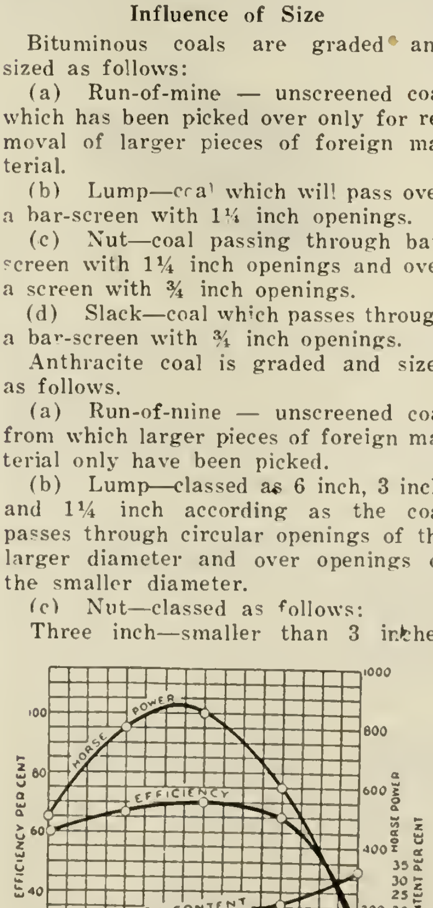


Fig 2

Influence of size of screenings on capacity and efficiency of a stoker fired 500 H P. boiler.

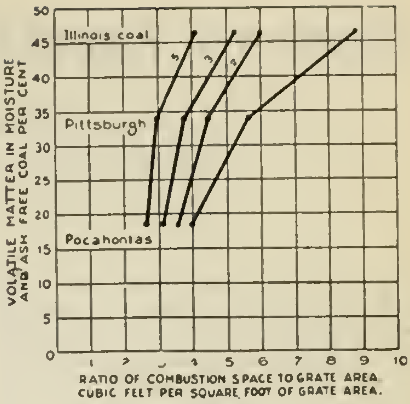


Fig. 3

(d) Screenings—everything which passes through a 1¼ inch screen.

The size of coal effects the draft of the furance and influences the capacity of the boiler. Thus, the presence of large quantities of fine coal and dust will materially check the flow of air through the fuel bed. When fine coal is used thin fires are necessary, and this usually results in a decrease in boiler efficiency due to the presence of holes in the fire.

The percentage of ash in fuel generally increases materially as the size of the coal decreases. The explanation is that dust and small pieces of foreign material from the roof or floor of the mine, having been separated from the larger coal naturally finds their way into the smaller coal. Fig. 2 illustrates the influence of the size of screenings on the capacity and efficiency of a 500 h.p. boiler fired by chain grate stokers.

The size of coal best suited to individual plant operating conditions should be determined by a series of tests. Once the most efficient size has been determined it will be found profitable to insist that all deliveries conform to this size.

Combustion Space

Different coals require different combustion spaces—the size of the combustion space required being determined by the quantity and quality of the volatile matter as indicated by the ratio of volatile carbon to available hydrogen, and also by the oxygen content of the coal on a moisture and ash free basis.

Fig. 3 furnishes an illustration of the point that the size of the required combustion space is dependent upon both the quantity and quality of the volatile matter and does not depend upon the percentage of volatile alone.

It is well worth while to have the combustion space in your furnaces checked up against the coal which you are now buying. In putting in new boilers be sure that the combustion space in the furnaces is designed for the coal which you can buy to best advantage.

It is important to know the B.t.u. con-

(Turn to page 44)

How to Keep Oil Engine Bearings in Alignment

Radical Difference in Combustion of Cylinders and Lack of Uniformity in Grade of Babbitt Among Problems Confronting Power Plant Engineers in Canada

ONE of the first things the operator of an oil engine must understand is that the crankshaft bearings must be kept in line. It formerly was the custom to ascribe the breaking of crankshaft to crystallization or improper heat treatment of the metal during the forging of the shaft. Other explanations have been offered, such as hydrogen embrittlement, meaning that during the heating of the billet hydrogen was encased in the steel, and upon meeting with oxygen left the metal and weakened the structure.

Of late, investigation of many fractured shafts has proved that in all these cases of damaged oil-engine crankshafts the cause of the fracture could be traced to misalignment of the main journal bearings. It is not claimed that no shaft has been broken by other causes; but of those examined, all showed at the fracture signs of the edges of the fracture having rubbed together by reason of the bending of the shaft, and, upon checking the bearings in all cases one or more bearings were found to be low.

It has been proved by exhaustive experiments that a shaft that is forced to bend at each revolution, as in the case of uneven alignment, will run a definite number of revolutions, after which it will break. The total number of times before fracture depends upon the metal, the diameter, and the amount of flexure. If these factors are known, the length of shaft life may be predicted with fair accuracy.

Discrepancy Unavoidable

No set of shaft bearings is ever absolutely in alignment; even when leaving the test floor the discrepancy will be around 0.01 in. With this amount of flexure the shortening of life is negligible; but when the discrepancy amounts to 1.32 in., the shaft life is reduced as much as 90 to 95 per cent. No shaft should be allowed to run for any length of time with a low bearing.

The question naturally arises, How may the engineer keep the bearings in alignment, and how may he learn whether one or more are low? A moment's consideration will cause one to concede that it is impossible to expect babbit bearing to wear at the same rate, even though the pressure be the same. In the actual engine it is quite customary to find the combustion in the several cylinders to differ quite radically. Often the cylinder pressures vary as much as 25 per cent. This means that 25 per cent. greater pressure is exerted on the two main bearings adjacent to this cylinder than upon the remaining ones. With the same babbitt lines these two bearings will wear faster. This means that soon the shaft has a perceptible kink in it, and at each revolution is flexed back and forth. Finally the shaft gives way.

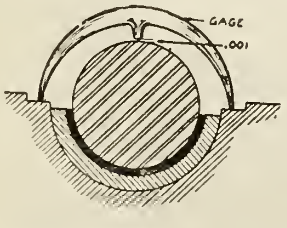


FIG. 1.

Second Cause of Wear

A second cause of rapid bearing wear is a difference in the grade of babbitt, or in the amount of peening done on it. The softer babbitt wears faster, throwing the shaft out of line.

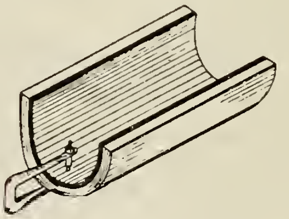
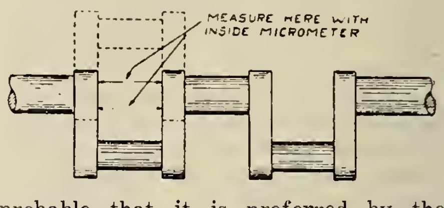


FIG. 2.

The engineer is then confronted with the problem of how to avoid this trouble. He cannot alter the character of the babbitt put into the bearing shell, but he can control the cylinder pressures. For this reason he should purchase an indicator, and occasionally take indicator cards from each cylinder. If the compression pressure in one of the cylinders is higher or lower than the others, it should be brought to its correct value by placing additional shims, or removing some of the shims from between the big end of the connecting-rod and the crankpin bearing. If the injection period is longer or shorter in one of the cylinders, by shifting the fuel-cam nose the correct injection period can be obtained.

These are the ways in which the bearing wear may be kept as near uniform as possible. But the engineer is confronted with the question of how to check the shaft alignment to find if things are in proper condition. Two methods may be followed, or a combination of both.

The first method to be outlined is the easier one, and for this reason it is probable that it is preferred by the majority of those engineers who attempt to keep shafts in alignment.



A gauge, as shown in Fig. 1, is made up out of sheet steel of, say, ⅛ in. thickness. This gauge is so made that when its two legs rest upon this bearing housing, the anvil just clears the shaft by 0.001 in. Gauges should be made for each bearing and numbered so that no mistake can be made. If the engine is a high-grade one and has had the housing planed and bored at one setting, the housings are all in alignment. One gauge only is needed under such circumstances.

Now, if a bearing wears, the shaft will, of course, bend until it rests upon the babbitt. This, then, causes the shaft surface to be lower than before the wear occurred. If the gauge is now placed on the bearing, the clearance between the shaft and gauge anvil will be more than the original 0.001 in.

An Accurate Method

A second method is more accurate, and is largely used by oil-engine builders.

The majority of engines have the housing bored for the bearing shells at the same time. The only difference in the misalignment of these housings is the slight inaccuracy of the boring mill. This difference should not be over 0.001 in.

The babbitt metal is cast into a steel or cast-iron bearing shell. These shells rest in the housings and are within 0.001 in. of being true. The difference in bearing heights will not exceed 0.002 in. If this thickness of the bearing shell was known, then any later wear could be detected by a decrease in the thickness of the bearing shell. A large gap micrometer may be secured from any gauge maker. This is similar to that shown in Fig. 2. By measuring the bearing shells when the engine is erected, any wear and shaft misalignment can be detected by rolling the shell out and remeasuring the thickness. This should be done at a point about 2 in. from each end of the babbitt liner about every six months.

Naturally the question arises: How

(Turn to page 44)

Solving Under Capacity of Absorption Systems

By C. O. FEHL*

A Description of the Modern Refrigerating Machine of This Type, Its Operation and the Causes to Which Under Capacity Can Usually be Attributed

THE modern absorption refrigerating machine consists of the following parts: a generator, an analyzer, a dehydrator, a condenser, a receiver, a weak aqua ammonia cooler, an exchanger, an absorber, a strong aqua ammonia tank, an ammonia pump and the evaporating system. The latter can consist of any apparatus with which evaporating ammonia can take up heat.

The main difference between a compression and an absorption machine is this, that the operation of the latter is chemical rather than mechanical, and depends on the fact that many vapors of low boiling point are readily absorbed by water, but can be separated again by the application of heat to the mixed liquid, in this case, aqua ammonia.

The functioning of the various parts of the absorption machine is as follows:

The ammonia generator is equivalent to the discharge stroke of the piston in a compression machine, steam being admitted to the generator coils, to cause the solution of ammonia and water to boil and vaporize, creating a pressure to force the vapor in the ammonia condenser to liquefy.

Reasons For Analyzer

An analyzer is used in connection with the generator for several reasons. First, to heat the cold incoming aqua ammonia to the generator with the hot ammonia vapor ascending from the generator, the incoming aqua passing over a series of cast iron trays, coming in direct contact with the hot ammonia vapor from the generator, as in a feed water heater, thus saving a great quantity of steam in the generator. Second, to condense a great portion of the water vapor entrained in the ammonia vapor, by coming in contact with the colder strong aqua ammonia solution, incidentally enriching both the ammonia vapor and the strong aqua, and at the same time removing the greater portion of the entrained water vapor.

The dehydrator or rectifier is for the purpose of removing the remaining water vapor entrained in the ammonia from the analyzer. It is provided with a trap which catches the condensed water vapor, and returns it to the generator, while the now practically pure anhydrous ammonia vapor passes on to the ammonia condenser to be liquefied. The ammonia condensers are of the same type as with compression machines. The pure ammonia vapor from the dehydrator is condensed and conveyed by gravity to the ammonia receiver. From the receiver the liquid ammonia is fed into the evaporating system, which is identical with that of a compression system except that a purging or pumpout line is connected to the lowest point.

Frees System of Water

This purge or pumpout line connects the evaporating system to the aqua ammonia pump and the absorber, and is for the purpose of pumping the contents of the system into the absorber or generator, in case a quantity of water has collected in the evaporator.

The absorber, from which this type of machine derives its name, acts in the same capacity as does the suction stroke of a compressor. Water has a great affinity for ammonia, one part being able to absorb approximately seven hundred parts of ammonia, therefore, the weak aqua ammonia from the generator meets the vaporized anhydrous ammonia from the evaporating system at the absorber, the weak aqua quickly absorbs the vapor, causing it to collapse, inducing a suction similar to that of a compressor.

The absorbing of the vapor by the weak aqua ammonia forms the strong aqua solution, which overflows from the absorber into a strong aqua tank, which acts as a reservoir for the aqua ammonia pump.

The aqua ammonia pump discharges the strong aqua ammonia into the generator after passing through the exchanger.

The exchanger is one of the refinements added to the absorption machine in recent years. The hot weak aqua ammonia from the generator exchanges or transfers its heat to the cold strong aqua ammonia from the absorber on its way to the generator, heating the strong aqua to within approximately 40 deg. F. of the temperature of the generator, and at the same time cooling the weak aqua on its way to the absorber, hence, the exchanger acts like a boiler feed water heater. It saves steam in the generator, and saves cooling water on the weak aqua cooler and absorber.

The weak aqua ammonia after leaving the exchanger is further cooled in a weak aqua cooler, so as to get the solution as cold as possible. The colder the weak aqua ammonia is on entering the absorber, the greater affinity it will have for the gas from the evaporating system.

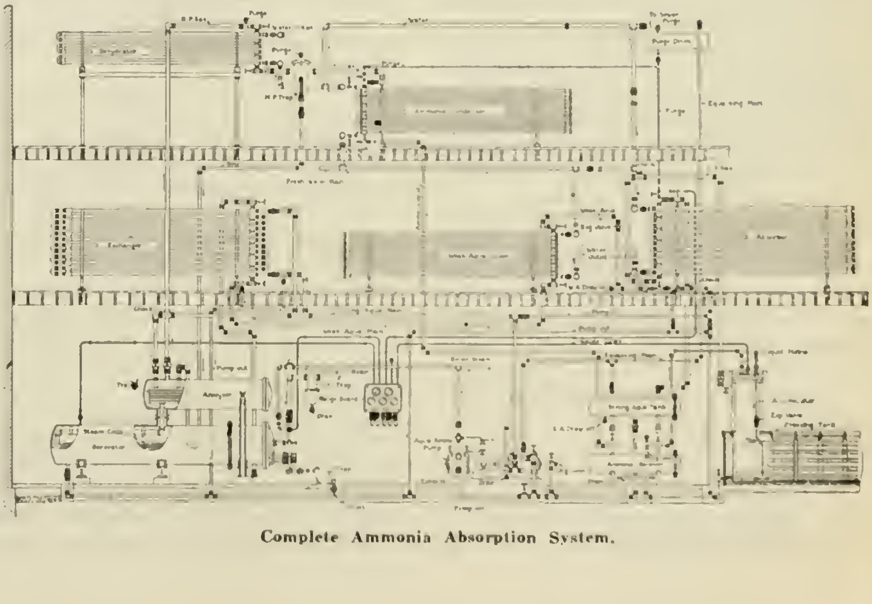
The various parts of an absorption machine are built in a number of types, such as double pipe, atmospheric, shell-and-tube or shell-and-coil types.

The type of apparatus preferred depends on the locality, the atmospheric conditions, the temperature and kind of cooling water available; however, the double pipe and atmospheric types are considered most efficient, and are most popular.

Operation Hints

The operating engineer should familiarize himself with the properties of aqua ammonia, its relations between boiling points at different strengths, temperature and pressure, as is necessary in the case of anhydrous ammonia, water, etc. Mollier's data are used entirely by the writer in designing and operating absorption machinery.

From these curves have been com-



Complete Ammonia Absorption System.

---

*Extracts from a paper read at a meeting of the National Association of Steam Engineers in Brooklyn, N.Y.

piled tables for the convenient use of the operator enabling him at a glance to determine the strength the strong aqua ammonia should have when leaving the absorber under any temperature and pressure used in practice. A second table shows him to what strength the strong aqua will be boiled in the generator when operating with different steam and ammonia temperatures and pressures.

In order to show how these tables will assist in the operation of an absorption machine, we will assume a plant supplied with 70 deg. F. cooling water. It is desired to operate the evaporator with 15 pounds gauge ammonia pressure (O degrees F. temp.).

With 15 pounds pressure the absorber pressure will be 2 to 3 pounds less, say 13 pounds gauge pressure.

Assume that the 70 deg. F. cooling water first enters the condenser, and upon leaving it enters the absorber at 80 deg. F., the strong aqua leaving the absorber at 10 deg. F. higher than the cooling water entering it; this would give the strong aqua leaving the absorber a temperature of 90 deg. F.

By referring to the table, we find that at 13 lb. pressure and 90 deg. F. temperature, the strength of the aqua ammonia leaving the absorber would be 37.2 per cent., or 30 deg. Beaume, which is the strength at which the aqua ammonia would start to boil under these conditions. If it were stronger, the absorber pressure would have to be raised, which, in turn, would raise the pressure and temperature in the evaporators.

Strength of Solution

Assume that in the generator approximately 6 per cent. of the ammonia is boiled out of this strong solution, what should the steam pressure be on the generator and what strength of weak solution would result?

With 70 deg. F. cooling water going to the condenser, we could expect a head pressure of 145 pounds gauge. With this head pressure, and five pounds steam pressure, the ammonia in the generator would boil until it reached a strength of 30.8 per cent., or 26.7 deg. Beaume; after it reaches this strength all boiling will cease under these conditions. If a lower strength is wanted, the steam pressure on the generator would have to be increased.

Knowing the strength of the aqua ammonia, it is necessary to know how much of the strong aqua must be circulated to produce one ton of refrigeration. In order to determine this, it is necessary to arrive at the quantity of anhydrous ammonia that the generator must boil off to produce one ton of work in the evaporator. This may be found by the following equation:

$$\frac{200}{R-(t-t_1)\ x\ s} = \text{pounds } NH_3 \text{ per min.}$$

per ton refrigeration.

200 = Btu per minute per ton refrigeration.

R = Heat of vaporization at evaporator temperature.

t = Temperature of condensing pressure.

t_1 = Temperature of evaporator.

s = Specific heat of ammonia, 1.1.

Using Goodenough and Mosher ammonia tables, the generator would have to produce, under the conditions mentioned,

$$\frac{200}{572.5-(82.3+0.5x1.1)} = 0.4152 \text{ lb. an-}$$

hydrous ammonia per minute per ton of refrigeration.

To produce one pound of anhydrous ammonia use the following equation to determine the amount of strong solution circulated,

$$\frac{100 - W}{S - W}$$

in which

W equals per cent. weak and S equals per cent. strong solution; therefore, we have in this case,

$$\frac{100 - 30.8}{37.2 - 30.8} = 10.81 \text{ pounds of 37.2 per}$$

cent. aqua.

> **An "old fogy" is a man who has ceased to accept new thoughts. And unfortunately some men show symptoms of "old fogyism" at the age of twenty-five. The question is important because the disease is a prevalent one and a menace to every industry. The man who ties the operation of his power plant down to inefficient methods and hampering limitations, who, by snap judgment, condemns any new device or method, without thorough investigation, does a tremendous injustice and hampers his own work.**

The number of pounds of 37.2 per cent. aqua circulated per ton refrigeration would then equal,

10.81 × 0.4152 = 4.49 pounds.

The specific gravity of 37.2 per cent. aqua is 0.875. Therefore, one gallon weighs 0.875 × 8.33 = 7.29 pounds, and the quantity circulated per minute per ton refrigeration is $\frac{4.49}{7.29}$ = 0.616 gallon.

Hence, in a 100-ton refrigerating plant, the ammonia pump would have to circulate 100 × 0.616 = 61.6 gallons.

Assuming that the capacity of the aqua pump is 5 gallons per revolution, it would have to operate at $\frac{61.6}{5}$ = 12.3 r.p.m., provided the cylinders were entirely filled; however, as the pump is not 100 per cent. efficient, it is customary to add 15 to 20 per cent. to take care of slippage.

Fully Charge Machine

The absorption, as well as any other type of refrigerating machine, will not operate satisfactorily if it is undercharged, therefore, the operator should at all times see that his machine is fully charged. By this we mean that the ammonia generator should never show an aqua level below the steam coils. The normal level should be from 1½ to 2 inches above the top of the coils, otherwise the full benefit of the pipe surface is not obtained.

The exchanger, weak aqua cooler, and absorber, if a "wet one," should be filled, and the strong aqua tank should be one-third to one-half full. If the absorber is of the dry type, a liquid level gauge is provided which should show a level well up in the glass.

In normal operation, the anhydrous ammonia receiver should be from one-third to one-half full, and the evaporating system should have sufficient ammonia in it to cause the vaporized ammonia to leave the evaporator with a superheat of not over 5 deg. F.

Aqua ammonia purchased commercially contains not more than 29.4 per cent. of ammonia, or 26 deg. Beaume, therefore, when higher operating strengths are required, it is necessary to add anhydrous until the aqua acquires the desired strength.

If the operator knows the number of pounds of aqua required to charge his plant it is easy to determine the amount of anhydrous required to raise the strength of the commercial 29.4 per cent. aqua to the strength used in normal operation by the following equation:

$$\frac{A\ (S\text{-}W)}{100 - S} = \text{pounds of anhydrous am-}$$

monia to strengthen A pounds of aqua to S.

A = pounds of aqua in system.

S = strength to which it is desired to increase strong solution.

W = the initial strength of aqua.

If a machine contains 10,000 pounds of aqua having an initial strength of 29.4 per cent., and it is desired to increase the strength of 37.2 per cent., there would be required

$$\frac{10{,}000 \times (37.2-29.4)}{100 - 37.2} = 1{,}236 \text{ pounds}$$

of anhydrous ammonia.

An Important Point

One of the most important points in the operation of an absorption machine is to see that the ammonia vapor leaves the dehydrator or rectifier at the proper temperature, for on this will depend the purity of the ammonia entering the condenser and finally the evaporating system.

If the vapor is allowed to leave the dehydrator too hot it will contain quite a quantity of water vapor, which should have been condensed in the dehydrator. This water vapor will enter the condenser with the ammonia, where it will be condensed, and finally be carried over into the evaporating system, where it will collect until the quantity becomes so great that the efficiency of the evaporating system is very much impaired, and that will necessitate pumping or purging out. This causes a loss of time.

The temperature of the gas leaving

the dehydrator should be from 15 to 20 deg. F. higher than the temperature due to the condensing pressure, never higher than 20 deg. F.; for instance, if the condensing pressure is 145 lb. gauge, the temperature due to this pressure is 82.5 F. The gas leaving the dehydrator should then be 97.5 deg. F. to 102.5 deg. F., not over the latter figure. The operator should keep close watch on this part of his machine.

Make Fresh Start

Should the evaporating system become filled with sufficient water to impair its operation, it must be pumped or purged out, and a fresh start made. A pipe connection for this purpose is usually provided, leading from the lowest point of the evaporating system to the absorber.

The operation of pumping out the evaporating system is very simple, and is best done in the following manner:

Close main valve in suction line.

Close liquid expansion valve.

Open valves in pumpout or purge line.

Allow balance of plant to operate as it usually does, except that it is sometimes necessary to slightly increase the speed of the ammonia pump and reduce the steam pressure on the generator.

In starting to purge the absorber and evaporator, the gauges may show a pressure very much higher than they do in normal operation, however, this will soon start to drop, and will continue to drop as the evaporator empties, until the pressure gauges show 0 pounds.

When zero pressure is reached, the evaporating system may be considered empty. The operator should then close the pumpout or purge valve, after which he opens the expansion valve slightly to create a pressure on the evaporator, and finally opens the main suction valve very slowly, after which the machine is again in normal operation.

During the process of pumping out, the anyhdrous ammonia that was in the evaporator is stored in the receiver and other parts of the machine. It must be returned to the evaporator as quickly as possible if work is to be done.

Keeping Machine Free

Another very important point in operation is to see that the machine is always kept free from foreign gases. The presence of these gases will very materially affect the tonnage, as they take up space in the coils, more particularly in the ammonia condenser and the absorber, reducing their effective surface.

In well-designed machines there should be a purge connection leading from the ammonia condenser to the absorber. The contents of the condenser can then be purged through this line into the absorber. By this means the ammonia will be absorbed, and any foreign gas can be purged from the absorber to the atmosphere.

Purging the Absorber

In purging the absorber to the atmosphere, a connection leading from the top of the absorber into a pail of water should be provided. If on opening the absorber purge valve foreign gas is present, bubbles will appear on the surface of the water. The purge valve should be allowed to remain open until all bubbles cease to appear on the surface; when they no longer appear, one can be sure the absorber is free of foreign gas.

The operator should open the purge valve on the absorber at least once a day to determine if gases other than those of ammonia and water are present.

The presence of these gases is revealed by the pressures on the various gauges rising above normal, the temperature in the evaporator naturally rising also, consequently the desired temperature cannot be maintained in the evaporator and other parts of the machine.

Under-capacity of an absorption machine can usually be attributed to one of the following causes:

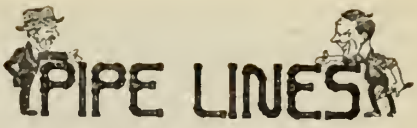
1. Under charge of ammonia.
2. Inadequate circulation of ammonia. The pump valves may be in bad condition.
3. The evaporating system may need pumping or purging out—contains too much water.
4. Condenser or absorber needs purging of foreign gases.
5. Insufficient water supply.
6. Condensers, dehydrator, weak aqua cooler and absorber may be dirty on the water side—remove the scale or dirt, as it is an insulator preventing the water from taking up the required amount of heat.
7. Steam pressure fluctuates. This must be kept steady on both the generator and pumps.
8. Sluggish brine circulation. The pump valves may be in bad condition.

Should trouble occur, look into the above causes for under-capacity and you will nearly always detect the trouble.

The conditions for operating an absorption machine differ in each case, depending upon the temperatures required and the water supplied. No set of rules can be given that will apply to the operation of all machines, therefore, for each installation the operating conditions must be arrived at as explained in this article.

Dickinson Dye Works, 986 Dufferin St., Toronto, are installing an underfeed stoker of the Jones type as well as a feed water pump and heater. George J. Soucy is the engineer in charge of the work.

Laughlin's Products Ltd., of Stratford, makers of Imperial oil burners, have issued, through their sales office at Welland, a booklet, Liquid Fuel, describing the origin and history of oils; the grades and the heat content of each; oil storage and handling; five methods of burning fuel oils, and some valuable hints for securing maximum efficiency in the power house.



UNCOVERED IN ANY OLD SPOT

Engineers well know it has been said:
"It takes a pull to get ahead!"
But lay aside those words as "bull"
It takes a head to get a pull.

* * * *

A pound of pure carbon requires 11.6 lb. of air for complete combustion. As coal is not all carbon, but contains a variety of ingredients, all of which vary in different coals, from 20 to 40 lb. of air per pound of coal is required. The difference between the theoretical quantity and the quantity practically needed is the "excess air," as it is called. "Too much excess air," then, means more than the quantity practically needed.

* * * *

A power plant problem properly stated is one nearly solved. It is often an aid in the solution of a problem to suggest its opposite; analogy encourages suggestions.

* * * *

A boiler should be considered as composed of two distinct parts—a furnace wherein fuel is burned to produce heat, and a shell or vessel containing water to absorb the heat produced. The furnace efficiency may be the maximum obtainable and yet the overall efficiency of the boiler be low because of scale and soot on the heating surface; the heating surface may be clean and capable of the most rapid transfer of heat, yet because of unsuitable fuel, plugged air spaces in the grate, leaky furnace walls and doors, the overall efficiency may be low.

* * * *

And so the wise men in the east have decided to resume digging coal and making steel.

* * * *

The sampling pipe through which passes the flue gas collected for analysis should be placed in the most active part of the gas flow. A good way to tell that you have the pipe in the right place in the uptake at the damper on the boiler side is to move it in and out across the gas path, analyzing samples collected at each position; the point where the quality of the gas varies most widely in a given time is the correct place for the sampling pipe.

* * * *

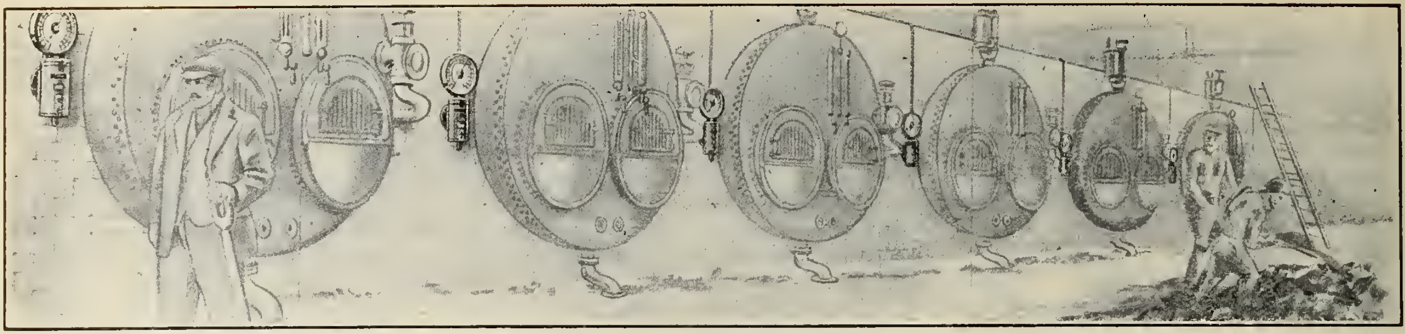
If an expert gambler can stack the cards, what can a good smoke stack?

* * * *

To reduce the maintenance cost of furnace lining in stoker-fired, forced-draft boilers, a high-grade firebrick is used up to the fire line; a bauxite brick is commonly employed for this purpose.

* * * *

A dainty little miss,
A lover, fond and true;
Four lips stuck together—
An ad for Carter's Glue.



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.
Director of Engineering, Central Technical School, Toronto.

FRICTION is defined by Rankine as "that force which acts between two bodies at their surface of contact so as to resist their sliding on each other."

The above definition does not seem to the writer to be quite complete because we have friction entering into the rolling of one body over another as well as sliding. These kinds of Friction may be classified as Sliding Friction and Rolling Friction.

Friction may act both while bodies are at rest or while they are in motion. For example a man may stand still on a sloping sidewalk because of the friction between his boots and the surface of the sidewalk. However, if the sidewalk is covered with ice, he will be unable to stand still because there is now very little friction between his boots and the ice.

We also know that when a body is in motion friction is constantly trying to stop the motion. The force required to start a body moving over a surface is called the Friction of Rest, while the force required to keep it moving once it has started is called the Friction of Motion. These two kinds of friction are not the same, as will be shown later.

Causes of Friction

Friction is caused by the roughness of the surfaces in contact and by the softness of the surfaces. We are unable to produce a perfectly smooth surface, although we can come very close to it. Looked at through a high power microscope the edges of two ordinarily smooth surfaces in contact would look something like Figure 1. The real positions of contact being a series of points where the slight irregularities of the surfaces happen to touch.

If a few points that first touch are not strong enough to support the weight to be carried, some of the points will be crushed, bent or driven into the other surface until sufficient other points come into contact to support the load. It will be clearly seen that if one of these surfaces is slid over the other, work must be done in bending or breaking off some of these points of contact or else in raising the upper surface sufficiently for its high spots to pass over the high spots on the lower surface.

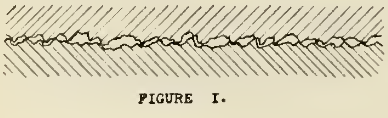


FIGURE I.

An example of the friction when the high spots break off is in the sandpapering of a piece of wood. Of the points of contact bending over, is in a steel shaft running dry in a babbitt bearing sufficiently slowly to be kept cool, the babbitt will be found to be dragged around in the direction of the motion of the shaft. It is doubtful if we ever have a true example of the case of the one surface being raised sufficiently to clear the high points of the other, because a certain amount of wearing away or smoothing down of the surfaces always occurs.

Softer Than Other

When one surface of a pair is softer than the other, friction may be caused by the harder one sinking into the softer as shown in Figure 2. Of course the greater the pressure between the surfaces the greater the distance one surface will sink into the other. This might well be illustrated by a weight on a piece of rubber. It is clear that if the top body in Figure 2 is slid along on the lower body, the edge "A" is continually digging into the lower surface and either cutting it or compressing it causing friction. This explains the fact that the friction between hard surfaces is less than that between soft surfaces of equal smoothness. This fact is well illustrated by the difference in power required to move a wheelbarrow over a concrete floor and over soft earth.

Rolling friction can be understood to be caused in the same way, because under a microscope, even a good roller bearing and its race would give an appearance similar to the cleated driving wheel of a traction engine riding on a stone road.

In the case of the traction engine it is easily seen that force is necessary to raise the whole weight of the machine over each cleat on the drive wheel or over each high spot on the road, also to press the cleats into the road surface or even to break up some of the stones of which the road is built, as well as to wear away part of the surface of the driving wheel. All these things take place when any one surface rolls on another.

Coefficient of Friction

The force required to move a body along a horizontal surface, divided by the weight of the body, is known as the coefficient of friction, and is commonly denoted by "f". This coefficient is not an exact constant for any material. The value may be 0.28 for wrought iron sliding on a piece of cast iron, while a piece of steel may give a value of 0.3 on the same piece of cast iron.

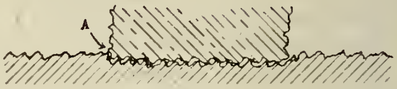


FIGURE II.

Also the fineness to which the material is smoothed will influence the value of this coefficient, as will the elasticity, hardness and toughness of the material, as on these properties will determine whether the high spots will break off, bend over permanently or bend over and spring up again. Thus numerical values for the coefficients of friction of various pairs of materials are of little real value, except as a rough guide of what to expect under certain conditions.

In the case of fibrous materials such as brake linings, fabrics or asbestos, it is found that if the weight is distributed over a larger surface, thus giving a smaller pressure per unit of area, the coefficient of friction is increased. This may be because the small projections on the surface are not squeezed down so tight and therefore catch against those on the other surface easier. Thus it would appear that if the unit pressure is increased the coefficient of friction of fibrous material would be lower. This is found to be the case, but does not apply to metals or non-fibrous materials. Because of this property, brakes with fabric lining such as on winches, motor cars, etc., should be made with as big surface as possible in order that they may exert their greatest friction while working at low pressures.

Decreased by Speed

The coefficient of friction is decreased by an increase in speed or relative velocity between the surfaces. This may be explained by the fact that the projections which have been bent over or squeezed in by passing over projections on the other surface do not have time to spring back to their full size or normal position again before they strike more projections to be passed over and therefore they do not have to be bent over so far or compressed so tightly as they did at a slower speed thus requiring less expenditure of energy. Or in the case of the harder materials, if one body is raised up to pass over irregularities in the other surface it does not have time to fall back all the way into the depressions before it strikes the next projections, or as one would say in slang, it has such high speed it "just touches the high spots."

This applies equally to sliding or rolling friction. The coefficient of friction increases as the relative velocity between the bodies gets slower until it is a maximum when the surfaces are stationary, or in other words the friction of rest is greater than the friction of motion.

The friction of rest between metals when dry is usually between 0.2 and 0.4. An example is the coefficient of friction of steel tires sliding on steel rails which has been found to be about 0.11 at ten miles an hour and only about 0.04 at fifty miles an hour. This explains why brakes give a much greater stopping effect at low speeds than at high speeds.

Fluid Friction

As well as the friction of solids sliding or rolling one on another, there is a form of friction where a layer of a fluid flows against a solid surface, or where different parts of a fluid flow with different speeds, one layer thus rubbing against another.

We know that there is such friction because it requires power to make fluid flow through a pipe; also the velocity at the centre of a pipe or a river is greater than near the sides because of the friction against the sides. Fluid friction may be caused by the supposed molecular structure of the fluid, in which the molecules must rub against or bump over each other in some way.

The friction between a solid and a fluid appears to be greater than between two layers of a liquid; a possible explanation of this phenomenon will be given after we look into the action of fluid friction.

Fluid friction is, unlike solid friction, independent of the pressure on the fluid. This is possibly because a fluid exerts the same pressure at all positions and in all directions, thus there is no way by which it can compress part of the container more than the other as a solid is shown doing in Figure II.

Fluid friction is somewhat similar to the friction between fibrous surfaces in that it is greater if the area against which it rubs is greater. This may be illustrated by say a gallon of water in a half inch pipe touching more surface than if it were in a six inch pipe, thus the friction loss in moving water through a small pipe is greater than in a larger one.

Velocity of Flow

In respect to velocity of flow, fluid friction is just the reverse of solid friction, in that the coefficient of friction increases with the velocity. At low speeds the friction increases very nearly in the same ratio as the speed, but at medium and high velocities the friction increases as the square of the speed. This fact will be made use of later on in explaining the phenomenon mentioned above.

The friction of a fluid does not depend on the kind of solid against which it flows, but only on the roughness of its surface. The friction of dense or heavy fluids is greater than that of light fluids. It is also dependent on the viscosity of the fluid, which is a measure of the speed with which it will flow or change its shape. For example, gasoline has very little viscosity while cylinder oil is quite viscous, especially if cold.

In order to investigate the way in which fluid friction acts, let us assume a layer of fluid between two flat surfaces, one of which is moving with respect to the other at the rate of say 125 feet per second. This might be illustrated by the cross head of an engine sliding on the guide. Figure III represents such a condition as seen under a microscope.

The surfaces are seen to be not actually in contact with each other but separated by a layer of fluid. It is likely that all the fluid or oil which is below the tops of the projections on the surfaces of the solids will remain where it is.

For a starting point let us assume that with a velocity of one foot per second, each unit area produces one unit of friction. We will consider one unit of area. We will first determine the amount of friction generated if all the fluid above the line marked C-C travels at 125 ft. per sec. and all below that line stays still. The relative velocity at the surface of rubbing will be 125 ft. per second, and since the friction varies, as the square of the speed, friction will be 125x125, equals 15,625 units.

Let us next assume that the fluid breaks up into six layers instead of two. That above line A-A will be going at 125 ft. per sec. That between A-A and B-B at 100 ft. per sec. and so on. Thus there will be five surfaces of contact at each of which the relative velocity will be 25 feet per sec. The friction at any one of these surfaces will then be 25x25 equals 625 units per unit area. Therefore the total friction will be 625x5 equals 3,125 units, which is much less than in the first case assumed.

Should Speed Vary

It is seen from the above that there will be very much less friction if all parts of the fluid do not travel at the same speed, and we find in practice that the fluid automatically divides itself into a very large number of very thin layers all moving with very low speeds with relation to the layers in contact. In this way the friction of a fluid is apparently much lower than that between the fluid and the solid, and it automatically maintains itself at this minimum value. This explains why the velocity in the centre of a pipe is greater than half way to the walls. It also gives us an easy way of cutting down friction by means of lubrication, provided we can keep the layer of lubricant between the surfaces moving.

Lubrication and lubricants will be discussed in a future lesson and the above material will be of value in understanding some of the points brought out.

A. J. Nesbitt, head of the firm of Nesbitt, Thomson & Co., Montreal, has taken over the Ottawa & Hull Power Co., the largest concern wholesaling power in the Ottawa and Hull district.

M.D.E.A. Notes

At a meeting of the Montreal and District Engineers' Association in the Royal Arcanum Chambers, 592 Union Avenue, Montreal, on July 27, H. Wright was unanimously elected Doorkeeper. Three new members were initiated, and applications received from three others. Lectures have been given the Association recently by Mr. Carter of the Canadian Ingersoll-Rand Co., and A. Aubin of the Canadian Comstock Co., and arrangements are now being made by the Educational Committee for the August 10 meeting. The membership of the Association is now over 150.

The officers appointed for the current term are: Past President, A. Kastello; President, W. G. Forbes; Vice-President, A. Hall; Secretary, I. McIntyre; Financial Secretary, A. J. Jones; Treasurer, W. H. Rose; Conductor, J. Dodds; Doorkeeper, H. Wright; Trustees, F. Stockden, J. A. Alder, and A. Reid.

U.C.C. of E. Notes

The Universal Craftsmen Council of Engineers are holding their 21st annual convention at the Powers Hotel, Rochester, N. Y. The convention, lasting four days, August 7, 8, 9, 10, 1923, includes an exhibit of power plant machinery, electrical equipment, accessories and supplies under the direction of the Universal Craftsmen Council of Engineers, being held in the banquet hall of the hotel.

Many events and features of interest have been planned for the entertainment of exhibitors, delegates and visitors to the convention.

Trade Catalogs

The Combustion Engineering Corporation, Limited, Bank of Hamilton Building, Toronto, have issued a condensed Canadian catalog, describing briefly the various lines of power plant equipment made and sold by them.

The type E, Coxe Travelling grate, Frederick, type K, and Green chain grate stokers are described, as well as a new type of self-contained travelling grate stoker, in which fans, motors, and the driving mechanism, are a part of the stoker. Other equipment shown includes the Quinn fuel oil burner, Lopulco pulverized fuel systems, Green cast-iron hoppers, Combusco water seal ash conveyor, Custodis chimneys, Detrick flat suspended arches, Uehling CO_2 recorders, and recording instruments and Arrow ash hoppers and ash grates.

Economies of Reducing Valves in Power Plants

By H. H. SHUGART*

Pressure Regulators Should be Given Care, Usually Accorded Automatic Machinery Functioning Continuously, to Attain Best Operating Results

IT HAPPENED almost in antiquity. Making his annual journey from his estate in a remote province of Egypt up towards Cairo, Al Hasson, a man of substance and great learning, saw a sight that filled him with astonishment, something entirely new. It was the first crude water-wheel driven by the waters of the Nile, with which men were grinding their grain. He was so taken up with the device that he returned home and forthwith set about the construction of a similar wheel, instructing his slaves intimately in the details. The wheel was finally completed and set in position, but, to his great chagrin, did not work. The stream in which it dipped its paddles was too small; the flow of water insufficient.

He cast about for a solution to the problem, but after much fruitless speculation sent for Mech-Anic, who had built the water-wheel on the Nile. Mech-Anic attacked the problem with gusto. First he dammed the stream. Then instead of having the water flow under the wheel, he caused a conduit to be made that directed the flow of water over the top of the wheel.

But the conduit was too large. The rush of water drove the wheel too rapidly, and to boot, soon exhausted the reservoir. So bethinking himself further he provided at a certain point in the conduit a controllable stop, or valve, by means of which he lessened and controlled the flow of water. Thus the problem was solved. The wheel traveled at the correct speed. It ground the grain properly. And the water was so conserved that there was power enough to do in a day what many slaves had failed to do in a week.

This man, therefore, in a simple way restrained the flow of large volume of fluid; reduced a higher pressure to a lower pressure; kept that low pressure constant (regardless of the amount necessary to drive his wheel, and regardless of change in the higher pressure). It is true that he had to have a man manipulate his simple valve constantly in order to do it. But the big point is—that by means of the valve he did something that could not otherwise properly be done.

Conserves Power

What has this to do with reducing valves? Let us see. A good pressure reducing and regulating valve (1) reduces a higher pressure to a lower pressure; (2) holds that lower pressure constant regardless of changes in the higher pressure; (3) holds that lower pressure constant regardless of changes in the demand on the low pressure side; (4) conserves, or saves power; (5) does something that could not otherwise properly be done; (6) does it automatically.

"But," you may ask, dispossessing yourself of all knowledge in order to get to the bottom of the subject, "why reduce the pressure? If the greater the pressure, the greater the power; why reduce power?" There are many answers.

Eliminating Waste

Suppose your heating system requires steam, as the average system does, at a pressure no greater than five pounds. And suppose you have no exhaust steam with which to supply this demand. You are compelled to use live steam from your boilers at, say, 125 pounds pressure; but instead of delivering it wastefully, and often dangerously, at this pressure, you use a reducing valve to cut the 125 pounds down to five pounds pressure.

Or assume that you do have a steam supply taken from the exhaust of engines and other equipment, but this supply proves at times inadequate for the heating load. Live steam must then augment the exhaust steam, and a reducing valve cuts down the pressure automatically, delivering it into the exhaust header at the correct low pressure. In both these cases, the small reducing valve investment eliminates the necessity of installing a low pressure boiler to carry the heating load.

A Second Purpose

Now to the second purpose of these valves. The reducing of pressure having been justified, why hold the low pressure constant regardless of changes in the high pressure? Consider this example. Boiler pressure varies. If a globe, or stop valve is set so as to cut 150 pounds down to 90 pounds pressure, an increase above 150 pounds will mean an increase above 90 pounds. In many cases, particularly in process work, this increased pressure results in financial loss.

A specific temperature is correct for the process, a higher temperature is either unrequired or damaging, and an increased pressure means a proportionate increased temperature. A good reducing and regulating valve, being operated or controlled from the low pressure side, maintains the correct low pressure regardless of either an increase or decrease in the initial pressure, provided, of course, the high pressure does not fall so low that it almost equals the desired low pressure.

A Third Purpose

The third declared purpose of a good reducing and regulating valve is holding the lower pressure constant regardless of change in demand on low pressure side. In practically all process work, quality production depends largely upon the temperature maintained in the cookers, moulds and other apparatus which are usually heated by steam. The desired temperature is, as a rule, maintained by keeping a constant steam pressure in the heating jacket or coils corresponding to the temperature desired. The demand for steam varies widely on these services, for when the moulds are filled with cold material to be cooked or cured, the demand for steam is very high as, under these conditions, the jacket or steam coils, condense it rapidly. After the material is warmed up, the steam demand is decreased, and after the apparatus is brought up to the proper temperature, the steam demand is slight indeed.

Retards Production

At the beginning of the process when supplying steam to cold apparatus, because the demand is excessive, the inferior reducing valve may permit the low pressure to drop considerably below the predetermined pressure. This wastes time and retards production. A good reducing valve answers the peak demand with more pressure. That is, more pressure through the valve in order to compensate for the drop in pressure in the apparatus due to the enormous quantity of steam consumed and the great condensation, holding the predetermined low pressure constant in the apparatus regardless of high demand and holding it constant at that pressure after the demand has fallen off.

The fourth reason for using reducing valves to conserve or save steam. If pressure is power, and all that is required to efficiently operate a given piece of equipment is a certain pressure, a high pressure is obviously wasteful—so many pounds of steam gone for nothing, so much coal, so much money.

Take for example such a common thing as a steam jet ash conveyor. The nozzle is designed to give you 100 per

(Turn to page 44)

---

*A. W. Cash Company.

Prolonging Valve Life in the Boiler Room

By ARTHUR MURPHY*

A Description of the Types in General Use in the Steam Plant Together with Hints as to Their Selection and Care in Their Maintenance

THE function of a valve is to control the flow of a fluid, the nature of the liquid or gas and the quantity handled determining the type best suited for the work. In the power plant the types generally used include globe, angle, gate, blow-off, safety, non-return, automatic stop, and pressure reducing. The recent tendency toward large units and automatic control has also brought about the development of remote control of main valves.

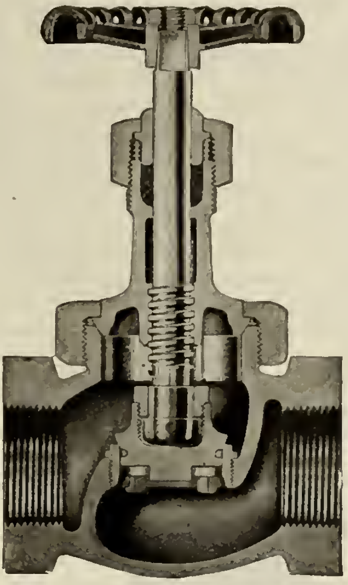
It is proposed in this article to describe the better-known types and emphasize points for the engineer to observe to prolong the life of the valves in his plant.

Renewable Disc

The globe valve is the most common of all types and is so well known to engineers that it will suffice to say that savings can be made by a little care in replacing worn seats or discs instead of throwing the valve away and buying a new one. The majority of valves of this type are made with renewable valve seats and discs that can be quickly replaced by sliding from a groove. The disc in the small globe valve is frequently made of a rubber compound, soft enough to conform to any slight irregularity in the seat. The proper disc should always be used. One intended for cold-water service cannot be expected to withstand the temperature of high-pressure steam. This point is often forgotten when running new pipe lines and making use of equipment on hand. Some of the newer types are made with a shoulder on the stem so that they may be packed under pressure when wide open.

The gate valve is an all-metal valve with metal-to-metal contact at the seat. As this valve when wide open presents practically a straight passage, the frictional loss in it is small. This type finds favor, especially in the larger sizes, for hydraulic work. It is advisable in such sizes to have both the seat and valve disc renewable. In the smaller sizes a valve reseating tool will aid the engineer in keeping the valve tight. Care must be taken when refacing the disc and the seat to secure the same angle on each, or the leak may be worse than before.

When used for superheated steam the body should be of some material other than cast iron.



Type of Globe Valve.

For protecting engines and turbines from overspeeding in case of failure of the governor and to protect firemen and others from scalding in case of a tube failure, automatic stop and non-return valves were devised. The valve disc is so balanced that the normal flow of steam will not operate it, but any abnormal rush or reversal of flow will cause it to close at once.

This type of valve is in common use on steam boilers between the header and the boiler. In case of a tube failure or sudden drop in pressure in the boiler, the friction of the steam through the valve causes the disc to close, in this way preventing any steam other than that in the crippled boiler from escaping and adding to the danger.

Another safety feature of the non-return valve is the fact that steam cannot be turned into a boiler which is open for repairs or cleaning to scald any men who may be in it.

The simple non-return valve closes only on reversal of the flow of steam; in others an automatic stop is provided by having a balanced double disc, then either a reversal of flow or a sudden rush of steam in case of a burst header will cause the valve to close, stopping the flow of steam from the boiler.

All boilers when used in a battery should be fitted with non-return valves. In some provinces their use is compulsory.

The Canadian interprovincial regulations require on each main or auxiliary steam outlet from a boiler a stop valve immediately at the boiler, when the working pressure exceeds 100 lb. per sq. in., and when the steam pipe is 2½ in. or over in diameter the stop must be of the outside screw and yoke type.

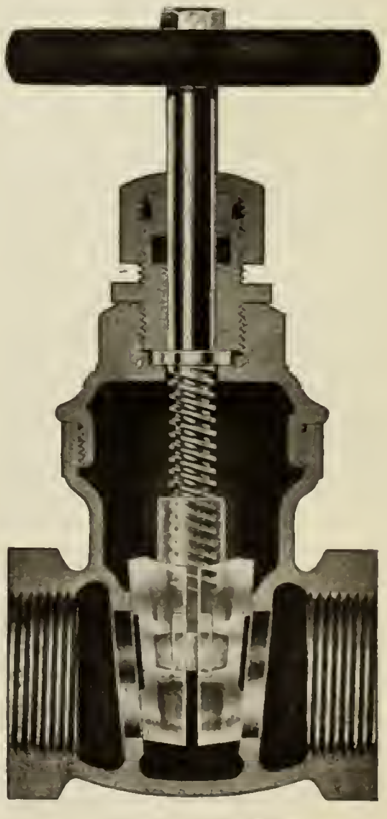
Where two or more boilers are connected to a common main and the pressure is 100 lbs. or over, each boiler must be equipped with an automatic non-return valve of approved design in addition to the boiler stop valve.

Another form of non-return valve is now being made for protecting turbines from back flow of water from a jet condenser containing a balanced check valve which closes when the condenser ceases to operate for any reason and water starts to back up in the main. It is customary to provide a relief valve between the turbine and the automatic non-return valve open to the atmosphere.

Severe Service

It would be difficult for any engineer to devise a more severe test for a valve than that given the blow-off valve on a steam boiler. The service is so severe that no ordinary valve will stand up any length of time, and as a result special designs are used. The valve must be tight under all conditions, any leakage being not only costly but dangerous.

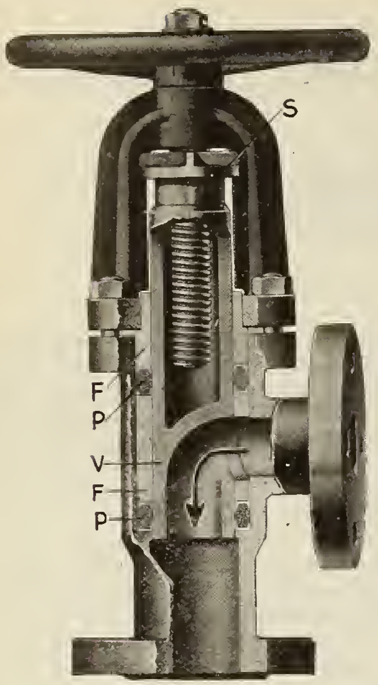
The water from the mud drum or lower part of the boiler passes through



Type of Gate Valve.

---

*Editor, Power House.



Type of Seatless Blow-off Valve.

the valve with high velocity and as it carries dirt, scale and other abrasive materials it causes considerable wear on any part that it comes in contact with, and furthermore when the valve is being closed small pieces of scale often lodge between the disc and the seat.

Eliminate Seats

For these reasons valves with ordinary gate or flat discs and seats are not used, a type in which the water and scale cannot score the seat being favored.

The valve shown in Fig. 1 was designed with these points in view and the fact that in some plants no repairs in over ten years have been found necessary proves that the principle is right.

The valve is shown wide open, presenting a clear passage for the water and scale. To close the valve, the handwheel is turned until the port in the plunger V has passed the corresponding opening in the body of the valve. After it has been closed, the shoulder S on the plunger V strikes the loose follower gland F. A hard turn of the handwheel then compresses the packing P above and below the port, making a tight valve.

The Canadian interprovincial regulations for the construction of steam boilers stipulates that each boiler must be provided with a substantial blow-off pipe and valve or packed cock. The valve or cock shall be extra heavy, of straightway or other approved or registered design, the minimum diameter being one inch and the maximum two and a half inches. Globe and angle valves shall not be used for this purpose. It is recommended that two valves, or a valve and a packed cock be provided at the blow-off outlet of each boiler. A blow-off cock shall be protected by a guard or gland.

In some cases a gate valve is used in place of a cock. Where a valve and cock are used it is customary to put the cock next the boiler and outside of the blow-off valve. If a gate valve is used instead of a cock it is advisable to install it with the stem horizontal, so that the movement of the disc will keep the scale agitated and prevent it lodging between the disc and the seat.

When blowing off a boiler the gate valve or cock should be opened first, then the blowing off operation proper controlled by the blow-off valve; upon finishing, the blow-off valve should be closed, then the gate valve or cock.

A safety valve must first of all be reliable and secondly must have ample relieving capacity. The greater number of safety valves in use in power plants to-day are of the spring loaded, pop type with the valve disc and seat either flat or bevelled at 45 deg. Safety valves should be opened at least once a day, preferably by raising the pressure in the boiler sufficiently high to cause the valve to open, or, if this is not convenient, by lifting the valve from its seat by the lever attachment.

Sometimes this precaution is overlooked, as in the case of a large low-pressure heating boiler in the city of Toronto. The safety valve did not open at 385 lb. pressure when tested by a boiler inspector; fortunately the man in charge did not attempt to open the valve by raising the pressure further.

Valves for Boiler Blow Off.

A leaking safety valve is not only annoying but wasteful and should not be tolerated in any plant. A few minutes' work with a grinding compound will remedy the trouble. The adjustment of the safety valve on a boiler should not be tampered with by anyone unless he has authority to do so; in many provinces this right is reserved for the boiler inspector.

Causes Chatter

An adjusting ring on the valve regulates the amount of blow down or the difference between the relieving and closing pressures. The difference should not be excessive or considerable steam will be lost every time the valve opens; not more than 4 lb. for boilers operating below 100 lb. and 8 lb. for boilers operating over 200 lb. Too small a pressure difference results in chatter.

The relieving capacity should be sufficient to prevent the boiler pressure exceeding 6 per cent. of the normal relieving pressure with it steaming at maximum capacity and with the feed water shut off and all other valves closed.

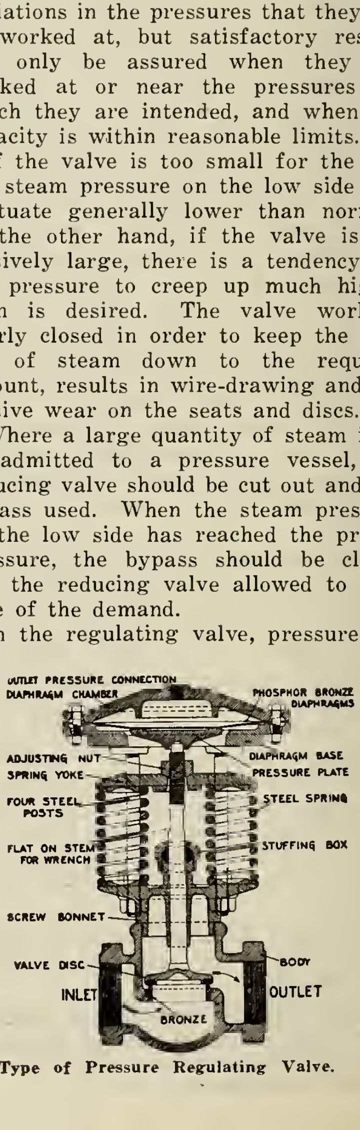
Protect Valve

Pressure reducing valves are in wide use in plants using steam for industrial processes for reducing the pressure from high to lower for the purpose of controlling the temperature; in others, to secure a steady pressure on some machine. The reducing valve in some plants is a continual source of trouble, more especially when used at the end of a long steam line which contains a fair share of condensate. The installation of proper traps and the use of a screen immediately before the valve will save the cost in a short time in repairs and annoyance of frequent shut-downs. A pressure reducing valve should always have a bypass in the line so that the valve can be cut off for inspection or repair and the steam regulated by an ordinary valve of the globe or gate type until the pressure reducing valve is in service again. These valves should be taken apart and cleaned at regular intervals. On valves of this type, the adjustment provides for considerable variations in the pressures that they can be worked at, but satisfactory results can only be assured when they are worked at or near the pressures for which they are intended, and when the capacity is within reasonable limits.

If the valve is too small for the job, the steam pressure on the low side will fluctuate generally lower than normal; on the other hand, if the valve is excessively large, there is a tendency for the pressure to creep up much higher than is desired. The valve working nearly closed in order to keep the supply of steam down to the required amount, results in wire-drawing and excessive wear on the seats and discs.

Where a large quantity of steam is to be admitted to a pressure vessel, the reducing valve should be cut out and the bypass used. When the steam pressure on the low side has reached the proper pressure, the bypass should be closed and the reducing valve allowed to take care of the demand.

In the regulating valve, pressure ad-



Type of Pressure Regulating Valve.

mitted at the opening marked outlet pressure connection acts on the top of a diaphragm and controls the movement of the valve stem and valve disc. An adjusting nut on the stem controls the pressure on the outlet side, giving the required variation in pressure.

When used for controlling the speed of a stoker engine or fan engine, a steam connection from the boiler is made to the top of the regulating valve, then an increase in pressure above that required forces the diaphragm down, closing the valve and reducing the amount of steam admitted to the engine, in this way cutting off some of the fuel or decreasing the speed of the fan.

Check valves in the power house are given hard service, especially when a defective steam pump is used as a boiler feed. The valve closes with a hammer-like blow and if not constructed of the best of materials will in a short time hammer its seat to pieces. A leaky check valve is a menace to efficiency, as the water in the boiler may escape and serious damage result through burnt tubes or sheets.

In one Toronto plant considerable trouble was experienced with the valve on the soot blower after it had been in service but a short time. The valve was installed at the bottom of a length of pipe, with the steam pressure acting against the valve disc. The valve leaked no matter how tightly it was closed.

Shrinkage of Stem

The valve maker was consulted and recommended that the valve be placed in a horizontal part of the pipe line close to the boiler with the pressure acting on the top of the valve instead of against it as in the first installation. When these changes were made, no further trouble was experienced with leakage.

In the first place before the valve was changed water would build up in the leg then leak through to the soot blower. The explanation given was that after the soot blower had been in use and the valve closed, both the valve stem and the seat were hot, water of condensation then collected in the piping above the valve and, since there was no circulation, the valve cooled off, causing the stem to shorten and the disc to shrink away from the seat, leaving a small opening, which though only a few thousandths of an inch was sufficient to start a leak.

With the pressure on the top of the disc and the valve stem kept hot by the steam, the valve remained tight and with only a short length of pipe between the boiler and the valve there was no water condensation to cause trouble.

The life of a valve in the boiler room depends in the first place on the quality and the kind of material used in its construction. The material must not be attacked by the fluid flowing through it. Even the highest grade of brass valve would not last as long as a poor one made of iron when used for ammonia service. For water, the valve should be non-rusting or resistant to corrosion. Cast-iron is not as suitable for superheated steam as cast-steel. Monel metal seats are claimed to stand up to superheated steam better than many other materials.

Special Valve Seat.

The requirements of a good valve may be summed up as follows:

It must be easy to operate the valve, even after it has been idle for some time.

It must not leak.

Wear should be slow but all parts on which wear occurs should be readily replacable, such as valve seats and discs.

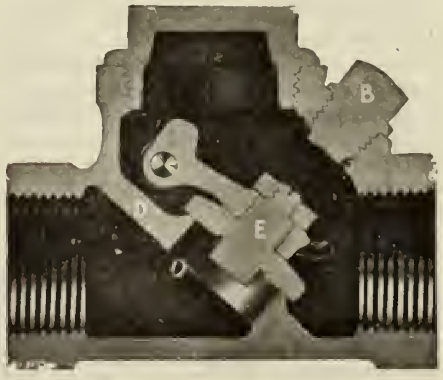
> **The inherently local nature of the generation and use of steam power prevent it from becoming a commodity. The contrary is true in regard to electric power. The characteristic of electric power constituting it a true commodity, the fact that it can be generated in bulk and sold at retail, the ease and flexibility of its transmission to a distance from its point of generation by means which can be extended at will, make natural the centralization of sign. This carbon will not settle out its generation.**

It must be strong enough for the pressures under which it is intended to operate.

The material of which it is composed should be suitable for the service intended.

Workmanship should be good and the external appearance in keeping with the location.

The stem and packing gland should be of a type that makes frequent repacking unnecessary but when required a quick and easy job.

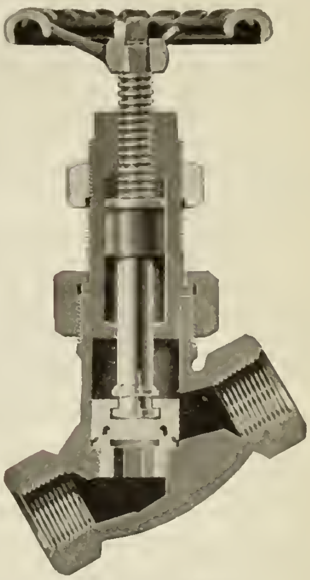


Type of Check Valve.

Frictional losses when used for liquids should be small.

The latest advance in the valve field is the application of remote control. The engineer can appreciate the advantage of being able to control all the valves in his plant by the pushing of buttons located on a central board instead of having to go from valve to valve and close by manual labor. Electricity is the usual source of power for working the valves but compressed air and hydraulic pressure are sometimes used.

When motor operated, the speed of closing can be varied to suit the requirements, large valves as a rule cannot be closed rapidly. A small motor is mounted directly on the valve and the power transmitted to the stem through gears, an automatic stop being provided for the motor for the open and the closed positions.



Type of Y Valve.

Safety valves have blow-down or huddling rings for adjusting the blow-down. If a valve opens at the correct pressure, but does not close until the pressure has dropped, say 5 lb., instead of the usual 3 lb., the huddling ring needs adjustment.

The safety-valve capacity on a boiler should be such that the valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to increase more than 6 per cent. above the maximum working pressure or more than six per cent. above the highest pressure to which any valve is set.

An automatic stop valve is just as much a necessary safety device for a boiler as a safety valve. And an automatic valve doesn't cost over 5 per cent. more than an ordinary stop valve of like size. Then considered as safety insurance the investment in a good automatic valve for each boiler is about as much for the money as could be had in most any other way.

Ford to "Burn Coal Twice" in Canadian Plant

New Process to Produce Coke, Benzol, Creosote, Sulphate of Ammonia, Gas and Basic Oils in $500,000 Plant at Ford, Ont.

WILL the farmer of the future fertilize his soil with a by-product of the coal consumed in city factories; will the motorist of the future operate his car with fuel and lubricating oil which is another by-product from the same base; will the factory of the future be designed to operate in conjunction with a new type of power-producing plant, where coal will be made to produce not only heat units but a wide variety of other things as well, such as benzol, creosote, sulphate of ammonia, fuel, gas, smokeless furnace coke and a number of basic oils?

It is an interesting and rousing speculation, and it is nearer to realization than many engineers suppose, for such a plant is now in course of construction by the Ford Motor Co. of Canada, at Ford, Ont., and is the material evidence of the first commercial realization of Henry Ford's much heralded scheme to "burn coal twice."

Ever since it was discovered that soft coal would burn, getting rid of the heavy soot and smoke has been a serious problem, and much time and money has been expended in efforts to find a practical method of disposing of it, even though it was commonly known that the smoke represented valuable properties which the ordinary method of burning soft coal liberated but failed to utilize.

Solution in Sight

That problem, however, may soon be written in the industrial history of a bygone day, for in the new Ford by-product plant, coal will be subjected to an entirely new process of treatment through which many by-products will be recovered before the coal, converted into coke, pulverized and fed into the furnaces by blowers is consumed in much the same way as gas is burned, and the by-products themselves in turn will be converted and consumed to serve a variety of purposes.

The new process is based upon a method of coal distillation which differs from all previous practice in that the coal is distilled at a comparatively low temperature, which makes possible the recovery of "volatiles" which have hitherto been lost because high temperature process ovens only have been used.

The distillation of coal through the application of heat, in an enclosed refractory chamber, in its earliest development, was accomplished in a crude way by the use of the beehive oven, and although the resulting coke was highly valuable for metallurgical purposes, all of the by-products were allowed to escape to the atmosphere.

Erected in France

In the year 1854 the first coke oven permitting the recovery of by-products was erected at Commentry, in France, and this led to the almost universal adoption of this method, as these by-products are the base for all the coal-tar products which are particularly valuable in the aniline dye industry.

The gases arising from coal as the result of low-temperature distillation are primary in character, and their products very closely resemble petroleum, but the character of these by-products changes as the heat increases, so that after the temperature to which the coal has been subjected passed 1350 degrees F., their structure due to the effects of heat, has been converted into an entirely new series of chemical compounds, of which Benzol is the most important. Benzol, when properly treated, is a gasoline substitute of excellent properties, largely used in the operation of automobiles.

Advantage of Low Temperature

The principal point of difference between the products of coal distillation at high temperature as compared with the products of coal when distilled at low temperatures is that by using the latter method a larger percentage of fractions suitable for use as gasoline substances is obtained. In other words, the material arising from the coal is in a gaseous state and on being condensed a greater proportion takes liquid form when cooled, in low temperature distillation, than in high temperature distillation.

After chemical treatment, the available amount of Benzol or Motor Fuel resulting from high temperature distillation will reach a maximum of 4½ gallons per ton of coal treated whereas in low temperature distillation this maximum will be increased to 12 gallons, and the resulting material from both a chemical and physical standpoint will be true gasoline, differing from gasoline obtained from petroleum only in its initial form, through the fact that it will contain a larger percentage of unsaturated hyrdocarbons. A large proportion of these unsaturated hydrocarbons, however, will be synthetically converted in the Ford Plant into their true gasoline form. and the cost of the gasoline produced by the new process is much less.

Universal Application

The importance of this development is not confined to the automotive industry, however. It is universal in application permitting the manufacture and production of the new motor fuel and equalizing the character of the products from the distillation of practically all carbonaceous deposits, so that the resulting coke will be of practically the same uniform quality, although the by-products will vary as to amounts of the several sub-divisions recoverable.

Coke Resembles Anthracite

The coke resulting from low temperature distillation is of a honey-comb-like character, and in the state in which it leaves the furnace is not suitable for shipment or use except in pulverized form as fuel for producing steam, when it can be so utilized without the necessity of transportation. This fuel, however, has all the properties of anthracite coal, and can be compressed so that sufficient density is obtained to permit shipment and storage.

In this compressing, or briquetting, process, it is necessary to use a "binder." In the Dominion of Canada there is available a vast quantity of what has been hitherto considered an absolutely waste product from the manufacture of pulp, know as "Sulphite Liquor," which, when concentrated, has proven an excellent binder. The low-temperature coke, when briquetted with Sulphite Liquor as a binder makes an entirely smokeless fuel, suitable for domestic purposes, and in the burning of which there will be absolutely no smoke or soot. A small percentage of pitch can also be used as a binder.

Chemistry of Coal

The chemistry of coal is very complex, and the number of chemical combinations recoverable from the products of coal distillation is practically limitless. There are certain commercial limitations, however, and only those elements which are most useful from an economic standpoint will be recovered in the Ford plant. Briefly, they consist of the following:

First—The coke, which will be burned in pulverized form under the power plant boilers.

Second—The surplus gas. of which about 4.000 cubic feet will be produced per ton of coal. This will be used in the forging and heat-treating operations required in the preparation of the high-grade steel for Ford cars.

Third—Sulphite of Ammonia, which is one of the cheapest and most valuable forms of fertilizer known.

Fourth—Creosote. a chemical in great demand as a timber preservative, especially for railroad ties.

Fifth—Gasoline and kerosene, of which a maximum of 12 gallons will be recovered per ton of coal and which contain all the properties of true gasoline and kerosene.

Sixth—Lubricating oils and grease,

which will not be taken from the oils remaining after the recovery of gasoline, kerosene and creosote at this time, but which may be utilized later for burning as ordinary fuel oil.

Value of Initiative

The value of the Ford Company's initative in its development to the Dominion of Canada is more thoroughly appreciated when it is considered that Canada has perhaps the greatest tonnage of lignite of any country in the world, large deposits of peat, and an appreciable amount of bituminous coal, but is without sufficient high grade coal to meet its domestic demands. Its supply of petroleum from which to derive gasoline and other petroleum products is limited. All of these factors result in the necessity for sending out of Canada a great amount of wealth to meet these necessities of modern existence.

Canada Has First Plant

Within the next few months, when the plant at Ford is completed, Canada will have in operation the first commercial realization of the research and development work which was carried on by V. Z. Caracristi, consulting engineer, and Emil Piron, chemical physicist for the last two years in New York, and which was verified semi-commercially in laboratories in Huntington, West Virginia. It would probably have taken these gentlemen and their backers several years longer to have secured the necessary financial assistance for the installation of a commercial plant, were it not for the fact that Henry Ford had previously expressed himself as vitally interested in the complete and economical commercial recovery of the by-products known to exist in coal before its destruction by burning.

The technical resources of the Ford Motor Company, Detroit, were placed at the disposal of the inventors. This assistance, headed by W. B. Mayo, has been of incalculable benefit in reducing the elements of uncertainty which naturally exist in any radical departure from accepted practice.

A similar plant, on a somewhat larger scale, is being installed at the River Rouge Plant of the Ford Motor Company, Detroit, but the Ford Motor Company of Canada is receiving preference, and its plant will be completed and in operation several months before the plant at River Rouge.

400 Tons of Coal Daily

The installation is for a plant to handle 400 tons of coal per day, but provisions have been made throughout for a plant to handle 2,400 tons of coal daily, so that additional units up to this capacity can be quickly installed, to keep pace with the plant's requirements.

Operations Continuous

All of the operations in Ford plants are continuous, not alone for production requirements, but in the maintenance of that accuracy which has been set up as a standard in Ford products. The low temperature distillation plant is also designed for continuous operation. The coal, lignite, or other material being distilled, is fed on a continuously travelling metal conveyor passing at the rate of approximately 25 ft. per minute through a sealed, heated chamber. The coal is stationary in relation to its carrier, and, being subjected to a "frying" action on a very hot plate, rapidly gives up its by-products in the form of gas. This gas is continuously taken off the furnace, its heavier portions condensed into a petroleum-like substance, its ammonia recovered through a continuous scrubbing operation with water, and the gasoline remaining in volatile form being brought into intimate contact with an absorbing oil which strips the gas of its burden of gasoline. This absorbing oil is continuously subjected to distillation for the purpose of recovering the gasoline, the gas going from this point directly to gas holders and point of ultimate consumption. The petroleum-like oil derived from the initial condensation of the gases is stored in wells, from which it is drawn and continuously distilled for the recovery of gasoline, kerosene and creosote fractions. The remaining oil is pumped to tanks and hence to point of ultimate consumption as oil fuel.

Crushed Coke Burned Like Gas

The coal, in raw state, is received by water or rail and stored in the river front coal storage plant, where facilities have been provided for the storage of 100,000 tons of coal. The coal is delivered, as required, by mechanical means, to a hopper from which it is fed into crushing mills which feed it upon a belt conveyor passing through a large reinforced concrete tunnel, and it is delivered by elevators and conveyors to steel storage bins of 100 tons capacity each. From these it is fed in a continuous stream one-half inch thick and eighteen feet wide to the primary distillation conveyor, and after passing longitudinally through the heating zone in the distilling oven, is dropped on a return conveyor which brings it back under the oven to a point directly under the feeders on the coal bin. After its passage through the oven the material has been changed from coal to low-temperature coke, and this coke, in lump form, passes through a screw type, water jacketed conveyor, and is again crushed to three-eighth inch size and under and elevated 100 feet to the level of the bunkers in the power plant.

It is fed to these bunkers through a dust tight screw conveyor, and is fed from them, by gravity, to pulverizing mills which reduce it to the consistency of flour. It is again elevated by an air current, integral with the pulverizing mill, to the height of the bunkers in which it is stored preparatory to firing under the power house boilers. From these bunkers the "Lopulco" pulverized coal feeders deliver it, as required, in the form of a dust-cloud, to the boilers where it is burned in suspension, like gas or fuel oil. The products of this combustion, passing through the boilers furnish the necessary heat for the production of the steam required in the power plant.

The coal, crushed coke, and pulverized coal are stored in large bins so as to provide against any temporary fluctuations in production, and this insures a continuous fuel supply for the boilers, which must operate without interruption.

Power Notes

The Residential Development Co., Montreal, have received a permit to build a power house on Simpson St., to cost in the vicinity of $11,000.

The City Council, Cooksville, Ont., is planning the installation of a power distribution and electric lighting system. The estimated cost is $30,000.

The Patterson Electric Co., 615 Yonge street, Toronto, have been awarded the electric contract for the new $20,000 school building at Cooksville, Ont.

The People's Electric Co., 656 Dundas St., London, Ont., have the electric contract for the new $50,000 registry office on King street for the city of London.

A. B. Carscallen & Co., Tamworth, Ont., are in the market for a belt-driven d.c., 125-volt generator, switchboard with equipment, one water-wheel, shafts, etc.

Daniel Reid Logan, Hamilton, Ont., manager of the B. F. Anderson Electric Supplies, died suddenly at his summer home at Burlington Beach, Ont., on July 15.

The City Council, Walkerton, Ont., plans to build a stand pipe and pump house, install gasoline-operated pumps and repair reservoir. Estimated cost $35 000.

Stan Lewis, 63 Metcalfe street, Ottawa, has been awarded the contract for the electric work in connection with the $150,000 office building on Sparks street, being built by the Sparks Estate.

Bernard H. Prack Hamilton, has been awarded the contract as architectural engineer for the new sub-station of the Hydro Electric Power Commission to be erected on Ottawa street, Hamilton. The approximate cost of this work is $45,000, and work will be started immediately.

Sir Wm. Arrol, Limited, St. Catharines, Ont., have been awarded the contract for the construction of the dam and power house for the power development of the Hollinger Consolidated Gold Mines at Island Portage on the Abitibi River. The plans call for the installation of equipment with a productive capacity of 25,000 h.p.

"A Good Time Had By All" At U.C.C.E. Picnic

By N. C. SHATFORD

Members of Canada Council No. 27 Enjoy Frolic at Ward's Island, July 21—A. M. Auchterlonie Again Victor in Keenly Contested Running Race

EVERYTHING in connection with the picnic of Canada Council No. 27, U. C. C. of E. on July 21, was true to form and with Old Sol working overtime and every one in good spirits it was only natural that the enjoyment of the day should be complete. Though it was a picnic, it must be understood that everyone worked hard—having a good time—young and mature, for there were no "old" ones there, taking part in the many items of sport scheduled by the committee in charge.

The usual races were run amid the usual excitement, the heat failing to dampen the ardor of those on frolic bent. Kiddies, arriving with their mothers, hopped around in an attempt to see everyone and everything at once, displaying such liveliness of spirit that it made one wonder "from whence this exuberance." The fair guests showed great satisfaction at being out of doors, knowing their children were quite safe playing around, glad to have a nice quiet chat—between races—with friends whom they see but occasionally.

As the engineers were in charge of the amusements they had little opportunity for "stalling," and everyone certainly deserves congratulations on the swing with which the whole afternoon went. It was a memory before one knew it, but a mighty pleasant one, put away side by side with the picnic on June 23 given by Ladies of Queen City Council.

The children of course enjoyed themselves thoroughly. Who ever heard of a kiddie not enjoying a picnic? It just seems to be the natural, accepted thing for them to go right ahead and do pretty much as they please, and they certainly made the most of their freedom from restraint.

In speaking to little Olivia Pope, her face was all smiles while the picnic and the coming exhibition were discussed, but when school was mentioned, there was a marked difference. "Yes, I'm having holidays now 'cause the school is closed, but I'll have to go back soon. You know, we go to school just twice as long as we can have holidays!" Such disgust, and so emphatic!

And little Alwyn Cudbird: "I don't know what we'd have done if it had rained to-day, but Daddy said it would be fine. Sure, I always come to these picnics."

Alwyn always goes to the picnics, he wouldn't miss one for anything!

The main excitement was the baseball game. The score was a bit uneven, Captain Davies and his team defeating Captain Holmes and his worthies, twenty-four to seven. The losers deserve credit, however, for they did all in their power to make the score appear less of a "walk-over," and the winners deserve credit for they had to work hard for the runs they got.

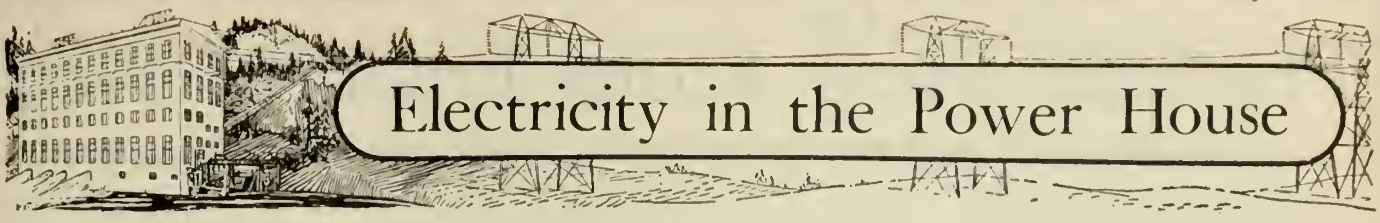
Congratulations are certainly in order to the entertainment committee, comprised of Chairman A. M. Auchterlonie, J. Grimshaw and T. C McAree.

Special mention and expression of appreciation should be made to T. C. McAree, who donated the ice cream, W. Russell Sexton who donated the milk, and C. Holmes, worthy chief of the council, who donated the tea and sugar.

The following are the races, winners and prizes:—

1. Tots' Race—O. M. Pope, Isabel May, Alwyn Cudbird and Albert Derbyshire.
2. Girls' Race—1st, Hazel May, doll; 2nd, Elsie Jenkins, beads.
3. Boys' Race—1st, Ronald Derbyshire, baseball; 2nd, Fred Davis, baseball bat.
4. Girls' Race—1st, Agnes Stephen, beads; 2nd, Helen Westwood, linen handkerchiefs.
5. Boys' Race—1st, Alex. Auchterlonie, baseball bat; 2nd, Lawrence Stephen, baseball.
6. Single Ladies' Race—1st, Anna Talbot, powder box and puff; 2nd, Helen Sexton, box stationery.
7. Single Men's Race—1st, John McBien, pr. silk socks; 2nd, Arthur Murphy, linen handkerchiefs.
8. Married Ladies' Race—1st, Mrs. Auchterlonie, rose bowl; 2nd, Mrs. Davies, aluminum pot.
9. Married Men's Race — 1st, Mr. Auchterlonie, pr. suspenders; 2nd, Mr J. May, leather belt.
10. Men's Measuring Contest—1st, Mr. Thos. Fisher, linen handkerchiefs; 2nd, Mr. P. Davies, pr. socks.
11. Officers' of Canada Council Race—1st, Mr. T. McAree, smoker's outfit; 2nd, Chas. Holmes, leather belt.
12. Egg and Spoon Race for Ladies—1st, Mrs. H. Eversfield, pr. silk hose; 2nd, Mrs. Auchterlonie, box chocolates. Prizes donated by Power House.
13. Men's Race, 50 yrs. and over—1st, Mr. J. Grimshaw, pipe; 2nd, Mr. H. Terry, pr. suspenders.
14. Candle Race for Ladies—1st. Mrs. W. MacMillan, electric toaster; 2nd, Mrs. J. Sandie, leather bound diary. Prizes donated by W. R. Sexton and W. Wolfenden respectively.
15. Men's Obstacle Race—1st, Mr. T. J. Pope, cigars; 2nd, Mr. H. Ward, speedometer. Prizes donated by Power House.
16. Consolation Prize Drawing for Ladies—1st, Mrs. McAree, Gibson teapot; 2nd, Mrs. T. Fisher, bon-bon dish.
17. Nail Driving Contest—1st, Mrs. Cudbird, silver deposit teapot; 2nd, Mrs. O. E. Wagge, box chocolates. Prizes donated by J. Grimshaw and H. McConnell respectively.

Future Engineers: Front Row: Alex. Auchterlonie Jr., W. Fisher, H. McConnell, Jr., B. McAree, P. Davies, Alwyn Cudbird, B. Cudbird, Jack Sexton.
Engineers: Rear Row: Alex. Auchterlonie, T. Fisher, H. McConnell, K. McAree, F. Davies, J. Cudbird, W. Russell Sexton.



Electricity in the Power House

D. C. MOTOR SPEEDS

IT IS sometimes necessary to increase the speed of a direct current motor in order to compensate for excessive voltage drop in the supply or through a faulty choice of motor in the first place. In the case of small motors this increase of speed is often effected by shifting the brushes back. The variation thus effected is limited by the increase in sparking at the brushes.

A still further increase in speed can be brought about by putting a series winding on the fields. This also brings about sparking and has the further disadvantage of unduly heating the field coils.

Within limits, however, both of these methods can be used with success. A particular case was noticed in which both had been adopted and overdone, with the following curious result. On starting the motor up, unloaded, it started to rotate in a certain direction and nothing unusual was noticed on the first three notches of the starter. On the fourth notch, however, the armature stopped and commenced to rotate in the opposite direction. This continued as the starter handle was advanced and excessive sparking resulted. The machine tended to race away. Matters were put right by bringing the brushes into a more suitable position.

A moment's reflection will show that the cause of this was the demagnetizing effect of the series turns, together with the similar effect produced by the setting of the brushes. As the starter handle was moved, resistance was cut into the shunt field which, being weakened by the series turns, was overcome by the armature reaction.

It was impossible to start the motor under load as the field was too weak to give the necessary starting torque.

In modern design, a ratio of field ampere turns to armature ampere turns of 1.1 is often used. so that stability really depends on the 10 per cent. excess. If unauthorized persons add differential series windings this 10 per cent. is not a large margin to work on.

FRACTURED PISTONS

A certain small generating plant of about 70 kw. total capacity supplied a small town for general lighting purposes. The plant consisted of two d.c. generators driven by two gas engines. During an overhaul by an incompetent workman, the gudgeon pin on one of these engines had been "forced" back. As no apparent damage had been done, the engine was put into service, presumably none the worse for the rough treatment it had received. Trouble was first noticed a few nights later during peak load, when the engine became abnormally hot. The effect was progressive, and despite the greatest efforts of the station staff in increasing the circulating water supply and in an extravagant use of lubricant, the trouble got worse and finally the engine stopped.

At once the piston was withdrawn and examined. Both the piston and the cylinder were badly scored, and on closer scrutiny fine cracks were noticed radiating from the gudgeon pin. These were obviously due to the expansion of the pin under heat.

As it was impossible to get a new piston at short notice, a temporary repair was necessary. The pin was removed with some difficulty and reduced with emery cloth until it was a comfortable fit. The piston and cylinder were carefully polished with an oil stone and the cracked piston replaced. The engine then ran well for some months without giving any further trouble.

INDUCTION MOTORS

What is the difference between a squirrel cage and a wound rotor induction motor? Which is the better type for loads with a high starting torque?—John Davis, Toronto.

Answer—The rotor of the squirrel cage motor consists of a laminated core, in the periphery of which are imbedded heavy conductors, short circuited to one another by being connected to conducting end rings. In the wound rotors the conductors in the slots are in the form of coils, the ends of which are connected to slip rings. Brushes bearing on these rings make it possible to add external resistance to the rotor and by short circuiting the rings it is possible to get in effect the squirrel cage motor.

The induction motor depends for its torque on the slip, that is difference in speed of the rotating magnetic field and the rotor, the greater the slip the more current flowing in the conductors in the rotor, hence the greater the torque exerted.

The effect of increasing the rotor resistance is to increase the slip necessary to exert a certain torque. In this way the addition of external resistance in the induction motor gives a greater torque.

As the motor speeds up the resistance can be gradually cut out and the rings short circuited.

For heavy starting torque the wound rotor with external resistance is better than the squirrel cage induction motor.

In This Issue

Editorial 21
Perfect Power Efficiency
An Analysis of Torque
Too Old at 100
Buying the Right Coal 22
By Robert June, A.S.M.E.
Oil Engine Bearings 24
Keeping Them in Alignment
Solving Under Capacity 25
C. O. Fehl Reviews Absorption Systems
Pipe Lines 27
Uncovered in Any Old Spot
The Friction of Motion 28
By M. Barry Watson, B.A., Sc. M.E.
Reducing Valve Economies 30
By H. H. Shugart.
Valves and Their Care 31
By Arthur Murphy
Ford "Burns Coal Twice" 34
New $500,000 *Plant in Canada*
U. C. C. of E. Picnic 36
Frolic at Ward's Island, July 21
Power Plant Electricity 37
D. C. Motor Speeds
Fractured Pistons
Induction Motors
Practical Ideas 38
Sensible and Latent Heats
Ammonia Leaks
Faulty Lubrication
Questions and Answers 39
Oil Engines
Boilers Compounds
Loose Piston Rods
Draft Losses
Cylinder Clearance
Engine Pounding
New Power Equipment 41
Ingersoll Rand Compressor
Mid-West Air Filter

Miscellaneous

The Canadian Mead-Morrison Co., Ltd., Montreal, Que., has been purchasing a considerable quantity of new equipment and machinery for its plate mill, including the latest type of rolls and gate shears and electric welding machines.

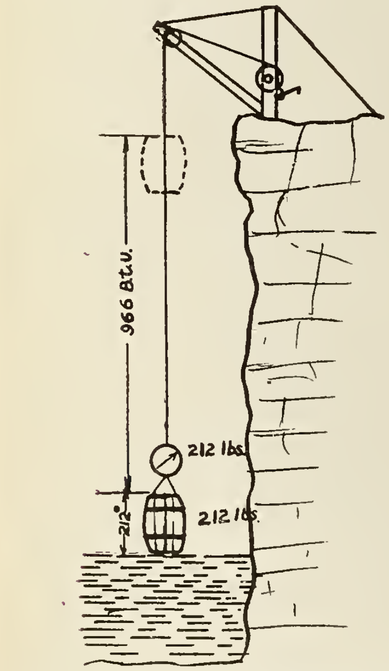
The Westco Manufacturing Co., recently organized in Toronto, with head office at 220 King St., W., has taken over the rights and organization of the Westco Pumps, Ltd., and will continue to manufacture pumps, water systems, etc.

Practical Ideas From Practical Men

SENSIBLE AND LATENT HEATS

Your recent article in Power House on the Benson Super Pressure Plant has made the question of sensible and latent heat a much discussed subject around our plant. In trying to make the matter plain I used the illustration shown in the accompanying sketch.

Let the suspended weight of the water in the barrel represent temperature, the spring scale in the lifting line the thermometer, and the power applied to the windlass above, heat applied. Then when the barrel is submerged the scale (thermometer) shows no weight (Temperature) but as the power (heat) is applied and the barrel is being raised out of the water, the scale (thermometer) registers a constant rise in pounds (degrees) until the whole weight (heat) of the water is indicated as 212 pounds (212 deg. F).



The barrel is now just clear of the water level and with a further application of power there is no further increase in weight and the scale cannot register the energy which is being stored in it, due to its elevation, just as the thermometer does not register any further application of heat beyond the boiling point.

The latent power in the barrel of water and the latent heat in the steam are both present in a changed condition, i.e., one case from a low elevation to a higher and in the other case from a liquid to a vapor.

If we let 966 feet of elevation in the case of the barrel of water represent the 966 B.t.u. of latent heat in each pound of steam at atmospheric pressure we will easily see the relation of latent to sensible heat.

The lowering of the barrel will return to the crank on the windlass, friction neglected, all the power which the water stored up when elevated just as the process of converting the steam to water will give up to the condensing water all the latent heat it held stored up in the vapor state.—R. MANLY ORR, 1551 Granville St., Vancouver, B. C.

AMMONIA LEAKS

While larger refrigerating plants are provided with safety helmets for use in case of serious ammonia leaks, small plants are seldom so equipped. For this reason the recital of what I did in one plant may assist some engineer on a like occasion.

In a refrigerating plant where gas-engine-driven compressors of 80 ton capacity were installed, a slug of liquid ammonia caused a gasket to blow out on the crank-end head of the compressor. The engine room was soon full of fumes, the other machines were still running and no helmets were in the plant. The engineer called up and I was sent to the plant to see what could be done.

When I got there it was impossible to enter it on account of the fumes which filled not only the building, but the street outside. I got all the information possible from the engineer as to the location of the valves and the particular machine that was leaking, there being three machines in the plant.

I then secured a quart of vinegar and after saturating heavy towels with it, wrapped these towels over my mouth and nose. After three attempts I managed to get the suction valve closed, and followed this up by closing the discharge valve. The engines were then shut down, and since there was a brisk wind blowing, the plant was soon cleared of ammonia fumes.

We then removed the piston and cylinder head and replaced the rubber gasket, which had sprung a leak, by one which we cut from a sheet of lead. We then reassembled the compressor and repacked the piston-rod stuffing box and started up after a shutdown of but seven hours and with only a small loss of ammonia.

FAULTY LUBRICATION

In vertical steam engines used around the power house for such purposes as driving fans, stokers, etc., it is customary to use a self-oiling type, in which the base of the engine acts as an oil reservoir. The oil is then pumped continuously to all parts of the engine by means of a small pump.

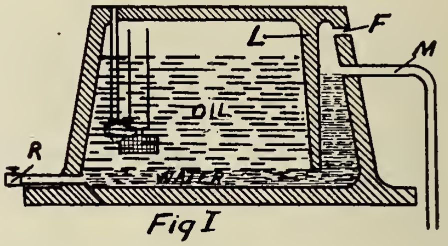


Fig I

Water leaking from the stuffing box finds its way to the oil sump and being heavier than oil collects in the bottom. If suitable means are not provided for removing this water continuously, it is only a matter of time until it will rise to the suction level of the oil pump, then the oil and water will sludge.

To prevent trouble from this source most engine bases are made as shown in Fig. 1, the lug extending to about one inch from the bottom of the base. A vent should be bored at F otherwise the drip pipe M will act as a siphon and empty the oil sump.

In one power plant, a stoker engine of the self oiling type, with an oil sump located in the base, gave trouble from the start unless the engineer drained the water at frequent intervals through the drain cock R. On examination it was found that the suction end of the oil pump extended to within ½ inch of the bottom of the oil sump, and that there was no method provided for continuous draining of the water.

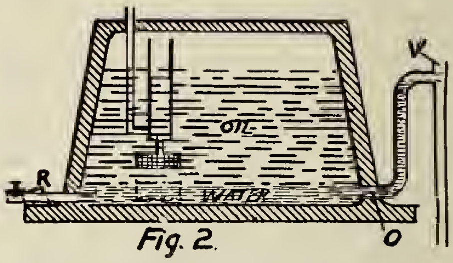


Fig. 2.

The trouble was overcome by the pipe arrangement shown in Fig. 2. A hole was drilled and tapped for ⅜ pipe, with the top about 1 inch above the bottom of the oil sump. An air vent was provided at V by using a T instead of an elbow. The suction strainer was also raised about an inch and all trouble with the lubrication of the engine ceased. Geo. Walsh, Winnipeg, Man.

The Goldie & McCulloch Co., Galt, Ont., held their annual picnic in Victoria Park on Saturday afternoon, July 21. About 400 were present.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

OIL ENGINES

What is the difference between the Diesel and the semi-Diesel engine, and which type is used in the large units? Is there any distinction between fuel oil and crude oil? —A. L. T.—Sarnia.

Answer.—In the true Diesel engine pure air only is drawn into the cylinder on the suction stroke, then compressed to a pressure of 500 to 600 lb. per sq. in., raising the temperature of the air at the end of the compression to such a degree that the oil sprayed in by the fuel valve is ignited at once, air pressure of about 1,000 lb. per sq. in. being used for atomization of the fuel. In the semi-Diesel the compression pressures are much lower, usually from 250 to 300 lbs. The temperature resulting from these low pressures is not sufficient to cause ignition of the fuel in a cold engine, additional heat, therefore, must be supplied by some other means, usually by a hot bulb or uncooled part in the clearance space, into which the fuel is injected at the end of compression.

The temperature in the hot bulb is always sufficiently high to cause ignition of the injected oil. In the semi-Diesel air pressures of 500 to 600 lb. per sq. in. are sufficient to secure proper atomization of the oil.

The main differences, therefore, between the two types are, lower compression pressures and the use of an uncooled part of the combustion chamber of the semi-Diesel, making preliminary heating necessary for starting, whereas the Diesel can start cold.

The Diesel engine is favored for the large power units because of its higher efficiency and better performance with fluctuating loads; the semi-Diesel is used in smaller units bceause of its lower costs, and the slightly lower efficiency is then not so important a factor.

Crude oil is the oil as it comes from the well, containing gasoline, kerosene, lubricating oils, etc. It is very seldom used in oil engines on account of the danger from the light fractions and because it contains gasoline and kerosene, making it too costly. Fuel oil is the residue after the light fractions have been removed. This is the fuel commonly used in the oil engine on account of its lower cost and the fact that it is not dangerous to transport or store.

BOILER COMPOUND

We use the following as a boiler compound: 60 lbs. sal soda, 12 lbs. caustic soda, 8 lbs. japonica, 2 lbs. magnesium dioxide, 2 lbs. Irish moss.

From what are the above ingredients obtained and what is their chemical symbol? What is the effect of the compound and each of the ingredients upon water in Toronto at a temperature corresponding to 120-lb. gauge?

—E. Golightly, Toronto.

Answer.—Sal soda or sodium carbonate (Na_2CO_3) is made from salt and limestone. Caustic soda or sodium hydroxide (NaOH) is strongly alkaline and is made from sodium chloride (common salt) NaCl. Irish moss and japonica are of vegetable origin. Magnesium dioxide does not exist commercially. In all probability you mean manganese dioxide (MnO_2) which is found in a black rock-like material. The sodium carbonate acts on the calcium and magnesium salts in the water, changing them to insoluble carbonates, which precipitate out.

The caustic soda precipitates any iron or aluminum compounds as hydroxides.

Manganese dioxide is an oxidizing agent and tends to hasten the precipitation of the calcium and other salts in the water. The finely-divided precipitate carries down any sediment or colloidal material suspended in the water.

The functions of the Irish moss and the japonica are not clearly understood, but they are believed to give a colloidal solution which acts as a protective colloid preventing the precipitated materials from compacting to a hard dense scale on the boiler tubes and sheets.

The compound as a whole, therefore, precipitates the salts contained in the water as insoluble compounds and these help to carry down any sediment or finely-divided materials in the water. The temperature of the water has little effect on the final reactions but as in most chemical changes the higher the temperature the faster the reaction.

LOOSE PISTON RODS

If the fastenings of the piston rod of an engine to the crosshead become loose, how can the proper position of the rod be found?

Ans.:—Loosening of the piston rod in the crosshead would be revealed by a hammering noise at the beginning of each stroke, and sufficient withdrawal of the rod out of the crosshead would cause the piston to pound in the head end of the cylinder. The length of the connecting rod and connection of the piston rod with the crosshead should be such that there will be equal piston clearance in opposite ends of the cylinder.

For the purpose of making the adjustments, remove the cylinder head, place the engine on a center and make a mark on the crosshead that corresponds with a mark made on the guide; and turning the engine over to the other center, make another mark on the guide to correspond with mark previously made on the crosshead.

The distance between the marks on the guides will represent the length of the stroke.

Next disconnect the connecting rod, replace the cylinder head and move the crosshead to bring the piston hard against first one end and then the other end of the cylinder, each time make a mark on the guide to correspond with the mark on the crosshead. The distance the crosshead has thus been placed beyond the marks previously made on the guide will be the piston clearance at corresponding ends of the stroke and should be the same for each end of the stroke.

When the piston rod is screwed into the crosshead, considerable adjustment for equalization of the piston clearance for opposite ends of the stroke can be obtained by screwing the rod in or out of the crosshead, but the rod should be set with a length of the threaded end in the crosshead of not less than its diameter, plus two or three additional screw threads. In case equalization of the piston clearance by screwing the rod out of the crosshead could not be obtained without shorter length of the screwed end of the piston rod, or the rod is a taper fit in the crosshead, then equalization of the piston clearance must be made by proper shimming of the connecting rod.

DRAFT LOSSES

In a water-tube boiler if the draft over the fire is shown by the gage to be 0.1 in., and the draft in the uptake is 0.4 in., does the difference, or 0.4—0.1=0.3 in., show the draft loss through the boiler? If not, how can the resistance be found?

Ans.:—If the draft over the fire is taken near the tubes at a point where the draft gage gives a constant reading, the difference between that indication and the draft in the uptake should be fairly representative of draft loss through the boiler. The more accurate method of obtaining the draft over the fire is to protect the draft-gage connection from currents and eddies of the gases.

CYLINDER CLEARANCE

How is measurement made of the cylinder clearance volume of a steam engine?

Ans.:—The cylinder clearance volume in each end of the cylinder is most readily determined from the volume of water that can be contained by the clearance space when filled from the piston, when at the end of the stroke, back to the valve seats. An opening needs to be provided at the top of the cylinder at each end for introducing the measuring water; or the water may be introduced through the indicator connections, using a standpipe of sufficient height for completely flooding the clearance space, with suitable provision for escape of air from the cylinder during the process of filling.

Place the engine on dead center with the piston in the head end of the cylinder, and after removing the valves, cover each valve seat with a rubber gasket, held down tight by a block of wood wedged or bolted in place. Pack candlewicking around the piston to prevent leakage of water past the piston. For this purpose the cylinder head must be removed and again replaced.

Provide two vessels, each filled with clean water and take the weight of each. Then fill the clearance space of the head end from one vessel and make a note of the time required. As soon as the space is filled, the first vessel is to be set to one side and subsequently determining the weight of the water thus used, and the clearance space is to be kept filled against leakage for five minutes by adding water from the second vessel. The vessels are again weighed to determine the weight of water used from each.

The average rate of leakage while filling the clearance space from the first vessel may be assumed to be one-half of the rate during the filling against leakage from the second vessel. If $W =$ weight in pounds of water required to fill the clearance space from the first vessel; t minutes $=$ the time required; and $w =$ the weight of water in pounds necessary to keep the clearance space filled against leakage for one minute, then the leakage during the filling is approximately $(w \times t) \div 2$, and the clearance space will contain $W - [(w \times t) \div 2]$ lb. of water. This multiplied by 27.7 gives the space in cubic inches.

ENGINE POUNDING

Recently, I took charge of a steam plant having a 125-hp. engine. Several engineers had been tried, but none of them had been able to locate the cause of a heavy pound.

I made a general survey of the engine and then took indicator diagrams, but the valves were found to be properly adjusted. It was decided that the engine might be out of line. It was taken down and then lined up. In reassembling the main bearings, crank and crosshead brasses were properly adjusted and the piston examined to see that it was not loose on the rod; in fact, the engine was put in good shape. When it was started, the pound was still present.

I shut down and the engine stopped on the center. I took hold of the flywheel to turn it off and noticed a slight lost motion. It then struck me that the flywheel was loose on the engine shaft.

An examination showed that the key had worked out slightly, which allowed the flywheel to be loose enough to cause the pound when it travelled over certain quarters. I put in a new key and drove it in snug, and there has been no trouble since.

Construction

Shavers Laundry Co., Ltd., 95 Canning St., Montreal, are in the market for one 60 h.p. steam boiler.

The Garden City Paper Co. plan to build a paper mill and are in the market for electric motors, etc. Estimated cost to be $400,000.

The Niagara Falls Arena, Ltd., are planning to build a new arena, 258 x 270 ft., on Victoria Avenue. Estimated cost $55,000. The owner is in the market for 30-ton ice manufacturing units.

The Sisters of Quebec Hospital, 11 Palace Hill, Quebec, are having plans prepared for the construction of a three-storey hospital including steam heating system. Estimated cost $600,000. Stevens & Lee, 62 Charles St., Toronto, are the architects.

The Canadian Comstock Co., Ltd., 10 Cathcart Street, Montreal, have been awarded the contract for the electrical work in the asbestos mill being built by the Asbestos Corporation, Canada Cement Building, Montreal. Estimated cost of the building $500,000.

The Hydro-Electric Power Commission, University Ave., Toronto, are having plans prepared for the construction of an addition to the transformer station on Davenport Road. Estimated cost $150,000. Purchase will be made of transformers, switches and electrical equipment.

The Ottawa & Hull Power Co., Hull, Quebec, have had plans prepared and will soon call for tenders for the construction of a dam, 400 ft. long, across the north branch of the Ottawa River near Bryson, Que., to include 75 x 450 ft. canal, headgates, etc., power house, 50-mile transmission line to Ottawa and substation at Ottawa. Estimated cost $1,000,000. They are in the market for three vertical shaft turbine units with generators, exciters, etc., 22,500 h.p., also electrical equipment, electrically-operated cranes, etc., for power house at Bryson, and step-down transformers, etc., for distribution of power, 66,000 volts, for substation at Ottawa.

The Liquid Air Co., with headquarters at Paris, France, have taken up with the Board of Trade, Sault Ste. Marie Ontario, the advisability of the establishment at the Sault of a half-million dollar plant for the manufacture of oxygen and acetylene gas. The company have a few plants in Canada, and if a sufficient market can be secured for their output are desirous of locating at Sault Ste. Marie.

The British Columbia Electric Railway are rushing work on the new million dollar dam at Stave Falls to increase the storage of Stave Lake, which will be ready by early fall. This is a sluice dam, 60 ft. in height, and will increase the storage of Stave Lake from 168,000 acre-ft. to 465,000 acre-ft. Anticipating the additional water supply, in 1922 a fourth unit of 9,000 kvs. was installed in the Stave Falls plant, bringing the capacity up to 36,000 kvs. Owing to the higher elevation of the lake due to this dam, the Blind Slough dam immediately above the plant is being raised 22 ft. If permission can be obtained by the company from the provincial government, they propose to divert the waters of Lake Alouette, lying above Stave Lake, through a 10,000 h.p. plant under a head 140 ft. As the demand for power increases following this development, a fifth unit of 25,000 h.p. capacity will be installed at the Stave Falls plant, and later a third plant will be built near the junction of the outlet to Stave Lake and Fraser River which will develop 80,000 h.p.

Personals

Frank Rutherford, Department of Technical Education, Parliament Buildings, Toronto, has been appointed honorary chairman of the Educational Committee of the Canadian Association of Stationary Engineers, and M. Barry Watson, Director of Engineering at the Central Technical School, Toronto, and Arthur Murphy, editor of "Power House," University Avenue, Toronto, have been appointed members of the Educational Committee.

W. Russell Sexton, of the W. R. Sexton Boiler Setting Co., 127 D'Arcy Avenue, Toronto, was responsible for the finding of the Studebaker Six car used by the men who robbed messengers of the Bank of Nova Scotia and the Sterling Bank in Toronto on July 24. Mr. Sexton, while walking with two friends on July 29, located the car in an isolated barn on the Dunlop Farm about ten miles northeast of the city limits. The finding of this car is the first definite clue uncovered in the robbery.

Progress in New Power Equipment

AMONG recent improvements in Canadian refrigeration plants is a new unit installed at the Chateau Laurier Hotel, Ottawa, Ont.

During the past few years many steam driven ammonia compressors have been discarded in favor of synchronous motor driven units and this installation is a good example of this practice.

The machine, which was built at the Canadian Ingersoll-Rand Co's Sherbrooke plant, is an 11 and 7-¾x12 inches Class PRE-2A direct connected motor driven, horizontal, duplex, double-acting, two-stage unit, without intercooler and has hand-operated clearance control pockets for regulating the capacity in three steps viz, full, three-quarter, or one-half load.

The motor is a Canadian Westinghouse 155 H. P. 237 R. P. M. unity power factor, 80 degree, two phase, 60 cycle, 2,200 volt, engine type, direct-connected motor with belted type exciter.

The compressor operates at 257 R. P. M. and is rated at 68 tons when operating with 15 lbs. back pressure and 185 lbs. head or discharge pressure.

The load assumed by this compressor was formerly handled by two old style steam-driven machines and comes principally from a brine cooler which serves the Chateau and the remainder from an ice making tank and an ice storage room.

The compressor is located in an extension of the central power plant. Cooling in the Chateau is accomplished by brine circulation. the brine being cooled in a double tube brine cooler situated near the compressor, ice tank, etc., at the power plant. The brine cooler is of course installed in an enclosed insulated compartment.

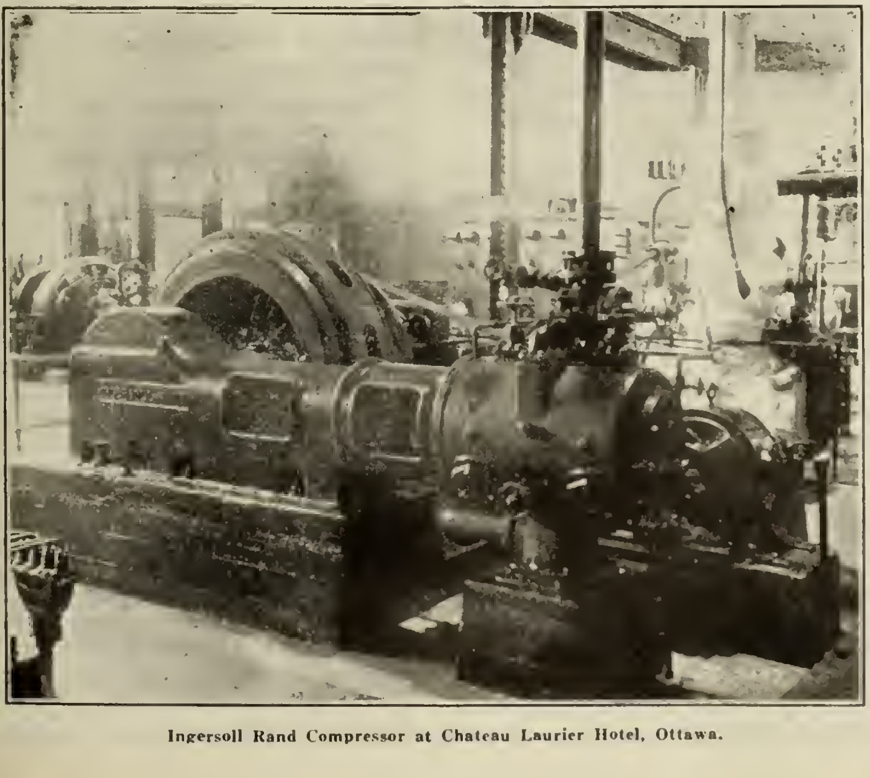
The reasons for installing this compressor were as follows: Electric power is generally so cheap as compared with steam that as is usually the case, conversion to electric drive was warranted even on the basis of installing new equipment.

A little more capacity was needed for handling the extreme peak load on hot days in summer and still more capacity was desired to take care of contemplated increases in ice-making load.

Synchronous motor drive was desired on account of its numerous advantages and a high speed direct-connected unit, permitting large output for floor space occupied, was practically imperative on account of the limitations in this respect.

It was also desired to install a unit having capacity considerably in excess of that demanded by existing requirements and yet be able to run it at partial loads to meet present needs. This condition was met by the hand-operated clearance control pockets. These act on a principle similar to the Ingersoll-Rand patented Automatic Clearance Control for Air Compressors and permit efficient regulation, without disturbing the mechanical, balance of the machine, at full three-quarter and half-load, with practically corresponding reductions in power consumption.

In addition to electrical driven units the company also makes a complete line of straight line steam and belt driven machines and belt and steam duplex units, for large or small plants



Ingersoll Rand Compressor at Chateau Laurier Hotel, Ottawa.

CLEAN AIR

An important but frequently overlooked factor in modern conservation, both of health, machinery and power plant equipment is clean air.

Chemical analysis shows that air is charged with fine particles of dust resultant from the disintegration and decomposition of every conceivable substance exposed to wear and tear, combined with that dirt which is the accompaniment of modern industry.

Thousands of tons of stone, coal, cinders, ashes, sulphuric acid, sulphuretted hydrogen, carbon bisulphide, ammonia, chlorides, sulphates, salts and fetid matter are suspended in the air or allowed to settle on the floors and walls of structures and street pavements, and clean air is therefore a commercial economy, an important factor in lowered depreciation of equipment, and in improved product with lowered costs.

Depreciates Machinery

It is obvious that fine stone, sand, carbon, soot, etc., which is suspended in the air in large quantities, must have a seriously deleterious effect upon machines and upon many products.

Certainly coarse "dust" is most injurious to moving machinery of all kinds. With compressors, gas engines and similar machinery, the "dust" combines with the lubricating oil or water and is deposited upon the cylinders, pistons and other parts where it serves as a very effective cutting compound. Thus it causes friction which results in excessive wear, rapidly lowers efficiency and causes frequent and expensive repairs.

In the case of electrical machinery, such as generators and air-blast transformers, dirt particles are sucked in slowly but continuously and clog the narrow air passages through the iron cores and are deposited upon the windings.

This partial stoppage of the air ducts, and often the ducts are completely filled by this dirt, reduces the flow of the air and increases the temperature of the machine. The accumulation on the coils is a poor heat conductor and is another cause for an increase in the temperature of the machine.

An increase in machine temperature must result in a reduction of the capacity of the machine, and such temperature rise may attain dangerous proportions. This can only be minimized by the more frequent cleaning of the machine which may result in taking the machine out of service at an inopportune time and must result in increased operating costs.

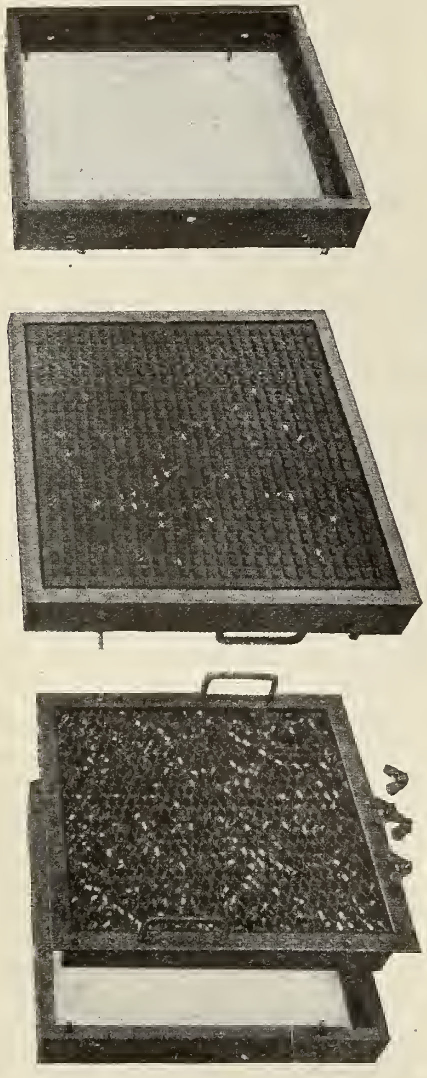
Dust Highly Injurious

It is obvious that the elimination of such "dust" from atmospheric air must bring increased efficiency to machinery, prolong its life and save money for the plant to a marked degree.

It is only during the last decade that this subject has been studied by the engineer and air-filters have become a scientifically designed product.

There are three main types or principles involved in the air-filters marketed to-day. The washer type, where the air is forced through a curtain of pumped water; the filter using a cloth or similar close-meshed screen; and the type using small hollow cylinders placed in a shallow rectangular box or "filter cell."

The method of filtration is based upon the principle of passing the atmospheric air through layers of small, irregularly placed metal cylinders, (filter bodies) which are coated with a non-drying, non-freezing viscose fluid especially developed for the purpose, called Viscosine.



The frame, cell, and complete air filter unit.

Filter Bodies Coated

Dust laden air encountering these layers of "filter bodies" is split into innumerable fine streams which are constantly forced to change their direction and thus the air winds its way through, depositing much of its "dust" content in the many corners and pockets. The balance of the "dust" is arrested by the coating upon the "filter bodies."

This type of air-filter is built on the "unit" principle.

These filter units comprise two elements, namely a steel frame and a filter cell fitting into the frame, with air-tight joints. The cells are 20" square with fronts and backs of specially perforated metal and are filled with "filter bodies." Each cell has two handles conveniently arranged so that one man can remove it easily for its periodical cleaning and recharging operations.

The frames are provided with "hooks" corresponding to eyes in the flanges of the cells, thus providing a simple effective means for holding the cells in place.

The filter units may be arranged in one or more planes, or in the form of boxes, etc., all depending upon local conditions and space available. Any local space may be utilized for the simple installation of this filter. They may be installed upon the roof or in the outside wall of the building as well as inside, without any decrease in efficiency.

For any given installation, the filter units are set side by side, or above each other; the frames are bolted securely together, thus forming a skeleton framework into which the filter cells are placed.

This type of air-filter is manufactured by the Midwest Steel & Supply Company Inc., of New York. This company is extending its activities to Canada and application has been made for a Canadian charter and a Canadian Company is being formed.

Willis D. Bishop of Bishop Sales Corporation, Montreal, is manager of the Canadian Company.

The field will be covered by district managers in the large centers in order to handle properly the needs of local industries.

Announcements

The Canadian Oil Co., Petrolia, Ont., held its annual picnic at Tashmoo Park on July 26, 1923. More than 500 people from Petrolia attended, and a number of visitors from Oil Springs and Oil City.

Goldie & McCulloch Co., Galt, Ontario, have shipped to St. John's Drydock & Shipbuilding Co., St. John, N. B., three Rees-Roturbo pumps, 48 x 42 in. volute type. These pumps are of a capacity to empty a drydock 1,200 ft. long by 120 ft. wide, containing fifty million gallons of water, in four hours.

The installation of new equipment, including boilers, in the municipal electric light plant at Kenora, Ont., is being considered.

The Canadian Fairbanks-Morse Co. are supplying motors and pumps for a waterworks system, valued at $8,000, in Duncan, B. C.

The Southern Canada Power Co. will probably call for tenders in September for the power development of Hemmings Falls, Quebec.

The Hydro Electric Commission of Ontario is contemplating the installation of three 100 kvs. transformers at the station at Acton, Ont.

The Hydro Electric Power Commission of Ontario is planning to build an addition to the transformer station on Davenport St., to cost about $150,000.

The Lower St. Lawrence Power Co. has been granted permission to erect a transmission line from Rimouski to Reviere Metis, about 22 miles distance.

The Hydro Electric Power Commission, Toronto, are considering the erection of a transmission line from Tilsonburg to Courtland, Ont., approximate cost $40,000.

George Crawford has been appointed electrical instructor at the Ottawa Technical School, his duties to commence in September. He formerly held a similar position in the Hamilton, Ont., tehcnical school.

M. C. Smith, superintendent of Light, Power and Railway department of the Nova Scotia Tramways & Power Co., Halifax, N. S., has been appointed manager of the Cape Breton Electric Co., Sydney, N. S., succeeding C. C. Curtis.

William Kennedy and Sons, 232 St. James St., Montreal, have been engaged by the Ottawa and Hull Power Co., to prepare plans for a power plant and dam to be erected at Cat Calumet Island Falls on the Ottawa River, near Bryson, Quebec.

The Sinclair Construction Co., Toronto, Ont., have been awarded the contract for the building of the new power house at Campbellford, Ont., by the Hydro Electric Power Commission of Ontario. The tender includes the erection of the power house and tail race, and is for $250,000.

Robert Taschereau, K.C., Montreal, and Hon. Honore Mercier, Minister of Lands and Forests, the former representing the Des Quinze Power Co. of Ontario, and the latter the Government, have signed the contract for the sixty-year lease of the third group of the Des Quinze River.

Dan M. Logan, identified with the Canadian General Electric, Toronto, for twenty years, latterly as sales manager of the lamp department, died in Hamilton on July 15, 1923. On May 1st, Mr. Logan severed his connection with this company and became associated with B. F. Anderson, Hamilton, Ont., in a lamp jobbing business.

POWER PLANT EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA
TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK & WILCOX, LIMITED

Toronto Office
Bank of Hamilton Building

ST. HENRY—MONTREAL

BUYING THE RIGHT COAL

(Continued from page 23)

tent of the coal which you are using. It is common to speak of an evaporation of 8 or 9 or 10 pounds of water per pound of coal as representing a relatively high efficiency. Such figures, however, mean nothing, unless the B.t.u. content of the coal is also given. For example, if coal contains 11,000 B.t.u. per pound, the equivalent evaporation of 8 pounds of water per pound of dry coal would represent 70.5 per cent. efficiency. However, if the coal contained 14.500 B.t.u. the evaporation of 8 pounds of water would represent only 53.5 per cent. efficiency.

Complete analyses of coal entering your plant should be made at frequent intervals. If you haven't a laboratory of your own put a barrel in the boiler room, have the fireman throw in a shovel from different parts of the car to be tested, then mix and quarter the contents of the barrel until you have a representative sample which you can forward to the nearest testing laboratory. In making a contract for the purchase of coal under specifications the following points should be taken into consideration:

(1) Amount and description.
(2) Time and condition of delivery.
(3) Adjustment in price for variations in B.t.u. content, moisture, and ash.
(4) Method of sampling.
(5) Designation of laboratory.
(6) Disposition of acceptable coal.

Proper selection of coal is at the very foundation of efficient power plant management. Time invested in the study of this question will pay rich dividends.

OIL ENGINE BEARINGS

(Continued from page 24)

much bearing wear and shaft bending can occur and still not require new bearings or readjustment? The allowable wear will vary in different sizes of engines. For engines over 200 H.P. the difference should not exceed 0.008 in. to 0.01 in. Smaller engines, having smaller shafts, can, of course, stand a greater variation, say up to 1-64 in. On the other hand thousands of semi-Diesel engines are running with bearings as much as 1-16 in. out of alignment. That such engines do not break their shaft speaks a lot for the high quality of the steel used.

The engineer who finds that the bearings are out of alignment is now up against the problem of realigning them. Many raise the low bearing by putting shims under the shell. The great objection to this is that one cannot be sure that the shim is supporting the shell, save at the bottom. The shell may break as a result.

High bearings should be scraped until they are as low as the worn ones. This is an easy job, and a scraper can be made of an old flat file. The edges are ground off square and will cut the babbitt without any trouble.

Coloring Rubs Off

After scraping the high bearing, all should be measured or "miked" to get them to agree. Upon being placed in the housing, lampblack, prussian blue, or red lead should be smeared lightly over the shaft. At all points where the shaft touches the babbitt the coloring will rub off on to the babbitt. By removing the shells again, these high spots may be scraped to bring the babbitt in contact with the entire journal. After the lower bearing shells are adjusted, the upper shell or cap must be replaced with running clearance.

Just how much clearance is necessary between the shaft and cap is a question. It is safe to make this 0.01 in. for shafts up to 6 in. in diameter and 0.007 in. for larger shafts. There is no reason for clearance at the top, save clearance for the oil film and to provide for the expansion of the shaft by reason of the working temperature.

Test Third Method

A third method of detecting low bearings (see Fig. 3) assumes that a low bearing will cause the width between the crank webs to change by the deflection of the shaft when the engine is turned so that this particular crank is at top centre and then at bottom centre. By measuring between the webs, by means of an inside micrometer, any change in the width may be detected at once.

If the crank to the right of this crank also shows a deflection, it is proof that the bearing between the two cranks is low. On the other hand, if the crank to the left shows a deflection while the one to the right does not then the left bearing is low.

This method is excellent, but the engineer must be careful in taking the measurements. It is necessary in most cases to remove the connecting-rods; but if the flywheel overhangs, removing the weight of the rods and pistons will cause the shaft to bend, thus giving incorrect measurements.

REDUCING VALVE ECONOMY

(Continued from page 30)

cent. efficiency at a certain pressure. A higher pressure of steam does no more work than the predetermined lower pressure, it simply wastes steam. If the conveyor works efficiently at 90 pounds pressure and your boiler pressure ranges from 160 to 180 pounds, the reducing valve, regardless of boiler pressure change, delivers steam to the jet at 90 pounds pressure.

The fifth reason for using reducing valves is that they do something that cannot be done properly by any other means. This is almost self-evident.

It is admitted that a globe or stop valve may be so manipulated as to reduce a pressure and control the flow of steam, but because both factors are changing, that is the high pressure is fluctuating and the low pressure will fluctuate answering a greater or lesser demand, it is necsesary that the stop valve have personal and continuous attention if proper control is to be secured. First, because the man who operates the globe valve will only respond to the fluctuations as they occur and he sees them recorded on a gauge; whereas, the reducing and regulating valve responds instantly to the changes, being controlled by them as they change, offsetting the one tendency or the other at the exact moment it occurs, so that the reducing and regulating valve is not only more efficient, as it prevents rather than corrects aberrations, but is profitable investment in that, being automatic, it saves labor.

Is a Money Saver

While often looked upon as an expense, the pressure reducing and regulating valve is in reality the means of saving a great deal of money. Here is a simple example. You undertake to generate steam as economically as possible; that is, at high pressure, say 250 pounds superheated 200 degrees. You set out to buy stokers and discover that the equipment is designed and manufactured to operate at 80 pounds pressure. But there is no necessity for buying specially designed equipment to withstand your high pressure, for the reducing valve steps in and turns the trick.

It reduces your 250 pounds superheat pressure to the 80 pounds pressure at which the stoker equipment will perform efficiently, saving you expensive apparatus for high pressure service. To carry the idea further, it is apparent that because of reducing valves the stoker manufacturers can make one class of equipment for standard pressures and produce them in quantity at a great saving in price.

Clogged With Debris

But I didn't finish my story. For it so happened after a space and a time Al Hassan sent for Mech-Anic and charged him with carelessness in the construction of his valve, for it had ceased to function. Upon inspection Mech-Anic found that it had become clogged with debris and filth. He ordered it cleaned and had a strainer woven of rushes placed before it to protect it and so reported to Al Hassan. But Al Hasson still found fault, saying, "We have ever had trouble with the valve since you made it."

Whereupon Al Hassan, being a just man, ordered him a thousand pieces of silver, a gift of horses, and corn more than he could carry away.

All of which is to say, that a regulator should be protected from damaging scale and grit by a strainer; that, being in reality a piece of automatic machinery functioning continuously, it should be given the care usually accorded machinery of that sort; that having moving parts it is eventually bound to wear; and that if given care, it really does for you automatically and dependably something that could not otherwise properly be done.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES ● $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you , 1 monthly until $12 is paid.

Signature ________________

Occupation ________________

Employed by ________________

Residence ________________

Reference ________________

POSITIONS WANTED

FACTORY SUPERINTENDENT OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

REFRIGERATING AND MECHANICAL ENgineer with 10 years' operating record, also with experience in heating and lighting work, desires employment in Toronto. Apply Box 108, Power House.

POSITIONS VACANT

STATIONARY STEAM ENGINEER WANTED—familiar with water tube boilers and Turbo Blowers and Generators. Must be an all round competent man, capable of taking charge of plant of about 2,400 B.H.P. Must have first class certificate. State in first letter salary wanted, age, experience, and when you can report. Apply P. O. Box 720, Port Colborne, Ont.

WANTED — SALES ENGINEER—EXperienced in steam specialty lines. University graduated preferred. Write stating experience and salary. Apply Box 109, Power House.

FOR SALE

BURNHAM STEAM PRESSURE PUMP, 10 IN. x 1⅛-inch. x 12 in., nearly new, with Fisher governor attached. W. Ahearn, 538 McLaren St., Ottawa. When answering this advertisement please mention this paper. P.F.H.

INDUCTION MOTOR — 220 VOLTS — 1800 r.p.m. 15 h.p.; single phase; can be bought cheap; write for particulars. Box 104, Power House.

I. H.C. 12 H.P. GAS ENGINE FOR SALE—ALL in good running shape, with 33-inch clutch pulley; will be sold reasonable on easy terms. Apply W. Harrison & Son, R. R. No. 5, Guelph. When answering this advertisement, please mention this paper. P.F.H.

M.BARRY WATSON

B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer

Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6970W

See
Buyers' Guide
Pages
50, 52, 54

·LIQUID·FUEL·

FOR · HEAT · AND · POWER
·HOW·TO·USE·IT·
SEND FOR IT ··· NO CHARGE
LAUGHLIN'S PRODUCTS LIMITED.
WELLAND · CANADA

TAYLOR SAFE FOR SALE

Inside dimensions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110, Power House.

YORK Ice Making & Refrigerating **MACHINERY**

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO., LIMITED

Villiers and Munition S's., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1150 Homer St., Vancouver

EDWARD VALVES

Valves for high pressures and superheated steam. Write for catalogue.

THE EDWARD VALVE & MFG. CO.

Main Office and Works: East Chicago, Indiana.
CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal; Valve Engineering Co., Toronto.

SUPERHEATERS

ELESCO

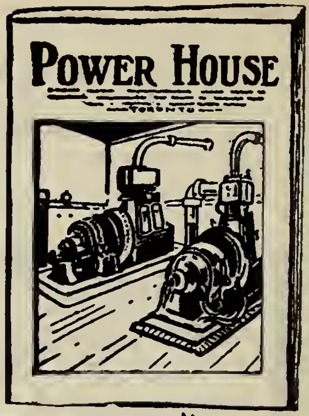
DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.



DO YOU Manufacture Industrial Equipment?

Are you a manufacturer of twist drills, hack saws, mechanics' tools, wire guards, bolts, rivets, paints—do you manufacture lines of any description that can be used in machine shops, metal-working plants, power plants or foundries? If you do the publications you see illustrated here (Canadian Machinery, Canadian Foundryman, and Power House) can build a bigger demand for your products.

This group of technical newspapers is read by the men who are prospective buyers of your lines. You can bring to the attention of these men the reason why they should demand your goods when purchasing from their dealers. You can effectively do this by placing a message in the paper which serves the field in which your products are sold.

CANADIAN MACHINERY AND MANUFACTURING NEWS is published weekly and covers the machinery, iron and steel and general metal-working industries of Canada.

POWER HOUSE is published twice a month; it serves steam, electrical, water and gas power plants, and the power houses of all general manufacturing plants.

CANADIAN FOUNDRYMAN AND METAL INDUSTRY NEWS is published monthly; it serves the grey iron, steel and non-ferrous foundries.

These publications reach proprietors, managers, purchasing agents, foremen—the men who direct the purchasing of goods. A message to these men in any of the MacLean Technical Newspapers is certain to have a strong influence.

Write for complete Data.

MACLEAN TECHNICAL NEWSPAPERS

153 University Avenue, TORONTO
Montreal, Winnipeg

It has saved more than one breakdown!

Vertical or Horizontal Styles.

The Unique Construction of the ANDERSON STEAM TRAP

enables you to place it anywhere there is condensation to handle. Absolutely prevents the escape of the live steam. Equipped with a removable strainer which prevents scale, packing, etc. from entering the valve

Positive-acting, with every part interchangeable, the Anderson Model "D" is the most effective Steam Trap because it automatically adjusts itself for any pressure within its capacity. Ask for our catalog giving full particulars.

THE V. D. ANDERSON CO.

1935 West 96th St., Cleveland, Ohio

De Laval Oil Purifiers

remove from used lubricating oil the water and dirt which are the forerunners of sludge and emulsion—the two chief causes of trouble in turbine lubrication. They do this by centrifugal force in a positive, mechanical way, so that the purity of the purified oil is never in doubt.

There is no longer an excuse for allowing sludge and emulsion to wear down your machines. The De Laval Oil Purifier ends trouble from dirty oil, and incidentlly saves oil by keeping it in service longer.

Write for Bulletin No. 105.

The De Laval Company, Ltd.
Peterborough, Ont.

Montreal
Winnipeg

Edmonton
Vancouver

Fans and Blowers

Air handling equipment for every purpose:—mechanical draft, heating, ventilating, exhausting vapors or gases, pressure blowers, etc., of any size or capacity. Forty years' success has established for Canadian Sirocco products a nation-wide leadership in all branches of industry.

Write for Bulletins

CANADIAN SIROCCO CO., LTD., WINDSOR, ONT.
BRANCH OFFICES IN ALL PRINCIPAL CITIES

(222)

"Sirocco" Products

TRADE MARK

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

A Jointless Gastight Furnace Lining

The resistance of a furnace or firebox lining is weakest at the exposed edges of the brick, and may be remedied only in one of two ways: first, by setting the brick in Sternson No. 30 High Temperature Cement, or, secondly, by eliminating all edges and building a one-piece lining with

STERNSON NO. 40 MONOLITH

There can be no cracks where Sternson No. 40 Monolith is used. It withstands over 3,000 deg. F. and is not only more satisfactory and economical in operation, but is actually lower in cost than the old way of firebrick and mortar.

It is invaluable for repair work and is often used on the side wall without drawing the fire.

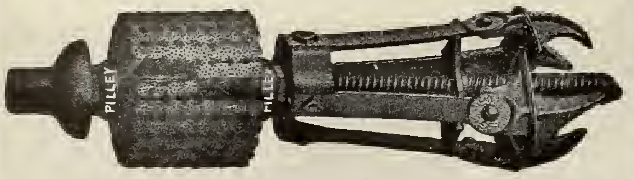
Write for Interesting Literature.
Let a Technical Firm Do a Technical Job.

G.F. Sterne & Sons, Limited
Chemical Manufacturers.
Consulting Chemical Engineers.

Brantford :: Canada

HINTS TO BUYERS

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO.
623 South Third Street - - - St. Louis. Mo.
Office: 71 Fulton St., New York.

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

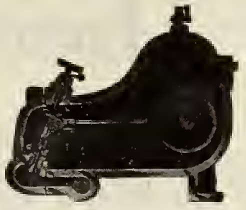
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



Make Good With
Your Product
and Then
Advertising Can
Make Good for You

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T. J. CUNERTY** *Company*
9 Richmond St E. *Toronto*

AMERICAN
STEAM ASH CONVEYORS

Labor-saving ash-handling equipment of proven economy. Information on request.

Canadian Representatives:
CLEATON CO. (Canada) Ltd., Montreal.
GORMANS. LIMITED. Edmonton, Calgary.
WM. A. GOOLD. Winnipeg.
T. M. GRINDLEY CO., Vancouver.

CONVEYORS CORPORATION OF AMERICA
326 W. MADISON STREET CHICAGO

MONCRIEFF'S "UNIFIC" WATER GAUGE **GLASSES**

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is **economical.** British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

BOICO BOILER COMPOUND Gets the Results!

Anti-Clinker Shell Bar Grates—Maximum air space ensures the last bit of heat from the last bit of fuel.

One-Piece Jointless Furnace Lining—Line your furnace with PLIBRICO. More efficient, less costly, lasts longer, easier to instal.

Tip-It Patent Welding Process. Gives you tools with shanks of carbon and tips of high-speed steel.

SHELL-BAR BOICO SUPPLY, Limited
1-15 Saunders Ave., Toronto.

SALES AGENTS: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot, Reg'd., Quebec; Adam Davis, Cobalt, Ont.

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING

Oil Burning Systems Installed

Full line of Power Plant Equipment and Supplies.

LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL.

Thrifty Managers

will be interested in learning more about the Sturtevant Fuel Economizer, which provides a number of other important economies, aside from saving fuel.

Ask for folder 609.

B. F. STURTEVANT CO.
OF CANADA LTD.
MONTREAL GALT TORONTO

REGISTERED J TRADE MARK

Jardine's Self-feeding Tube Expanders

All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co., Ltd.
Hespeler, Ont.

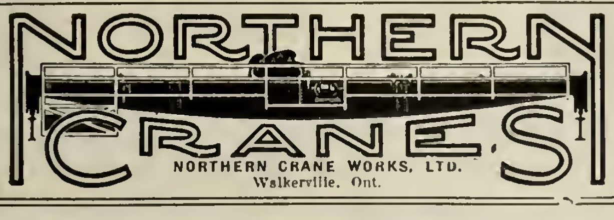
INVESTIGATE THE
ADVERTISEMENTS
APPEARING IN EVERY ISSUE
OF POWER HOUSE

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE MEANS ECONOMY

Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.



NORTHERN CRANES
NORTHERN CRANE WORKS, LTD.
Walkerville, Ont.

Hays Apparatus
STANDARD GUIDES TO EFFICIENT COMBUSTION
The Jos. W. Hays Corporation
MICHIGAN CITY, INDIANA

SEND INFORMATION ABOUT
☐ AUTOMATIC CO₂ & DRAFT RECORDERS
☐ HAYS DRAFT GAGES
☐ HAYS IMPROVED GAS ANALYZERS
☐ HAYS AUTOMATIC GAS COLLECTORS
☐ "BESTIX"-COATING FOR SETTINGS
☐ "SPIZZERINKTUM"-BOILER METAL TREATMENT

NAME
POSITION
—COMPANY
ADDRESS

CARHARTT

CARHARTTS TRADE MARK

BUILT UP AND SUPPORTED BY ORGANIZED LABOR

OVERALLS

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto

ASBESTOS SPECIALTIES
Can. Johns-Manville Co., Ltd., Toronto.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Kirby & Co., Toronto, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julien, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catherines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
Refrigerating Engineers, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co. Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreel.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

COAL HANDLING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.
Northern Crane Works, Walkerville, Ont
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.
Jeffrey Mfg. Co., Montreal, Que.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto
Refrigerating Engineers, Ltd., Toronto, Ont
York Manufacturing Co., York, Pa
Wilson & Sons, J. L., Toronto, Ont.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N. Y

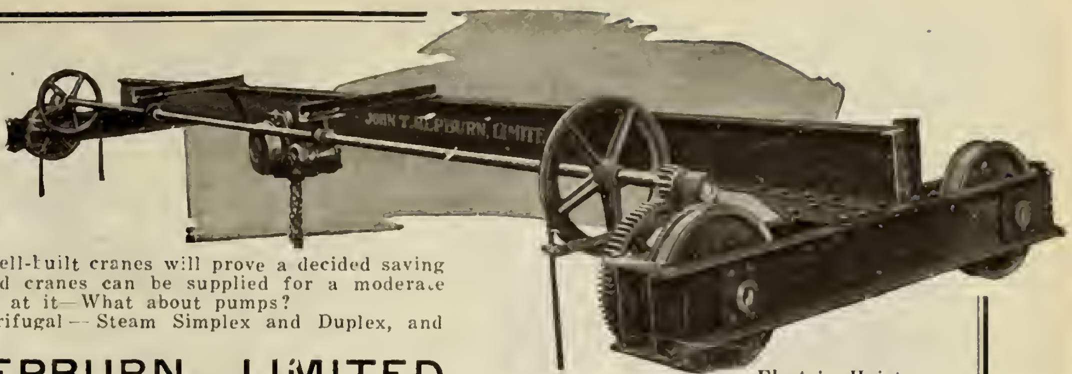
CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

HEPBURN CRANES



Electric Hoist or Chain Block

These easily manipulated, well-built cranes will prove a decided saving in the Power House. Hand cranes can be supplied for a moderate outlay. And while you are at it—What about pumps? We make all kinds—Centrifugal—Steam Simplex and Duplex, and Power Pumps.

JOHN T. HEPBURN, LIMITED
Engineers and Iron Founders
18-60 VAN HORNE STREET - TORONTO, CANADA

Metallic Packing For Condenser Tubes

Makes tight condensers and stops tube faliures due to stresses of expansion and contraction. - Seals but does not bind tubes. Prevents electrolytic disintegration of tube ends by offering a path of low resistance between tubes and sheet. When over hauling or buying new condensers specify "JOHN CRANE" Process. Our text sent on request.

"MADE IN CANADA"

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.

BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B. C.

B S CO. LTD.

FIBRICO
JOINTLESS
FURNACE LINING

for

Complete Furnace Linings

Will outlast ordinary fire brick two to four times.

JOINTLESS - MONOLITHIC

Beveridge Supply Co., Limited
628-630 St. Paul St. West
Montreal, P.Q.

Stocked also in Toronto, Winnipeg, Vancouver.

Don't clog your mind wheels up with unreliable, out-of-date reading. Get the latest technical information on Power House Equipment by reading POWER HOUSE, Canada's only Power Plant paper devoted entirely to the practical engineer's interests.

$2.00 *SUBSCRIPTION PRICE Send in yours TO-DAY* ***$2.00***

THE MACLEAN PUBLISHING COMPANY, LIMITED, 143 University Avenue, TORONTO

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schnefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N. Y. .

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Jeffrey Mfg. Co., Montreal, Que.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER PURIFIERS
Stephens Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaaffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE. PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio
Reading Steel Casting Co., Hartford, Conn.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Reading Steel Casting Co., Hartford, Conn.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS. STEAM, WATER)
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co. St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd. Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto
Durabla Mfg. Co., New York, N Y
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
Kirby & Co., Toronto, Ont.
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div-Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
-land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Dominion Engineering Agency, Toronto, Ont.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Moad-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Batting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turnar Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Maad-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg.' Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Dominion Engineering Agency, Toronto, Ont.

OILS
Imperial Oil, Ltd., Toronto.

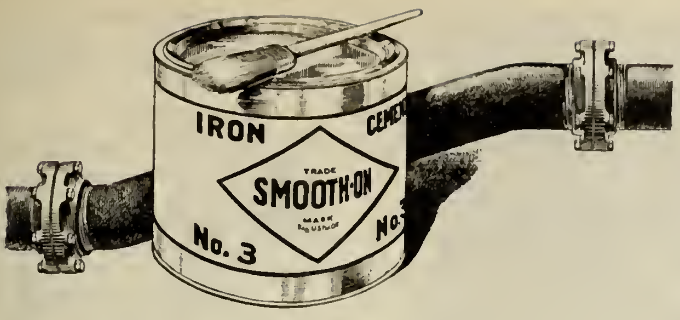
OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil. Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V D Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.



—and therein is the secret of never-leaking joints!

KEEP Smooth-On No. 3 handy and use it on every screw-thread joint. It fills the voids completely and never dries out or shrinks, therefore making a tight, never-leaking seal.

You avoid much future trouble and expense — with little effort and for little money — by making all screw-thread joints with Smooth-On No. 3.

Write for a free sample, and copy of the Smooth-On Instruction Book, which explains uses of other Smooth-On products.

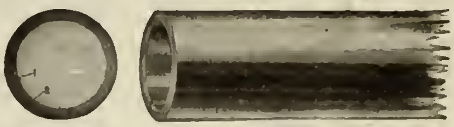
Smooth-On No. 3, identified by the gray label, is sold by supply houses everywhere in 5, 10 and 25-lb. tins. If not obtainable, tell us your dealer's name and we will see that you are supplied.

The Canadian Asbestos Co.
Dept. 52-H Montreal, Que.

SONDERGLASS

"The Unbreakable Boiler Gauge Glass"

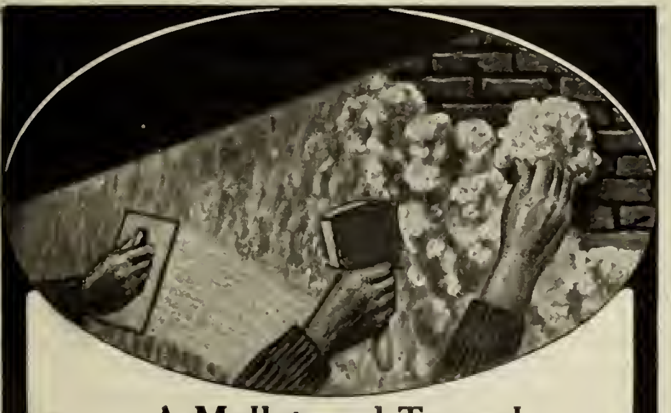
Two Glass Tubes in One



The different metals used allow for expansion and changes of temperature to which the glass is subjected, and add greatly to its pressure-resisting qualities, as each of these metals has different degrees of expansion. The inside of the tube expands in proportion to the temperature of the steam or hot water and the outside according to the temperature of the air.

There are no others "Just as Good"

LYTLE ENGINEERING CO. LIMITED
404-406 St. James Street, Montreal
VALVE ENGINEERING COMPANY
174 King Street West, Toronto



A Mallet and Trowel

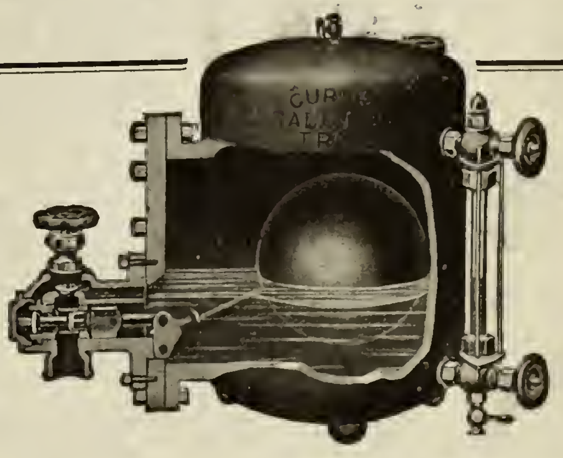
AND A SUPPLY of Betson Plastic Fire Brick make the most durable boiler furnace lining, because it is all in one piece, free from cracks, seams, joints, moulded brick and fire clay.
Shipped either mixed ready for use, or dry to mix with water (the cost is the same) from our warehouses in principal cities.
How to obtain Greater Efficiency, more power from the fuel burned, and how to save about 50 per cent. on repair and upkeep costs are told in our booklet. Send for a free copy.

Write for valuable booklet.

Betson Plastic Fire Brick Co., Inc.
P.O. Box 386-6, ROME, N.Y.
Canadian Distributors:
INTERNATIONAL CHEMICAL CO.,
26-8 Adelaide St. E., Toronto, Ont., Can.

BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

Send for descriptive circular of this trap.

Sole Distributors for Canada:
DARLING BROS., 120 Prince Street, Montreal, P. Q.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.

PACKING, AMMONIA, STEAM AND WATER

Beveridge Suppy Co., Montreal
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Bolco Supply Ltd., Toronto.

PACKING, OIL

Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS

Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Kirby & Co., Toronto, Ont.

PAINTS

Shell Bar Bolco Supply Ltd., Toronto, Ont.

PIPE COILS

Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER

Armatrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED

Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS

Crane's Limited, Montreal.

PIPING AND FITTINGS

Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont

PIPING, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUMBING SUPPLIES

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS

Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

POWER PUMPS (OIL, GASOLINE)

Pratt & Cady, Hartford, Conn

PRESSURE REGULATORS

C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES

C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC

Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES

C. A. Dunham Co., Ltd., Toronto
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL

D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH

Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Mon'real.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID

Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX

The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE

Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL

Albany Pump Co., Toronto, Ont,
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY

Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO

Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal,
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX

Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING

Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL

Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS

Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS

Crane's, Limited, Montreal

RADIATOR TRAPS

C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS

Jas. Morrison Brasa Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES

C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS

Shell Bar Bolco Supply Ltd., Toronto.

REBOILERS

Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECORDING INSTRUMENTS

Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2

Sarco Company, Inc., New York.

REFRACTORY MATERIALS

Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
Refrigerating Engineers, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.
Wilson & Sons, J. L., Toronto, Ont

REGULATORS, TEMPERATURE

Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER

Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE

Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co. Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto. Ont.

REFRIGERATING PIPE COILS

The Superheater Co., Ltd., Montreal.

REGULATING VALVES

H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS

Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING

Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES

Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER

Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)

Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY

Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS

Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM

V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co. Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS

W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE

C A Dunham, Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT CLEANERS

Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET

Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS

Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

SPUR WHEELS

Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt,

STEAM, AIR AND ELECTRIC HOISTS

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM TRAPS

Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS

Smart-Turner Machine Co., Hamilton.

STEEL DRUMS

Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL

Can. Fairbanks-Morse Co., Ltd., Montreal.

STRAINERS

Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK

Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES

Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS

Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF

Waterous Engine Works, Co., Brantford.

TANKS, BRINE

Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE

Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING

Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa
Wilson & Sons, J. L., Toronto, Ont.

TANKS, GASOLINE

Imperial Oil, Ltd., Toronto.

TANKS, OIL

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharinea, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co. Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada

TRANSFORMERS

Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES

Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING

Grant E, Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.
Kirby & Co., Toronto, Ont.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER

Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES

Babcock & Wilcox, Ltd., Montreal,
Can. Fairbanks-Morse Co., Montreal.
Edward Valve & Mfg. Co., East Chicago, Ind.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lytle Engineering Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont
Reading Steel Casting Co., Hartford, Conn.
Shell Bar Bolco Supply, Ld., Toronto.
Valve Engineering Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Underfeed Stoker Co., Toronto, Ont.
Wilson & Sons, J. L., Toronto, Ont.

WALKWAYS, (Irving Subway)

Irving Iron Works Co., Long Island City, N. Y.

The LOGIC of INSULATION

¶ The idea of insulating heat is a relatively new one. It was only a few short years ago that the practice of insulating heated surfaces began to be recognized as a thing worth while.

¶ And yet the theory of insulation is based on a simple fact which has been recognized by man as far back as his cave dwelling days; namely, that to conserve heat it pays to cover heated surfaces with a "blanket" or protection of some kind. This realization prompted the first wearing of clothing.

¶ That is the reason why today we put on heavy clothing and storm overcoats in winter weather—to conserve our body heat and energy.

¶ The heat generated in a boiler or furnace or kiln is as susceptible to atmospheric conditions as our own human bodies. A protecting "blanket" of insulation over the surface (or installed within the walls) of such equipment as boilers, furnaces, kilns, ovens, etc., serves directly as a guard against heat loss through the walls and tops.

¶ Sil-O-Cel Heat Insulation is furnished as Brick, Block, Powder and Cement, and is readily adapted for the insulation of any type or shape of equipment.

¶ The cost of insulation with Sil-O-Cel is generally paid for in fuel saving alone within six to twelve months of operation, and these savings continue each year through the life of the equipment.

Bulletins containing complete information gladly sent upon request.

CELITE PRODUCTS LIMITED

New Birks Bldg., Montreal, Que.

Established 1907 **POWER HOUSE** Member A.B.C.

B. G. NEWTON, Manager
S. S. MOORE, Advertising Manager

CANADA—**Toronto** (head office): 153 University Ave., Tel. Ad. 5740. **Montreal**: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. **Winnipeg**: 810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—**New York**: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. **Chicago**: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. **Boston**: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—**London**: The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A
Anderson Co., V. D. 47
Armstrong Cork and Insulation Co., Ltd. 11
Audel Co., Theo 45
American Steam Pump Co. 8
B
Betson & Wilcox 43
Betson Plastic Fire Brick Co. 53
Bristol Co., The 9
Buyers' Directory 50, 52, 54
Bird-Archer Co., The 9
Beveridge Supply Co. 51
C
Can. Fairbanks-Morse Co. 6
Can. Ingersoll-Rand Co. 13
Celite Products 55
Classified Adv. Section 45
Conveyors Corp. of America 48
Counerty, T. J. 48
Crane Packing Co. 51
Can. Sirocco Co. 47
Carhartt Co., Hamilton 49
Crane, Ltd. 15
D
DeLaval Steam Turbine Co. 12
DeLaval Co., Ltd., The 47
Dart Union Co., Ltd., The 8
D'Este Co., Julian 53
Diamond Specialty, Ltd. 5
Durabla Mfg. Co. 6
E
Elk Fire Brick Co. 49
Engineering & Machine Works of Canada ....Inside Front Cover
Edward Valve Mfg. Co. 45
F
Foxboro Co. ....Inside Back Cover
Flexible Metallic Packing Co... 51
Frick Company 10
G
Garlock Packing Co. 2
Garth Co., The 48
Goldie & McCulloch Co. 20
Greene, Tweed & Co. 4
Gutta Percha & Rubber, Ltd. . 7
Green & Sons, Ltd., E. 12
H
Hints to Buyers 48
Hepburn, John T. Co. 51
Hays Co., Jas. W. 49
J
Jardine, A. B. 49
Jenkins Bros. 17
Jointless Firebrick Co. 8
K
Kerr Engine Co. 18
L
Laurie Engine Co. 49
Laurie & Lamb 19
Lytle Engineering Co., Ltd. 53
Laughlin's Products, Ltd. 45
M
Mueller Mfg. Co. 16
McLaren, D. K. Co. ....Front Cover
McGowan Co., John H. 52
Magnolia Metal Co. 56
Moncrieff Ltd., John 49
Morrison Brass Mfg. Co., Jas. Outside Back Cover
N
Northern Crane Works 49
P
Pilley Packing & Flue Brush Mfg. 48
Pratt & Cady Co. 18
R
Reading Steel Casting Co. 18
Refrigeration Dept. 10
Refinite Co. of Canada 48
S
Schaeffer & Budenberg Mfg. Company 11
Smooth-On Mfg. Co. 53
Superheater Co. 45
Sturtevant & Co., Ltd., B. F... 49
Shell Bar Boico Co. 49
Sterne & Sons, G. F. 47
Stephen Chemical Co. 56
Smart-Turner Machine Co., Ltd. 5
T
Taylor Instrument Co. 18
U
Underfeed Stoker Co. of Canada, The 3
V
Vilter Mfg. Co. 10
Valve Engineering Co. 53
W
Wall, W. J. 49
Waterous Engine Works Co. 1
Watson, M. Barry 45
Watson & McDaniel Co. 48
Y
Yarnall-Waring Co. 19
York Mfg. Co. 45

MAGNOLIA

Magnolia Anti-friction Metal is the choice of thousands of engineers and machinists because it is always uniform in composition, dependable in service, melts and pours well, is widely adaptable, and assures cool running, efficient and economical bearings. Government tests prove it to have the lowest frictional coefficient of any known bearing metal. Write for test data

MAGNOLIA METAL COMPANY of CANADA Limited
37-39 SHANNON ST., MONTREAL, P. Q.
Magnolia Factories also at London, New York, Chicago, San Francisco

TRADE MARK

ANTI-FRICTION METAL

Stephen's Boiler Feedwater Treatment

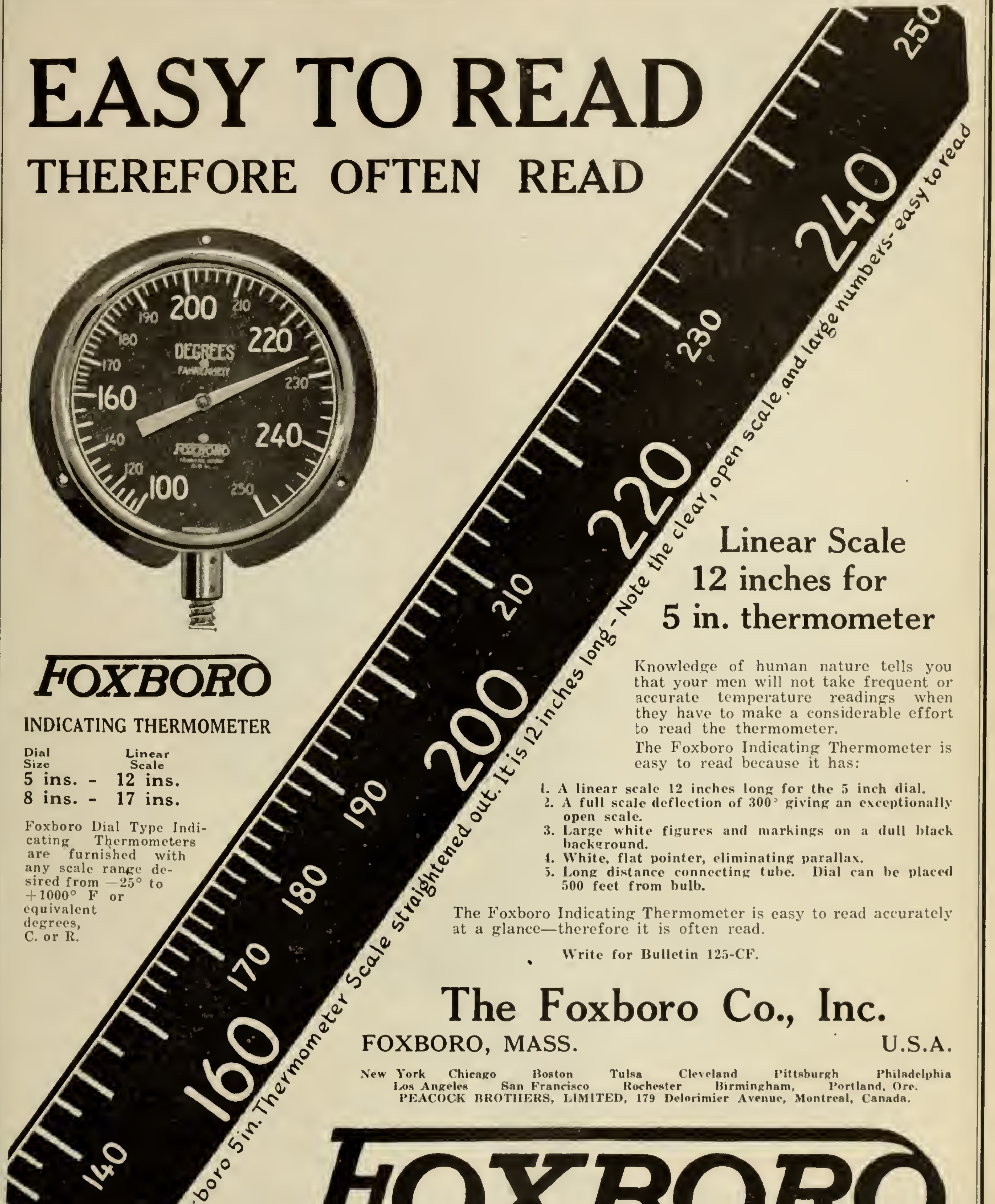
Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you.

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

EASY TO READ

THEREFORE OFTEN READ



Here is the Foxboro 5 in. Thermometer Scale straightened out. It is 12 inches long - Note the clear, open scale and large numbers - easy to read

FOXBORO

INDICATING THERMOMETER

Dial Size	Linear Scale
5 ins. -	12 ins.
8 ins. -	17 ins.

Foxboro Dial Type Indicating Thermometers are furnished with any scale range desired from −25° to +1000° F or equivalent degrees, C. or R.

Linear Scale 12 inches for 5 in. thermometer

Knowledge of human nature tells you that your men will not take frequent or accurate temperature readings when they have to make a considerable effort to read the thermometer.

The Foxboro Indicating Thermometer is easy to read because it has:

1. A linear scale 12 inches long for the 5 inch dial.
2. A full scale deflection of 300° giving an exceptionally open scale.
3. Large white figures and markings on a dull black background.
4. White, flat pointer, eliminating parallax.
5. Long distance connecting tube. Dial can be placed 500 feet from bulb.

The Foxboro Indicating Thermometer is easy to read accurately at a glance—therefore it is often read.

Write for Bulletin 125-CF.

The Foxboro Co., Inc.

FOXBORO, MASS. U.S.A.

New York Chicago Boston Tulsa Cleveland Pittsburgh Philadelphia
Los Angeles San Francisco Rochester Birmingham, Portland, Ore.
PEACOCK BROTHERS, LIMITED, 179 Delorimier Avenue, Montreal, Canada.

FOXBORO

REG. U. S. PAT. OFF.

THE COMPASS OF INDUSTRY

5493

MORRISON

Pressure Reducing Valves

Dependable Pressure Regulation

MAINTAINING correct reduced pressure on steam, air and gas lines is too important to be entrusted to valves of untried reputation.

More than 50 years of engineering experience is back of the Morrison Reducing Valve design.

Morrison Reducing Valves are furnished in all sizes with bronze or iron bodies for all ranges of pressure up to 300 lbs.

"Every Installation is a Demonstration of Merit."

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Fostering Economy in the Development of Power for All Industries

Vol. XXVI—No. 16
Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.
August 20, 1923

Jenkins Automatic Equalizing Stop and Check Valves

Extra Heavy Iron Body Globe or Angle Patterns

These valves are designed to provide a wide margin of safety, being perfectly adapted to withstand the strains of high steam pressure and expansion and contraction of piping.

Each valve is tested to 800 pounds hydraulic pressure and guaranteed for working steam pressure up to 250 pounds.

If a tube should burst or other internal rupture should occur, valves will automatically shut off steam from the header to boiler.

Bodies and bonnets are made of high grade cast iron, spindles of manganese bronze—other mountings of best hard steam metal.

Detailed description will be found on page 85 of Jenkins Catalog No. 9—free on request.

Fig. 553.
Angle, Flanged.

Fig. 551.
Globe, Flanged.

JENKINS BROS., LIMITED
Head Office and Works: 103 ST. REMI ST., MONTREAL
Sales Offices: Toronto, Vancouver.
European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, England.
Factories: Montreal, Bridgeport, Elizabeth.

Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

15 cents a Copy
$2.00 a year

STEAM POWER PLANT EQUIPMENT

COMBUSTION ENGINEERING CORPORATION LIMITED

JUST ISSUED!

A Condensed Catalogue Covering Products Offered by This Organization

Interesting and Informative Descriptions of:

- TYPE E STOKERS
- COXE STOKERS
- TYPE K STOKERS
- NEW FREDERICK STOKERS
- SELF CONTAINED STOKERS
- CUSTODIS CHIMNEYS
- ARROW ASH HOPPERS AND ASH GATES
- DETRICK FLAT SUSPENDED ARCHES
- UEHLING CO_2 RECORDERS
- GREEN CHAIN GRATE STOKERS
- LOPULCO PULVERIZED FUEL SYSTEMS
- QUINN OIL BURNING EQUIPMENT
- GREEN CAST-IRON HOPPERS
- COMBUSCO WATER SEAL CONVEYOR

It will pay you to have this information available.

Combustion Engineering Corporation
LIMITED

A. J. T. TAYLOR
President

Main Office:
TORONTO

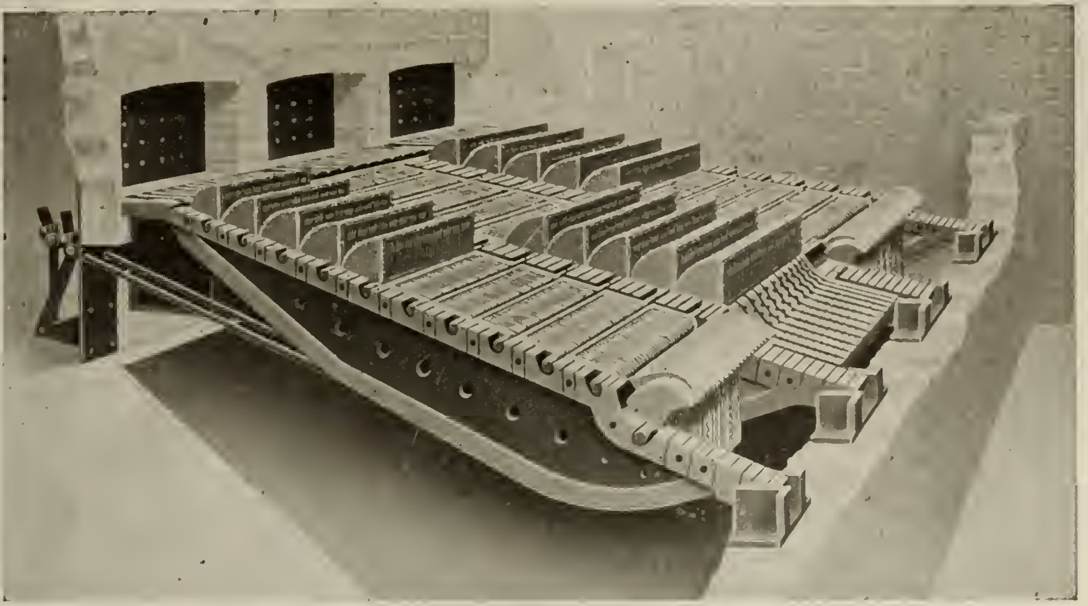
JOHN T. FARMER
Chief Engineer

MONTREAL

WINNIPEG

VANCOUVER

"Everything in the Boiler Room Except the Boilers"



THE FILES STOKER

Pays for Itself in One Year

Below is a copy of one of the many letters we have received, telling of the efficiency and economy of the Files Hand-Operated Stoker

Re FILES HAND STOKERS

Gentlemen:—

Frequently we receive letters from manufacturers, asking for information and our experience with the "Files Hand Stokers"—the most economical and efficient system of burning coal with the utmost conservation of labor.

As these inquiries are becoming more and more frequent, our better plan will be to furnish you with a letter to pass on, outlining our experience and satisfaction.

In September, 1920, we placed an order with you for two 150 H.P. Tubular Boilers, specifying our desire to have them equipped with "Files Hand Stokers." This we did on the recommendation of our United States Engineering Department, who had installed "Files Hand Stokers" in some seventeen plants, finding in them a decided saving and advantage over flat or shaking grates.

Speaking for ourselves, we have found them most satisfactory and economical, particularly so in regard to the elimination of smoke, rapid disposal of ash and clinker, thorough cleaning of fires without disturbing the active fire, and in maintaining an even bed of fuel.

We are able to keep a clean fire at all times, we have no cleaning period, for with the "Files Hand Stoker" the grate can be cleaned at peak load. It is only a matter of working one rod on each section, which can be done in less than two minutes.

The better the coal the better the result, but almost any kind of coal that will burn free can be used. With good coal, however, it is an easy matter to procure 150% boiler rating, which in reality is 12½ lbs. evaporation per pound of coal. Generally speaking, evaporation is around 7 or 8 lbs., and often as low as 5 or 6 lbs.

Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel.

And what we have done and are doing with them others can do.

We know they effect a saving; we know they are a convenience; they have proved satisfactory in every particular, and we have no hesitation in recommending them.

Yours very truly,
THE MERIDEN BRITANNIA CO., LIMITED.

Why not Profit by others' Experience?

Waterous

BRANTFORD, ONTARIO, CANADA

*5 Retort RILEY STOKERS installed under 487 H. P., G. & McC. boilers.
Smith, Hinchman & Grylls, Consulting Engineers, Detroit.*

More Steam at Lower Operating Cost

THE PROBLEM.

At the plant of Hiram Walker & Sons, Ltd., Walkerville, Ontario, more steam was required. Their boiler room contained 10—125 H.P. boilers. These boilers were economically fired but the plant layout in general was inefficient.

THE SOLUTION.

They replaced these *10* boilers with *3* of 487 H. P., fired by Riley Stokers which now gives them ample steam capacity. Although the normal boiler H.P. is increased but little the *actual* capacity is about three times greater because the Riley Stokers will operate the boilers up to 250% of rating or more. *When the above picture was taken two of the boilers were making 200% of rating.*

THE RESULT.

Greatly increased capacity with a *reduction in operating expenses.* The improved power plant layout with automatic coal and ash handling equipment and Riley stokered boilers has made possible a reduction in labor from 8 men to 2 men per shift. This saving in labor alone amounts to nearly $100 per day.

Find out what the Riley can do for you. Ask for the catalog.

RILEY JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

The Under-Feed Stoker Co., of Canada, Ltd.
146 King Street, Toronto

"Jones" Stokers, "Riley" Stokers, "Murphy" Furnaces

Alta. & West. Sask.:
Mr. J. Twomey,
Camrose, Alta.

Man. and East. Sask.:
W. W. Hicks & Co.,
Winnipeg.

British Columbia:
E. A. Earle, Limited,
Vancouver B.C.

Quebec:
The Cleaton Co., (Canada), Ltd.
Montreal, Que.

"To economize, Cochranize"

The Cochrane Hot Process Water Softener

Saves Time, Money & Labor—Let Us Show You

A Satisfied Customer—Our Greatest Asset.

Shortly after installing a Cochrane Softener, a pulp and paper company wrote us as follows:

"Your letter re water softening plant received some days ago and must say the plant is working O.K. It is keeping the clean boilers clean and cleaning the dirty ones.

Six months later a second letter was received, as follows:

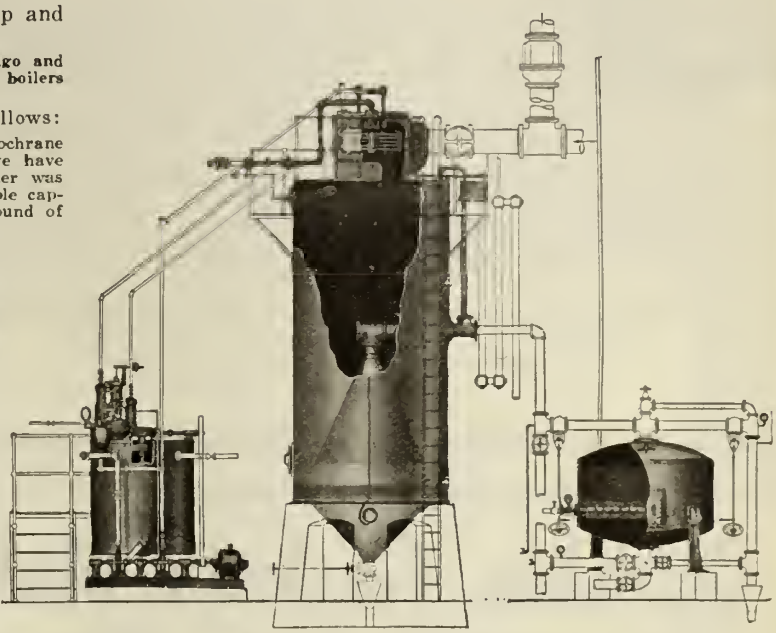
"On August 9th, 1921, we started up the 18,000 G.P.H. Cochrane Hot-Process Water Softener in our boiler room, and while we have no exact data as to our performance before this water softener was installed, I can state that it has added materially to our possible capacity in B.H.P. and has also increased the evaporation per pound of coal.

"We can now operate our boilers at a continuous rating of 200 per cent. for six months without cleaning, and at the end of that time when a boiler is opened, we find only a small amount of sludge, which can readily be washed out with water, whereas, with raw water, at the end of six months we used to get 3000 lbs. of scale from a boiler, taking two men three weeks, working 9 hours per day to clean.

"Since installing this water softener we have not had to put in any new tubes. We have no deposits in the feed lines and the feed water leaving the filter is always crystal clear; but, as a matter of fact, we never did have deposits in feed lines, as our raw water is clear but hard. For the six months that we have used treated water we have not noticed any deposits in steam lines and do not anticipate any.

"The attention required by this plant takes about one hour in the morning and one hour in the evening of one man's time, and we have not increased our staff to take care of the apparatus.

"The great benefit we derive from this plant is clean boilers all the time. Before installing this water softener we always had one or two boilers down for new tubes or cleaning. The cleaning was a long, hard job, as the scale was very hard. Now we can operate all our boilers all the time, if necessary, as far as the cleaning is concerned."



Cochrane Hot Process Water Softener, complete with Chemical Reagent Tank, Flow Proportioner and Sand Filter.

CANADIAN ALLIS-CHALMERS PRODUCTS

- Hydraulic Turbines
- Centrifugal and Steam Pumps
- Steam Power Plant Equipment
- Mining Machinery
- Crushing and Cement Machinery
- Flour and Saw Mill Machinery

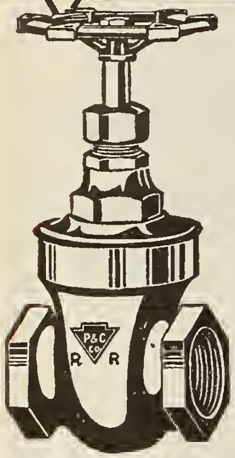
CANADIAN ALLIS-CHALMERS LIMITED

Head Office—KING AND SIMCOE STREETS, TORONTO

BRANCH OFFICES: HALIFAX, SYDNEY, ST. JOHN, MONTREAL
QUEBEC, OTTAWA, HAMILTON, LONDON, WINDSOR, COBALT, SOUTH PORCUPINE
WINNIPEG, CALGARY, EDMONTON, VANCOUVER, NELSON AND VICTORIA

Write for Bulletin 933
Yours for the Asking

PRATT & CADY VALVES



Every part of these valves is easily renewable without removing valve from pipe line.

No Chance of Leakage with Pratt & Cady Bronze Gate Valves

with renewable seat-rings

Pratt & Cady Bronze Gate Valves are the ideal valves for steam, water, air and gas lines. They have two chances of being tight where any Globe Valve has one chance.

All seat rings are independent rings of bronze, or any special metal or material best adapted to the service for which the valve is to be used. They can be easily renewed. The gate is a double-faced, wedge-shaped casting with side grooves by means of which it slides on guides in the valve body.

Great pains are taken in the machining of all parts of these valves to insure their accuracy and interchangeability. The wedge can be taken out of the valve and replaced with the opposite faces in contact, and will fit accurately. Being double-seated these valves can be used with the pressure applied at either end.

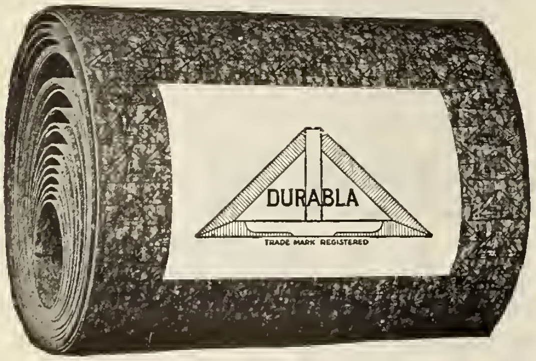
Write for Price List and Full Particulars

The Canadian FAIRBANKS-MORSE Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg,
Regina, Calgary, Vancouver, Victoria.

60

Durabla Gaskets Make Tight Joints



Withstanding all Temperatures and Pressures

Wherever a permanent Gasket is required, use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids.

Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla Trade Mark which guarantees strength and quality.

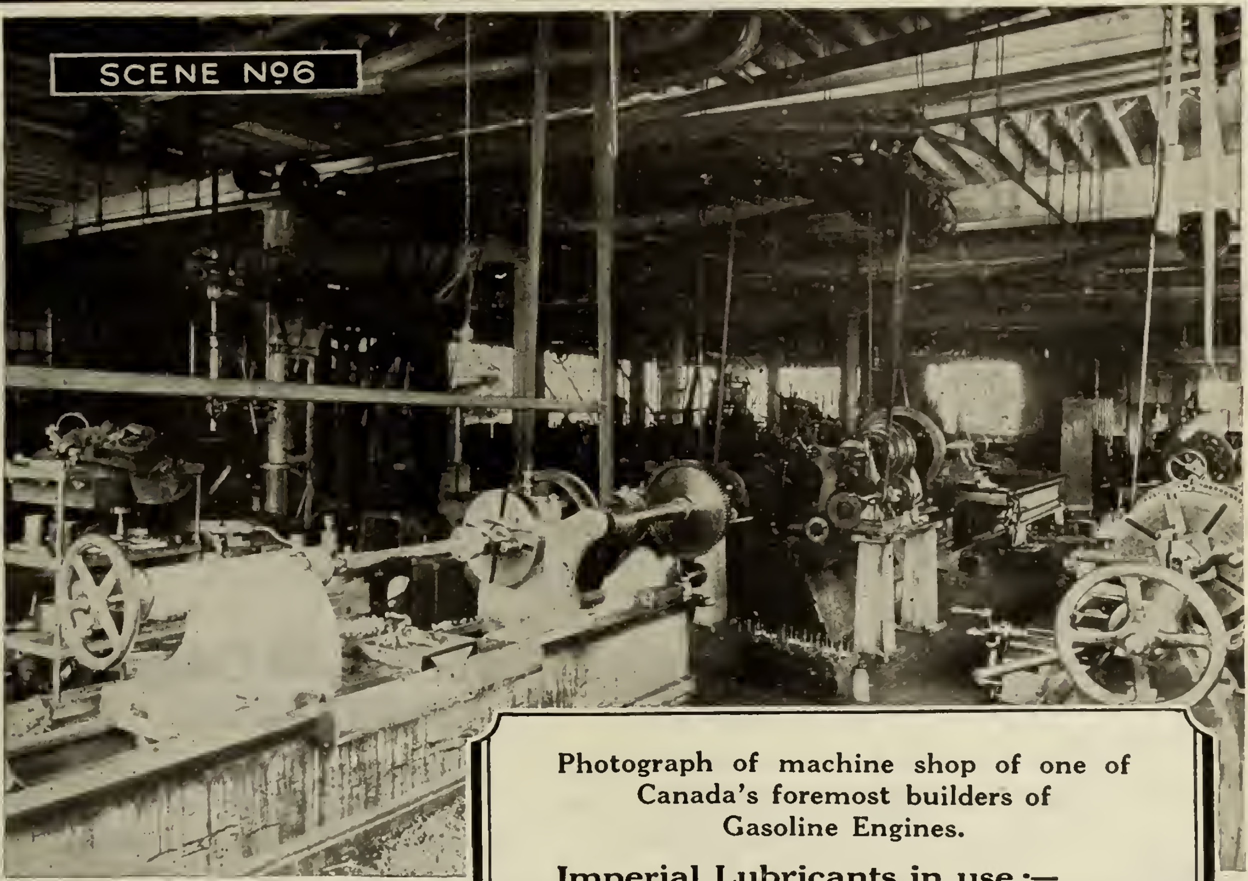
Made in Canada in Stock Sizes 36″ wide x 150″ long, in thicknesses of 1/64, 1/32, 1/16, 1/8″.

Let us send you a trial shipment

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA



Photograph of machine shop of one of Canada's foremost builders of Gasoline Engines.

Imperial Lubricants in use :—

Imperial Renown Oil.
Imperial Capitol Cylinder Oil.
Imperial Atlantic Red Oil.
Imperial Arctic Cup Grease.
Imperial Cutting Compound Antiseptic.
Imperial Polarine Motor Oils.

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

Hundreds of Canadian firms have used Imperial Lubricants exclusively for years. The fact that we manufacture a grade of oil or grease for every lubricating requirement and always maintain the same standard of quality and service, makes it easy and profitable for you to standardize on Imperial Lubricants.

Write our nearest branch for the advice or service of an expert lubrication engineer.

IMPERIAL OIL LIMITED

How Do You Know Instructions Are Being Followed?

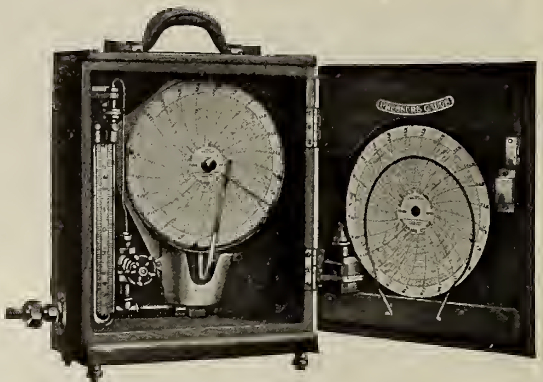
From a study of Bristol's chart records, it has been possible to establish a process that is most resultful. By a continued study of the records of

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

Recording Pressure Gauges

you can tell whether this efficiency is being maintained — whether your instructions are being followed.

The marked simplicity of Bristol's instruments, is the chief reason why our recording gauges operate continuously for years, with little attention and few repairs. Catalog 1006-A is waiting for your request.



The Bristol Company

Waterbury, Conn.

Canadian Distributors:
Eastern Territory—POWERLITE DEVICES, LTD., Toronto and Montreal.
Western Territory—GORMAN'S LTD., Edmonton.

The Livest Firms and Progressive Towns will use

High Powered Gasoline Engines on Centrifugal Pumps, Air Compressors, Shovels, Locomotives and Electric Generators

Sterling
THE ENGINE OF REFINEMENT

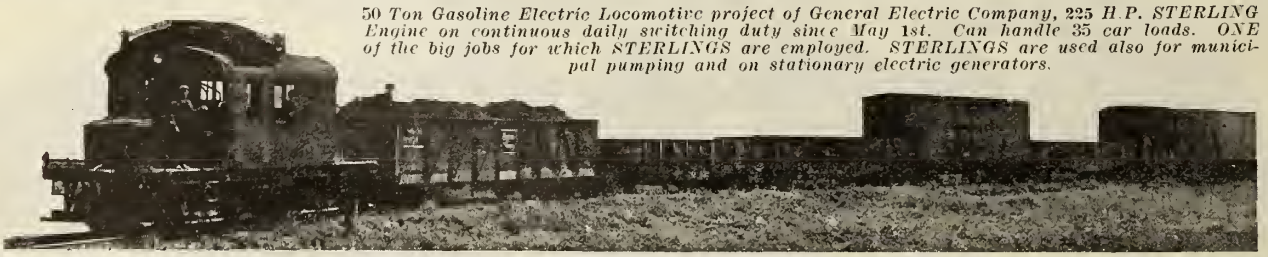
Because—

- They cost less than any other form of power.
- Are cheaper to run than a steam plant, particularly in isolated districts.
- Are easily transported, readily installed.
- Can be run by any intelligent engineer.
- Are built in **large** sizes for big pumps and generators.

The contractor with this equipment carries the smaller investment, can work faster, with less labor, finish the job sooner; underbid the other fellow and handle more jobs at a profit. The city or manufacturer that uses STERLINGS for emergency has an unfailing source of power.

Send for a Catalog.

Sterling Engine Co. (Dept. C4) Buffalo, N.Y., U.S.A.



50 Ton Gasoline Electric Locomotive project of General Electric Company, 225 H.P. STERLING Engine on continuous daily switching duty since May 1st. Can handle 35 car loads. ONE of the big jobs for which STERLINGS are employed. STERLINGS are used also for municipal pumping and on stationary electric generators.

Let the Users Give the Evidence!

Fisher Reducing Valves are exceptionally sensitive and accurate. More than that, they are so simple in principal and honor-built in construction that they continue to give perfect satisfaction when you might expect them to be worn out.

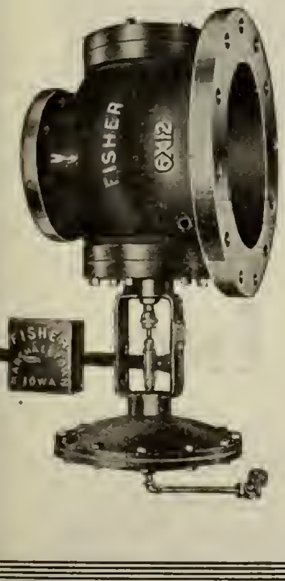
Here are two examples from Canada of the wonderful service they give:

> "Fisher Reducing Valve purchased from you in 1904. We wish to say that this valve is connected to a 4½ x 2¾ x 4 duplex pump, used for pumping pickle. An air pressure of 40 lbs. is used on the diaphragm and the valve will start and stop the pump and maintain a constant pressure within 2 lbs. with very little attention. The valve has been in daily operation since we purchased it and the results we have received have been most satisfactory."
>
> THE INGERSOLL PACKING COMPANY, Ltd.,
> Ingersoll, Ont.

> "Regarding Fisher Reducing Valve purchased from you on Sept. 3rd, 1907. This valve is in use and has given us very good service. We have had to renew the valve and seat a few times, but these repairs were inexpensive. We like the valve on account of its simplicity and reliability."
>
> P. BURNS & CO., Ltd.,
> Calgary, Alberta.

Hundreds of letters like these are in our files. That kind of evidence means something to every buyer of power plant equipment.

Our Bulletin No. 201 gives full information about Fisher Reducing Valves. Let us send it to you.



The Fisher Governor Company

948 Fisher Ave.,
MARSHALLTOWN, IOWA

FISHER
Reducing Valve

(Type 11--A)

It Can't Air-Bind!

When steam is shut off the Steam Trap Sarco opens automatically and stays open until steam is again applied—then the steam forces all the air out and closes the trap until condensation again opens it. No air or water can stay in the trap.

Consequently the Sarco cannot freeze.

Steam Trap Sarco keeps the lines drained at all times. There is no big body of water in the trap to cool the steam and reduce it to liquid.

Has only one moving part. No levers, gauges, stuffing box, etc., to corrode or gum up and stick, and cause the trap to stay open and waste steam.

Can be screwed into pipe line at any angle and takes practically no space. No platform, pit or support needed.

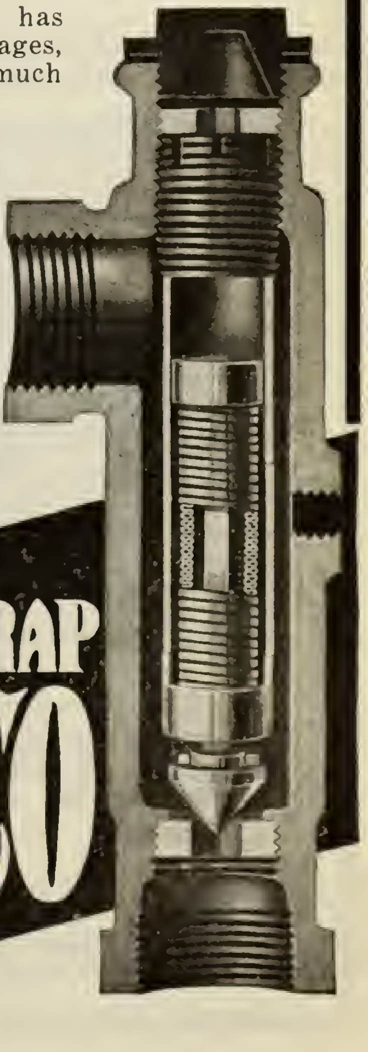
Although the Sarco has many exclusive advantages, it costs but one-third as much as most traps.

Try a Sarco 30 days free.
Booklet J-36 sent
on request

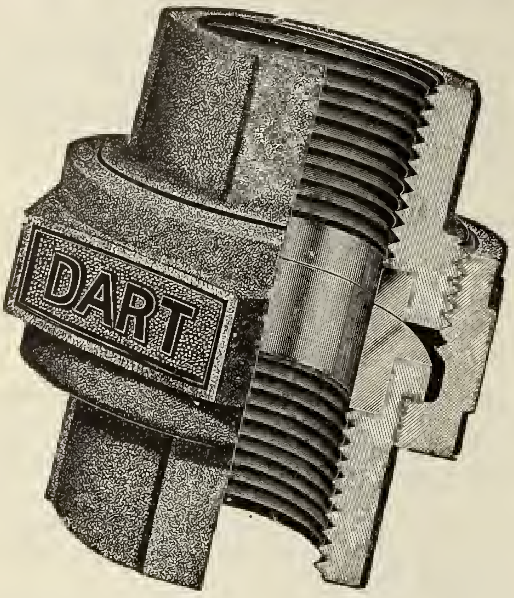
Sarco Co., Inc.

239 Broadway
New York City

Peacock Bros., Limited.
Montreal



STEAM TRAP SARCO



DART UNIONS

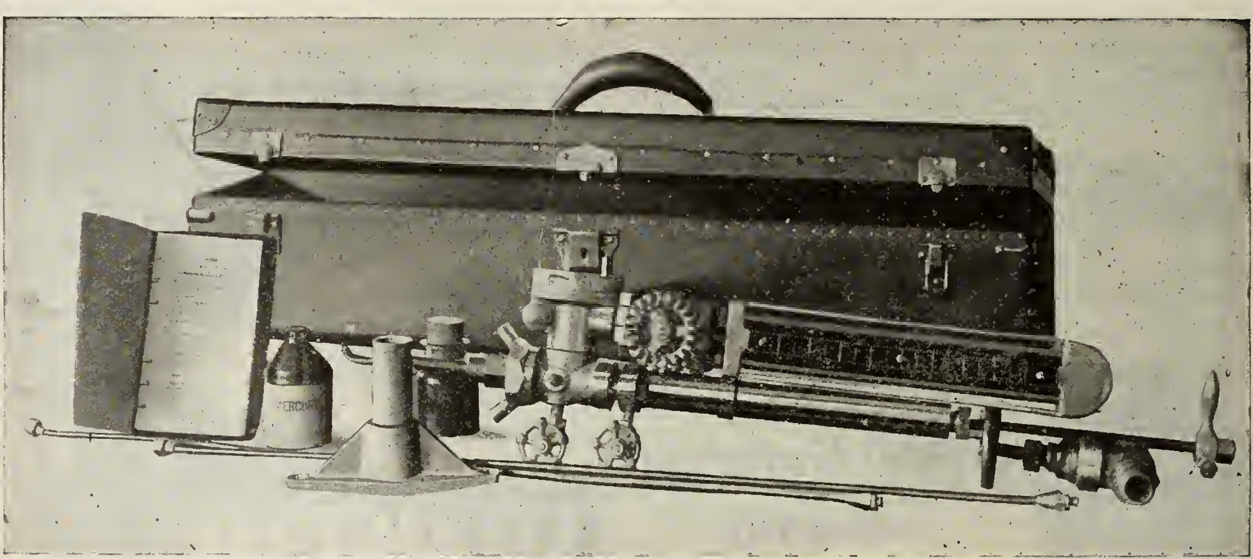
Stay Tight Permanently

No Upkeep Cost
No Replacement Cost
No Loss from Leaks

Because—THEY ARE BRONZE TO BRONZE AT THE JOINT

Your Jobber Sells Them

Manufactured by
DART UNION CO., LIMITED, TORONTO, ONT.



Cory-Royer Flow Indicator
Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

CHAS. CORY & SON INC.

183-7 VARICK STREET - - NEW YORK CITY

VANCOUVER
P. A. Goepel,
525 Pender St. W.

Est. CORY

TORONTO
The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers

What Makes One Door Better Than Another?

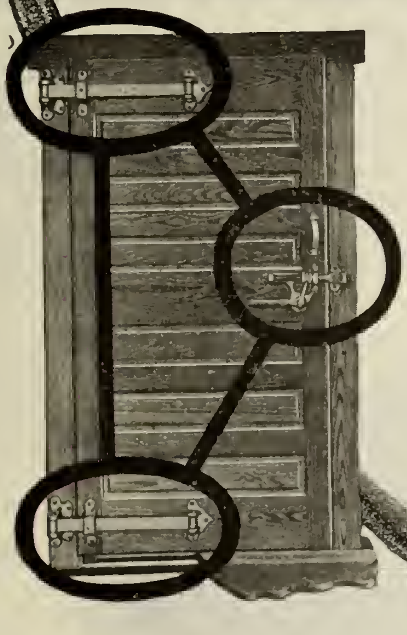
WITH "Your Plant Only as Good as Your Door," it is an equal fact that the door itself is only as good as its **hardware.**

In the **hardware** lies one door's advantage over another! It is on the hardware that the door swings. It is the hardware which is responsible for efficient shutting. The difference in hardware helps to make the difference in doors.

Jamison Cold Storage Doors—sturdily built of heavy materials and properly insulated—are fitted with hardware embodying patented features owned exclusively by us—hardware heavy enough to "carry the load" and complete the job of the door. Hardware that is guaranteed against breakage in line of duty. Hardware that keeps your plant "**in** commission" and **out of repair shops,** with attendant loss of time and money.

BETTER REFRIGERATION
JAMISON
HAGERSTOWN MD. U.S.A.

Adjustable Spring Hinges and Automatic Self-Tightening Fasteners are some of the Jamison "Strong Points."



Both of these "strong points" are exclusively Jamison's. The Adjustable Spring Hinges enable you to keep the door forced tight against the double seals of contact at all times — regardless of shrinking, swelling or wear — through the process of a simple adjustment.

The Self-Tightening Fastener is a massive device of great strength and power that requires but a slam of the door to force it perfectly tight, at the same time exerting constant inward pressure on the door. This Fastener closes the door to stay — it cannot reopen through the force of a slam!

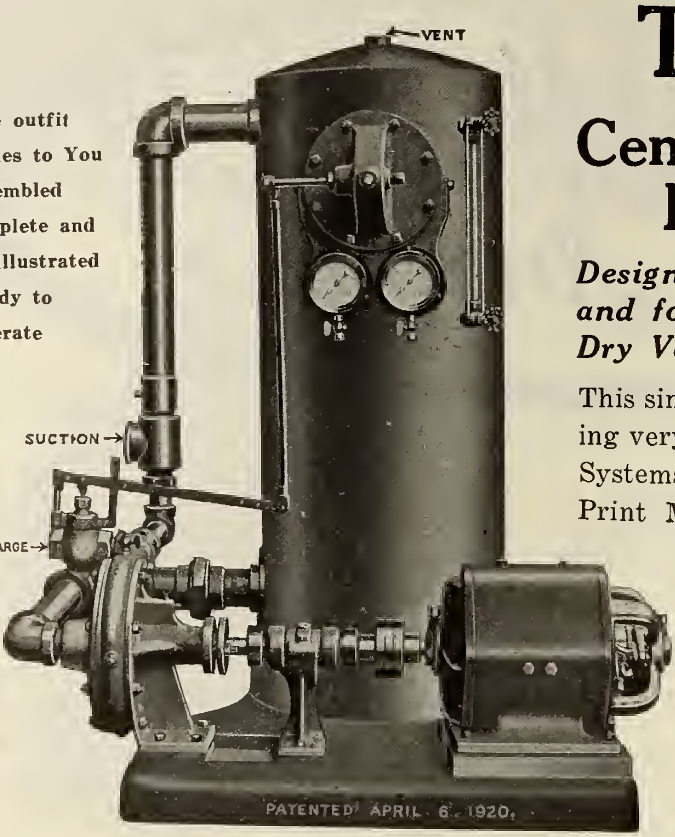
Catalog No. 10 fully describes the various Jamison Patents which give Jamison Products their superiority. You'll find it interesting. Copy will be mailed upon request. Write to "Desk 11," Please.

JAMISON

COLD STORAGE DOOR CO.

Hagerstown, Md., U.S.A.

The outfit
comes to You
assembled
complete and
as illustrated
Ready to
Operate



The YOUNG

Centrifugal Vacuum and Boiler Feed Outfit

Designed for Vacuum Heating Systems and for All Conditions Where a Wet or Dry Vacuum is Desired—Highly Efficient

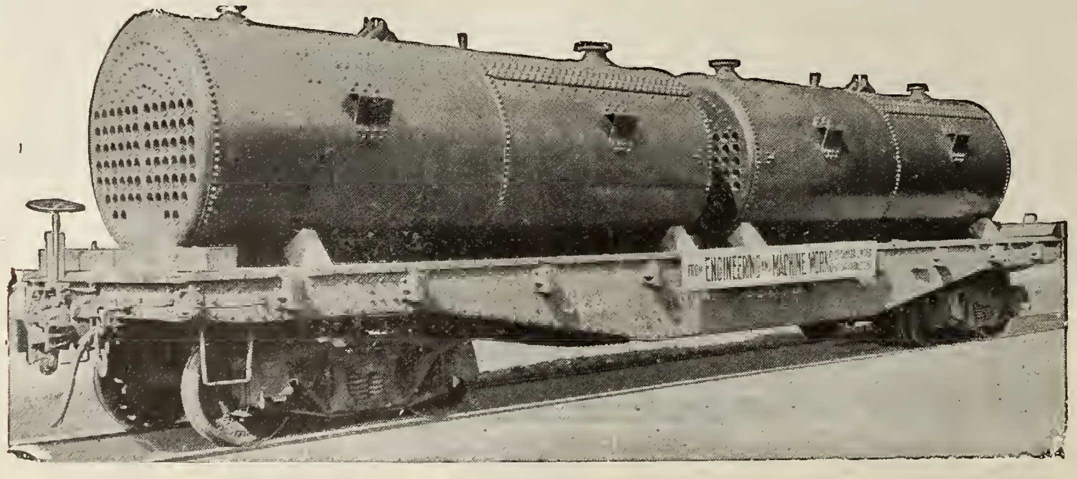
This simple, inexpensive and noiseless outfit is giving very satisfactory results with Vacuum Heating Systems, Dry Kilns, Paper Driers, Feed Driers, Print Mills, Cooking Apparatus, Vacuum Pans, etc., for the purpose of effecting a saving by returning the condensate for boiler feed.

Manufactured in Canada by

Young Pump Co. of Canada
96 Mary Street
HAMILTON, ONT.

Don't Fall Behind Your Competitors

Sometimes you wonder why your competitor's plant seems to run just a little more efficiently than yours—with fewer breakdowns, shut downs and incidentally they seem to get their selling prices below yours a little too often. Just take thought to your Boilers at this point—maybe the trouble is there. Remember, a high-grade, modern economical Boiler—such as we make—can effect steam, water and coal savings (to say nothing of avoiding repair costs) and call for fewer men to stoke and run them, in a way that will surprise and delight you, and make for a smoother running plant all through.

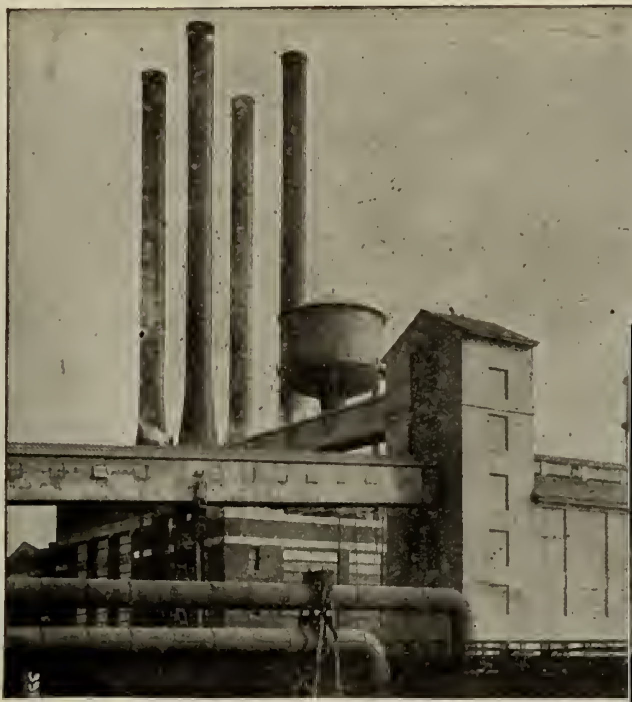


Engineering and Machine Works of Canada, Limited

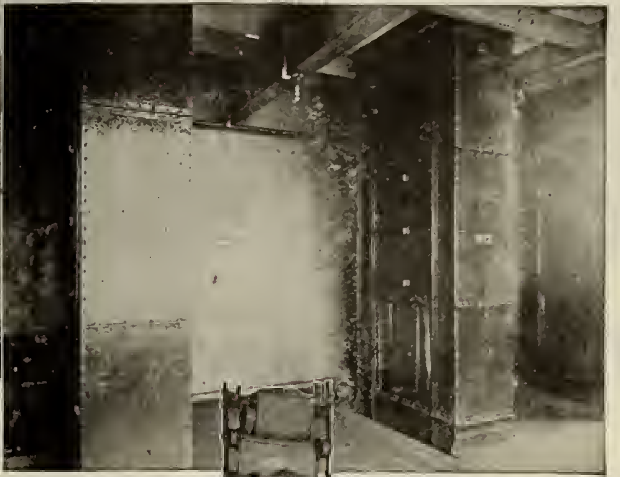
ST. CATHARINES, ONT.

Eastern Sales Offices:
HALL MACHINERY CO., Sherbrooke, Que., Birks Bldg., Montreal

At the Ford River Rouge Plant



A Jeffrey Pivoted Bucket Carrier



THE economy and efficient performance of Jeffrey Conveying Equipment is very evident at the Ford River Rouge Plant.

Here in the pulverizer building, 250 tons of coal per hour are ground into boiler fuel. It is then conveyed through the pulverizer building up to the tower by a Jeffrey Pivoted Bucket Carrier on to the cross conveyors into the boiler room.

In the Ford Plant and in hundreds of industrial power plants Jeffrey Equipments are important factors in lowering the cost of generating power.

Jeffrey Labor—aiding Coal and Ashes Equipments include Track Hoppers, Feeders, Crushers, Conveyors, Elevators, Skip Hoists, Weigh Hoppers, Portable Loaders and Unloaders, Portable Belt Conveyors, etc.

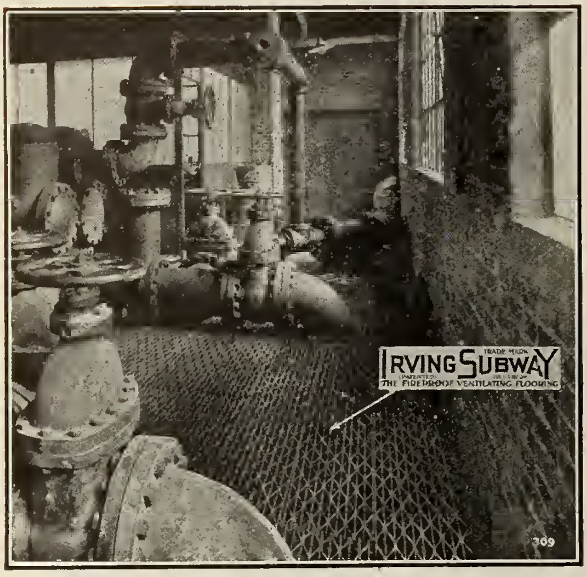
The Jeffrey Manufacturing Company

Canadian Branch and Warerooms: Montreal

JEFFREY

MATERIAL HANDLING MACHINERY

IRVING SUBWAY (PATENTED) TRADE MARK
THE FIREPROOF VENTILATING FLOORING



IRVING SUBWAY TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

A floor of Irving Subway is permanently smooth, yet permanently non-slipping—a paradox hard to be grasped except by those who have had actual "foot experience" with this open steel flooring. There is all the shock-resistance and wear-resistance needed to stand hard service—and yet that comfortable, foot-gripping surface is never lost. Safety and comfort are inbuilt features of this all-steel open flooring—as lasting as the structure of the Irving Subway. Let us send Catalog 3A50.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Canadian Agents:
Montreal, P.Q., 304 Coristine Bldg.
Winnipeg, Man., 141 Bannatyne Ave.
Welland, Ont., Standard Steel Cons. Co.

Manufacturers of

IRVING SAFSTEP TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS

The government-proved bearing metal

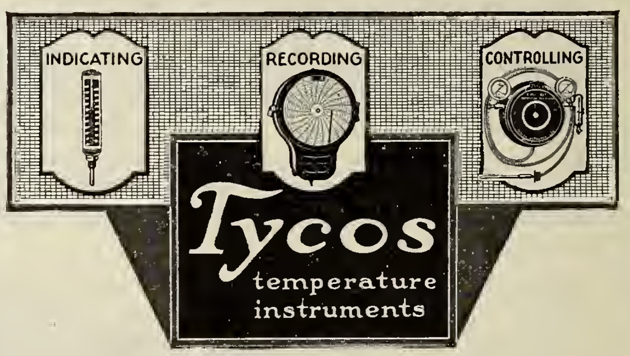
Magnolia Anti-friction Metal has been proven by United States and foreign government tests to have the lowest frictional coefficient of any known bearing metal. This fact alone clearly establishes its superiority to ordinary babbitts.

And there are additional reasons for the wide popularity of Magnolia Metal. It melts and pours well, is easily peened and scraped in, is always uniform in composition, adapts itself quickly to shaft inequalities and gives long and dependably good service.

A single trial will quickly prove the advantages of Magnolia Metal. If your dealer can't supply you, write direct to our nearest office. 20

Magnolia Metal Company
37-39 Shannon St., Montreal, P.Q.
Magnolia Factories also at London, New York, Chicago, San Francisco.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK



Do you expect much from your temperature instrument? If so purchase those capable of giving much. Specify *Tycos* for indicating, recording or controlling temperatures.

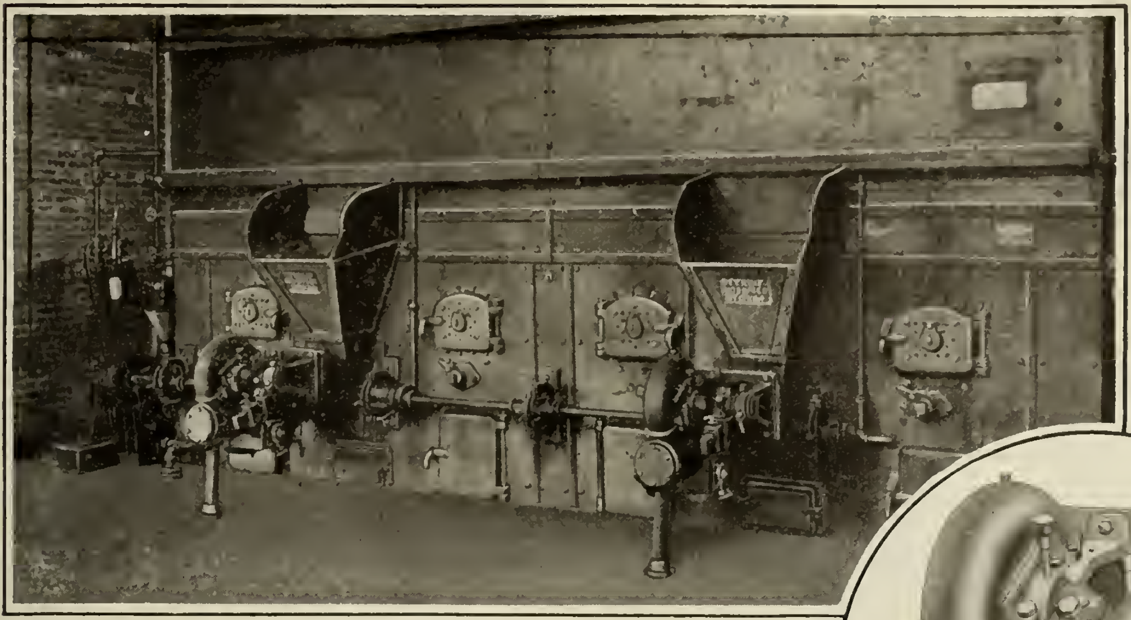
Write for special Power Plant catalog part 1.

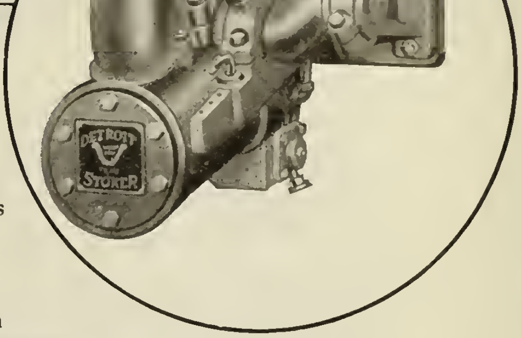
Taylor Instrument Companies
110-112 Church St., Tycos Building, Toronto

There's a *Tycos* or *Taylor* Temperature Instrument for every purpose

SUPERIOR DESIGN and CONSTRUCTION

Detroit Single Retort Underfeed Stokers





Built Heavy for Hard Service and Durability

You will find that the design and construction of Detroit Underfeed Stokers sets new and higher standards in the manufacture of stokers.

For example, note such construction details as:

GEAR CASE: The reduction gears and worms are assembled in an enclosed gear case, with anti-friction roller-bearings, easily accessible, fully enclosed, free from dirt, and running in oil.

REDUCTION GEARING: The design and construction of reduction gearing presents a distinct advance over current stoker practice. The train consists of two sets of heavy worm gear reductions, the smaller being *made of bronze*. Both gears are machined and the worms are cut from drop steel forgings.

ANTI-FRICTION ROLLER-BEARINGS are provided throughout—an exclusive feature. This construction greatly reduces the power required for operation. Large worm is connected to an extra-heavy crucible steel crankshaft. *To get the whole story write for Bulletin 238.*

An Exclusive Feature—

Thrust Roller Bearings are applied to both large and small worm shafts

Detroit Multiple Retort Underfeed Stokers for large boilers, are described in a separate bulletin. Ask for it.

DETROIT STOKER COMPANY

Underfeed Forced Draft and Overfeed Natural Draft Stokers

238 GENERAL MOTORS BUILDING DETROIT, MICHIGAN

DETROIT UNDERFEED STOKERS

"A.B.C." Audited Circulations

---a requirement for membership in the

BUSINESS NEWSPAPERS ASSOCIATION OF CANADA

ONE of the qualifications that the "B.N.A." of Canada demands of its members is that their circulations claims and methods be verified and audited by the Audit Bureau of Circulations—an organization whose stamp of approval is accepted by advertisers in Canada and the United States.

The A.B.C. in its audit sifts the dross from the gold of circulation. Its methods are scrupulous and it classifies those subscribers who have actually paid for the paper.

Bought and paid-for circulation implies reader interest and reader demand—something that can only be built on sound editorial service. All this means that the sterling mark of "B.N.A." not only confirms the correctness and honesty of circulation claims and methods but also indicates high editorial quality.

The publications below are "B.N.A." members and accept and conform to its rigid demands in business and editorial practice.

Members of Business Newspapers Association of Canada:

- Bookseller and Stationer
- Canadian Automotive Trade
- Drygoodsman and Women's Wear
- Canadian Foundryman
- Canadian Grocer
- Canadian Machinery and Manufacturing News
- Canadian Railway and Marine World
- Clothier and Haberdasher
- Construction
- Contract Record
- Dry Goods Review
- Druggists' Weekly
- Financial Post
- Footwear in Canada
- Hardware and Metal
- Marketing and Business Management
- Men's Wear Review
- Motor Trade
- Municipal World
- Power House
- Le Prix Courant
- Printer and Publisher
- Sanitary Engineer
- Western Lumberman

Association Offices - - - - 70 Lombard St., Toronto

Compare the Cost of Upkeep of

D. K. McLAREN'S

Genuine British Oak-Tanned Leather Belting

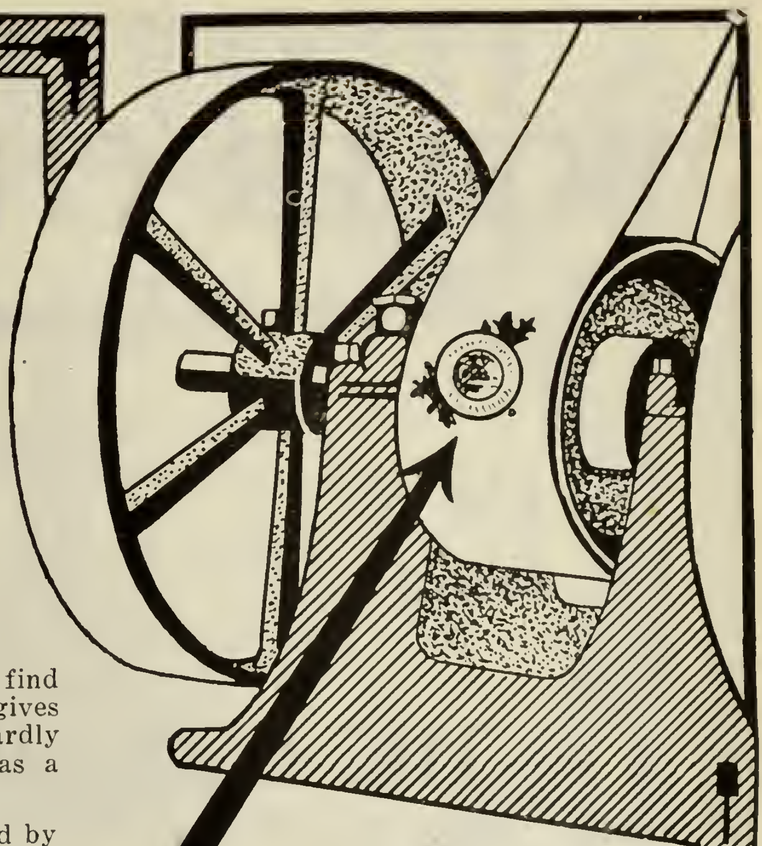
with that of any other make and you will find that D. K. McLaren's Belting not only gives a service that is exceptional—requiring hardly any attention at all—but invariably has a longer life. This is because:

Only the choicest hides, specially selected by experts, are used and, of these, everything but the **tough back portions** is discarded so far as D. K. McLaren's Belting is concerned.

Because every inch is subjected to the Genuine British Oak Tanning Process which has no equal for strengthening the leather and making it flexible.

Because all the stretch is taken out of D. K. McLaren's Belting before it goes into service, so that it maintains a positive grip and can be depended upon to run true at all times.

Ask any user and be convinced



Look for the Oak Leaf

Every length of D. K. McLaren's Leather Belting is stamped with the Oak Leaf. This is your guarantee that you are getting belting that is tanned by the Genuine British Oak Method. It's your guarantee of better service at lower cost.

D·K·McLAREN LIMITED

Head Office and Factory
351 St. James Street, Montreal, P.Q.

BRANCHES
Toronto, Ontario, 194 King Street West,
St. John, N.B., 90 Germain Street.
STOCK DEPOTS
Gorman's, Limited, Calgary and Edmonton, Alberta,
T. M. Grindley Company, 1158 Homer St., Vancouver.

BOILER CHEMICALS

Made in Canada for You

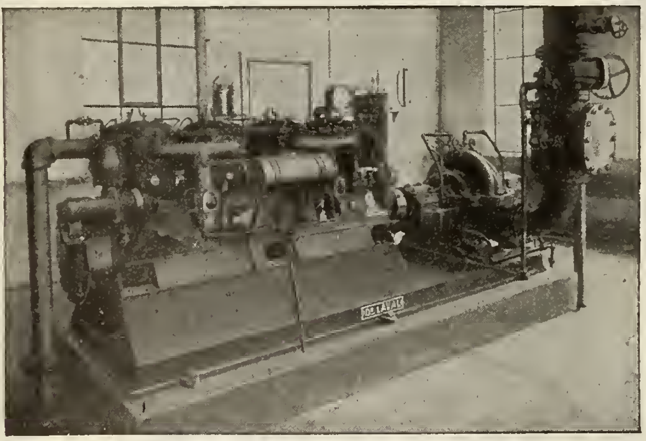
Do it Now

Not a hit-and-miss ready-made compound, but made for you on scientific principles.

Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal **Factory: Cobourg**



One of two DeLaval centrifugal pumps driven by gasoline engines; installed for the City of Pembroke, Ont.; 900 gal. per min. against 349 ft. head at 1,400 r.p.m.

Gasoline Engine Driven Centrifugal Pumps For Water Works Service

THE high thermal efficiency of internal combustion engines, the small amount of attention required in their operation, and the small building space and light foundations required, recommend them as a most economical drive for pumps under certain conditions, particularly for standby or reserve plants.

The photograph shows one of two De Laval units recently installed for the City of Pembroke, Ontario. In this unit, the numerous pump valves, packings, etc., found in reciprocating pumps, are eliminated, so that attention is rarely required. Such parts as are subject to wear are made on an interchangeable limit-gauge basis, and worn parts can be replaced easily by new parts ordered from the factory. The high efficiency of De Laval pumps results in a marked saving of fuel.

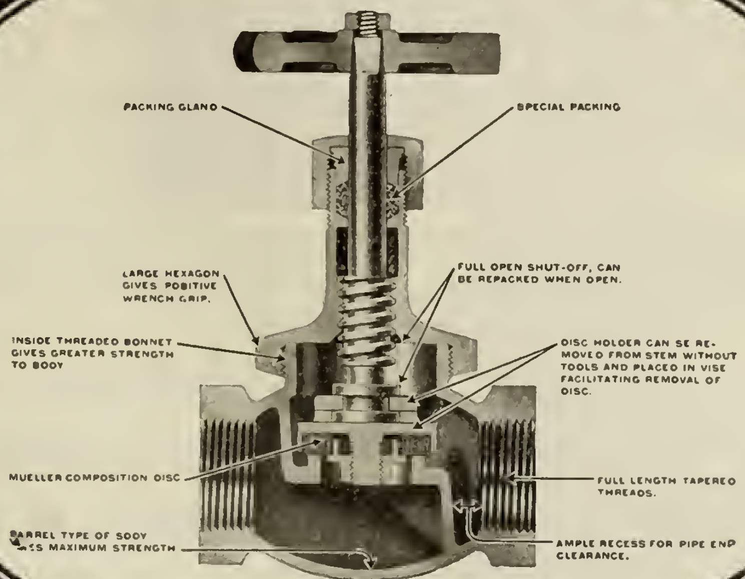
If you will state your pumping requirements fully, our engineers will advise you as to the best type of equipment for your conditions. **Ask for special publication W 100.**

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

Make
Canada
Prosperous
by
Buying
Canadian
Products


PACKING GLAND
SPECIAL PACKING
LARGE HEXAGON GIVES POSITIVE WRENCH GRIP.
FULL OPEN SHUT-OFF, CAN BE REPACKED WHEN OPEN.
INSIDE THREADED BONNET GIVES GREATER STRENGTH TO BODY
DISC HOLDER CAN BE RE-MOVED FROM STEM WITHOUT TOOLS AND PLACED IN VISE FACILITATING REMOVAL OF DISC.
MUELLER COMPOSITION DISC
FULL LENGTH TAPERED THREADS.
BARREL TYPE OF BODY GIVES MAXIMUM STRENGTH
AMPLE RECESS FOR PIPE END CLEARANCE.

VALVES--AND VALVE EFFICIENCY

Maximum Efficiency with Minimum Attention—that's the Service delivered by Mueller Steam Valves.. Meeting the full demands of hard service, we know they will suit your requirements.

A full range of Pressure Reducing and Regulating Valves is also among Mueller Products. Acquaint us with your problems—Mueller Engineering Service is ever at your command.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.
Water, Plumbing and Gas Brass Goods and Tools.
American Factory at Decatur, Ill., U. S. A. **Branches. New York and San Francisco**
Mueller Metals Co., Pt. Huron, Mich., makers of "Red Tip" Brass Rod, Brass and Copper Tubing, Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

© 1917 H MM Co

Why Individual Boiler Feed Water Treatment

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)

Distributors : William C. Wilson & Co., 21 Camden Street, Toronto

Phone Adel. 1054 or write for full particulars.

THE FOUR 72" x 18'-0" H.R.T. OIL BURNING BOILER8 AT THE

ROYAL COLISEUM CANADIAN NATIONAL EXHIBITION

WERE **BRICKED IN** BY US

A. E. RULE Coy.

SPECIALISTS IN SETTINGS FOR H.R.T. AND WATER-TUBE BOILERS

122 GARDEN AVE. **TORONTO**

A MARVEL OF SIMPLICITY

See the Westco Boiler Feed Pump in the Royal Coliseum Boiler House

— and —

Visit our Exhibit in Machinery Hall, North-west Corner

WESTCO MANUFACTURING COMPANY, LIMITED

220 KING ST. W., TORONTO

THE
ROYAL COLISEUM
LIVE STOCK
ARENA

CANADIAN
NATIONAL
EXHIBITION

THE FOUR 150 HORSE POWER H.R.T. BOILERS

IN THIS BUILDING

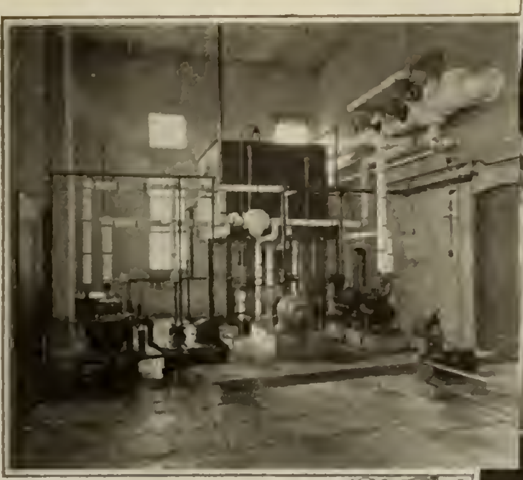
ARE EQUIPPED WITH "CUNERTY" PATENT OIL BURNERS

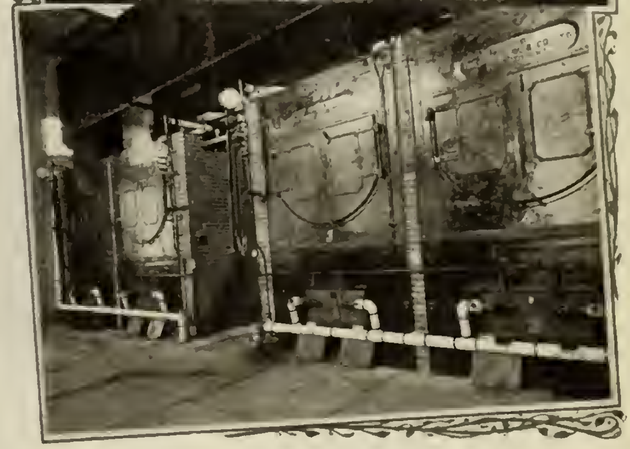
THIS IS ONLY ONE OF MANY PLANTS SIMILARLY EQUIPPED

THE **T. J. CUNERTY** COMPANY

FUEL OIL COMBUSTION ENGINEERS

TORONTO **9 RICHMOND ST. E.** **ONTARIO**





Entire Heating System

OF THE

"Royal Coliseum"

(CANADIAN NATIONAL EXHIBITION)

INSTALLED BY

PURDY MANSELL, Ltd.

Illustrations Show:

(1) Pump Room in Boiler House.

(2) East Annex showing distribution of steam mains for East Side.

(3) Interior of Arena.

(4) Boiler Room showing installation of the four 72″ x 18′ 0″ H.R.T. Boilers.

* * *

HEATING AND POWER PLANTS Designed, Installed or Remodelled to reduce your maintenance cost to a minimum.

Expert Advice Given to All Branches of Plumbing, Heating and Sprinkler Work

Purdy Mansell Limited

63 Albert St., Toronto

G. & McC. Co.
SECTIONAL WATER TUBE
BOILERS

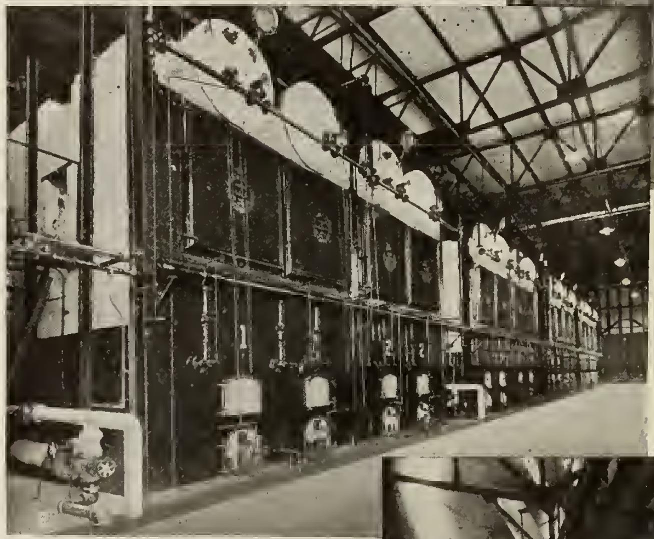
provide efficient service
in three plants of

THE IMPERIAL OIL CO.,

one of Canada's Biggest and Most Important Industries

This is what they say :-

3



No. 1.—Sarnia, Ont.

No. 2.—Dartmouth, N.S.

No. 3.—Regina, Sask.

IMPERIAL OIL, LIMITED
SARNIA, ONT., June 9, 1922.

The Goldie & McCulloch Co., Limited,
Galt, Ontario.

Dear Sirs:

I am in receipt of your letter of the 31st ultimo in reference to your Water Tube Boilers which we have installed at our various Refineries, and wish to advise that during the last five years we have installed at our different Plants the following Goldie & McuCloch Type "B" Sectional Water Tube Boilers:

No.	Rated Capacity	Working Pressure	Year Installed
Refinery at Dartmouth, Nova Scotia:			
4	405 H.P.	200 lbs.	1917
4	405 H.P.	200 lbs.	1919
2	405 H.P. fitted with built in Steam Superheaters.	200 lbs.	1921
Refinery at Sarnia, Ontario:			
4	425 H.P.	200 lbs.	1919
2	425 H.P.	200 lbs.	1920
Refinery at Regina, Saskatchewan:			
2	313 H.P., fitted with built in Steam Superheaters	200 lbs.	1920

As to our experience with these Boilers, I am pleased to advise that same have been very satisfactory. We are able to operate them at very high overloads, exceeding at times for quite long periods 200 to 225 per cent. rating. The refractory materials in the furnaces seem to be the limiting factor as far as capacity is concerned. I believe the above, also the fact that our costs for repairs have been negligible, is good proof that the design, material and workmanship are in every way first-class. We are therefore pleased to go on record in stating that the Boilers in every way have been up to our expectations, and our repeat orders as shown above are without doubt our best evidence in this connection.

Yours very truly,

T. MONTGOMERY, Chief Engineer.

TM/K.

1

G. & McC. Co.

Sectional Water Tube Boilers provide more rapid circulation and increased steaming capacity.

Design, Workmanship, Material,
Everything FIRST CLASS

Our new Catalog No. 40 will be mailed FREE to persons interested.

THE GOLDIE & McCULLOCH CO., LIMITED

HEAD OFFICE AND WORKS: GALT, ONTARIO, CANADA

TORONTO OFFICE:
SUITE 1101-2,
BANK OF HAMILTON BLDG.

WESTERN BRANCH:
248 McDERMOTT AVE.,
WINNIPEG, MAN.

QUEBEC AGENTS:
ROSS & GREIG,
400 ST. JAMES ST.,
MONTREAL, QUE.

BRITISH COLUMBIA AGENTS:
ROBT. HAMILTON & CO.,
VANCOUVER, B.C.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

N. C. SHATFORD
News Editor

Size Up Plant Wastes

TOO many Canadian engineers, especially those in the smaller plants, are overawed by the term "increased efficiency," feeling that it is something mysterious which can only be accomplished by an expert at great expense, or by entirely revamping the existing apparatus.

As a matter of fact, economy merely involves the application of the first principles of engineering, coupled with common sense, for it resolves itself in a nutshell into getting out of the fuel consumed the greatest amount of steam or power possible. While waste is doubtless less in a plant where the operatives take an interest in securing the best results than in a plant loosely run, it is surprising how much either case opens itself to possibilities in the way of savings by a systematic study of conditions. Too often the operating engineer allows himself to become so wrapped up in ordinary routine that he loses his ability to size up the situation as a whole, which is also often the reason why an outside engineer can put into effect all sorts of savings which it is the wonder of the management did not occur to the operating man long ago. Of course, it is fortunately true that striking exceptions to this line of reasoning crop up from time to time, such as the phenomenal savings affected by A. M. Auchterlonie, engineer at the Sick Children's Hospital, Toronto, in the past three or four years.

* * * *

Avoiding Fuel Wastes

MANY engineers, who have studied the principles of combustion, believe that there is much greater waste in the aggregate from chimneys that do not smoke than from those which may be smoking all day long. The most active agent of destruction from chimneys is the sulphur dioxide which eventually, after combination with atmospheric moisture and further oxidation, becomes converted into sulphuric acid.

The comparatively low temperature of the domestic grate is insufficient to prevent sublimation of the sulphur before it reaches the atmosphere, so that most of the sulphur remains in the chimney and an analysis of domestic chimney deposits shows this to be the case.

In the case of the high temperatures associated with industrial chimneys, a much larger proportion of the sulphur finds its way out of the chimney top with correspondingly less deposit in the chimney.

This emission of destructive acid fumes is not dependent primarily upon the amount of smoke given out by chimneys, except so far as the smoke represents unnecessary waste of fuel, but is entirely dependent upon the total amount of fuel burned, wastefully or otherwise. In avoiding smoke, recourse is often made to the use of excess air in unregulated amounts, accompanied by increased consumption of fuel and increased damage to property from the invisible acid sulphur products of combustion.

From long observation and investigation of the subject in question, it can be safely said that fully 80 per cent. of all factory smoke is unnecessary and not in any way essential to the products concerned and that most of the remaining 20 per cent. could be eliminated by additions to the plant equipment and changes in the systems of firing and control.

* * * *

Firemen Not Responsible

WHEN there is a waste of steam anywhere around the plant, why hold the fireman responsible? He has nothing to do with the steam except producing it. Its travel, use and work are entirely beyond his control and usually outside his interest. Neither is he responsible for variations in the loads. He simply has to meet and carry whatever load may come on.

Then, when a carload of indifferent coal is dumped into the bins, why say to him: "Jim, it's hard luck, but here's where your chance to win blows up."

What the fireman should be judged by, all and singular, is strictly the things he is responsible for, whatever his own conduct and work will produce an effect upon, and that alone.

What he is responsible for, and nothing else, is combustion efficiency, because his business is the burning of coal. He is charged solely with the duty of getting the most heat out of his fuel, burning it with the least waste, using the proper thickness of fuel bed and amount of draft, doing his cleaning thoroughly, being efficient in the burning of whatever coal he is supplied with, in the furnace he works with.

It is only the obligation of the plant to give the fireman the best outfit he can, and to maintain it in an efficient condition, for the selfish sake of his own profits.

* * * *

The Universal Verdict

THIS is the day of avoidable wastes. Production costs must be reduced. No matter from what angle one approaches the subject, be it from that of a desire to sell in the markets of the world, that of a need to reduce living costs, or that of a desire to make a greater profit, the answer is that production costs must come down. It is a universal verdict. The result is to be accomplished by better practices and up-to-date equipment.

There must be better designing, better operating practices, better control of material and production processes.

The boiler room is one of the elements and it is a fruitful field to-day in Canada for correct and effective control methods.

* * * *

Take Care in Installation

THE modern power house, designed for economy at the lowest possible first cost, depends on care and accuracy in installation as well as in operation.

A gasket omitted from a vacuum line, rubbish from welding carelessly left in the steam passages of the boiler, or a supposedly flexible steam connection which has been made rigid, may cause needless expense and embarrassment for the engineer at an unexpected time.

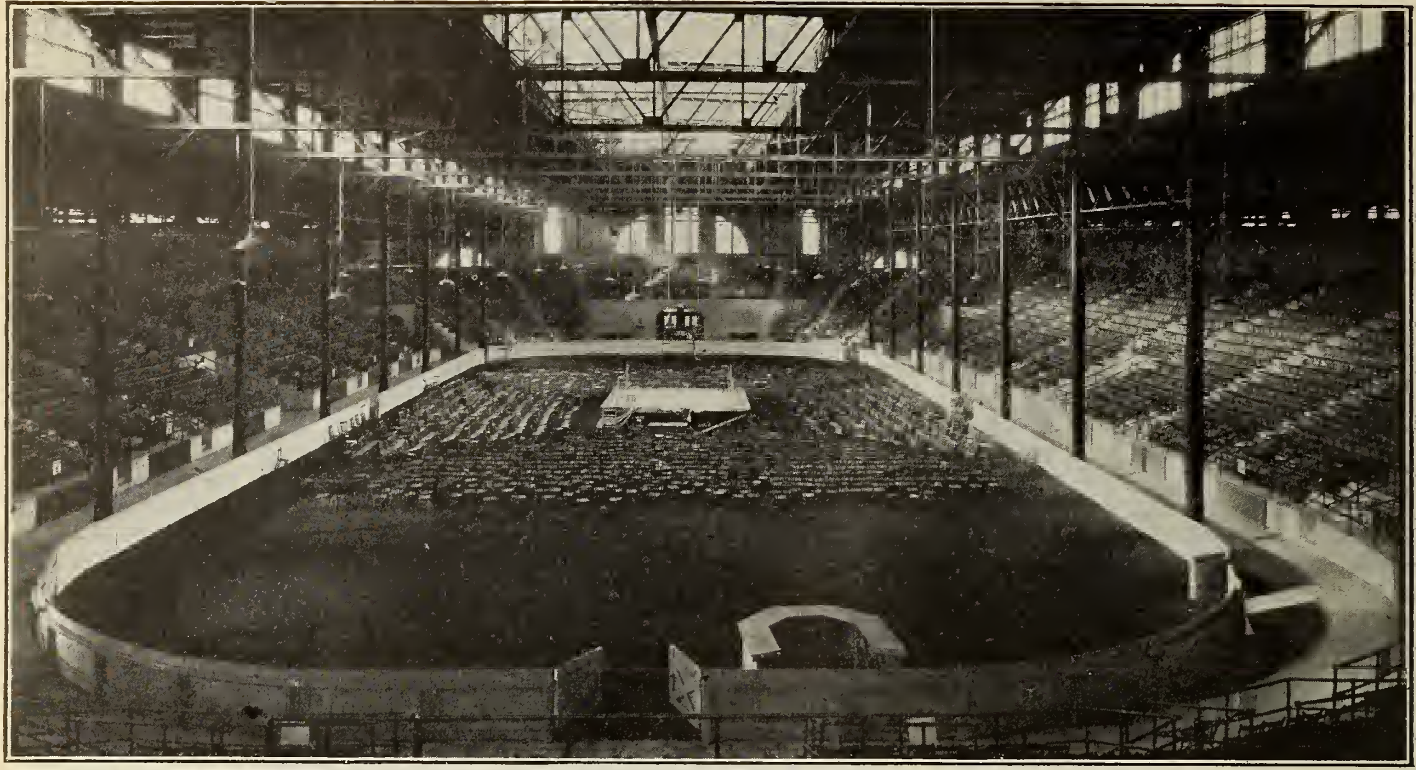


Fig. 2—Interior view of Arena Coliseum, Canadian National Exhibition, Toronto.

Heating Canada's Coliseum With Oil As Fuel

By MELVERN F. THOMAS, M.M.E., Consulting Engineer, 229 College St., Toronto.

A Timely Description of the Problems Peculiar to the Heating of the Huge Arena and Its Annexes on the Eve of the Opening of the Canadian National Exhibition

THE building known as the Coliseum at the Canadian National Exhibition, is 600 feet by 390 feet wide, consisting of a centre section called the Arena, 240 feet by 390 feet, and 54 feet in height on the inside, and the east and west annex buildings, each 180 feet by 338 feet, two stories in height.

The structure is symmetrical about its two main axes, and four towers rising to a height of over 100 feet form the corners of the Arena or centre section.

The walls are constructed of brick, the ground floor of concrete laid on the earth, the terraces for the seats in the Arena and the upper promenade at the rear of reinforced concrete. The second floors of the annex buildings and the entire roof, are constructed of wood supported upon a steel frame.

Figure 1 shows the south front of the Arena and a portion of the annex buildings, and the north elevation has a similar appearance.

Used Throughout Year

The Coliseum is one of the group of buildings in Exhibition Park. It is used throughout the year for many purposes, unlike many of the other buildings which are seldom used except during the Canadian National Exhibition.

In the west annex there is a large, completely equipped kitchen, with dining and lunch rooms, which can be put into service quickly to supply meals to meet any demand.

The large floor areas in the annexes are used each year during Exhibition to house domestic equipment and during the Royal Winter Fair the west section is utilized for similar purposes and for the display of food products, while the east section houses exhibits of birds, fowls, small farm animals and cattle.

Last winter, these sections of the buildings were used for a furniture exhibit, extending over a period of two weeks.

Space for 7,800 Chairs

The arena has an oval, 100 feet wide by 230 feet long, floored with cinders and covered with tan bark. Surrounding this oval, there is a concrete promenade, 12 ft. wide, from which the reinforced concrete terraces rise and furnish space for 7,800 chairs. This section of the building is shown in Figure 2, and has already been used for musical events, grand opera, boxing contests, live stock judging, horse shows, riding and jumping contests and it is proposed to provide at some future time, an artificial ice rink in the oval for hockey games and skating contests.

As the building is intended for service throughout the year, it was necessary to provide artificial heat, and the writer was instructed to design a system which would meet the demand for any of the foregoing services as well as possibly for flower shows. The system also had to be adapted to permit the plant to be closed down during the winter for several weeks, should there be no demand for the building, although at the same time provision had to be made to quickly raise the temperature in one or more sections of the building for an event possibly lasting only one evening.

Used Direct Radiation

The building was completed before the heating plant was designed, and after considerable study of the problem, the writer decided to use direct radiation, divide the building into sections, and install a vacuum steam system arranged so that all of the piping and radiators could be drained clear to the power house.

The quantities entering into the computations for heat losses, were a total volume of 8,000,000 cu. ft., exposed wall surface, 75,000 sq. ft., (13½", 18" and 22½" solid brick without furring), exposed glass in wall, 17,300 sq. ft., single thickness, glass in sky lights, 13,000 sq. ft., single thickness and roof surfaces aggregating 216 000 sq. ft., constructed of wood throughout, covered with roofing felt and the flat surfaces protected by tar and gravel. There is no air space or other insulation to reduce the heat losses from the roof.

Used Temporary System

In the west annex, a heating system consisting of approximately 18,000 sq. ft. of direct radiation and distribution piping had been installed, with a temporary boiler plant, before the system was designed for the old portions of the building. The radiation and piping in this section were not altered, but the temporary boiler plant was removed and new steam mains extended to supply this annex from the new plant.

In the East Annex, 12,000 sq. ft. of direct radiation was installed to replace the heat losses from the exposed wall, glass, sky lights, roof and a small air change, the piping being arranged and valved to control this section of the building in four parts.

This part of the building presented no difficult heating problems, except perhaps estimating the quantity of cold air entering the building, due to infiltration, the opening of doors for stock and constant crowds of people, as well as estimating a surplus heating capacity, necessary to allow the building to be warmed in 4 to 8 hours, after the steam had been off for an extended period.

Problems in Heating

In the centre, or Arena, section of the building, there were several special problems in heating. The large masses of concrete forming the terraces, which are difficult to warm after the heat has been off for several days, the circulation and warming of the large pool of cold air filling the oval, and the difficulty of counteracting the cold current from the roof and sky-light, without placing large coils overhead and inviting a heavy heat loss due to their misuse, as well as the elimination of discomfort from over-heating when the house is crowded, are some of the problems which entered into the design of the heating system.

By distributing a small amount of radiation over the terraces under the seats, the "chilly" effect of the cold concrete was counteracted, and by concentrating radiation at the foot of the terraces and in the passage ways, allowing the air from the centre section to circulate by opening the gates in the close wooden barrier surrounding the oval, it was found possible to temper the larger volume of air in a few hours, even after the building had been out of service for several weeks.

Below Concrete Work

Figure 3 shows the arrangement of the radiation in this section of the building. The entrances and offices at the north and south ends of the Arena are all heated, but this radiation is not shown, as these spaces are below the concrete terrace work.

The total radiation in this section of the buildings is approximately 18,000 sq. ft.

The radiation under the seats consists of a single run of 2" pipe supported in small C. L. pedestals behind each row, each group of terraces being operated as a single radiating unit. A detail on Figure 4 shows the arrangement of the piping for this terrace heating surface, and Figure 3 shows that there are 36 of these groups.

When there is an event requiring the oval to be used as seating space, it will probably be found difficult to prevent some cold draughts in the centre section should the weather be extremely cold and windy.

The entire heating system has been successfully controlled, by having a trained attendant constantly passing through the different sections of the building and operating the valves on the different sections of the mains and the radiator valves on the masses of radiation at the foot of the terraces and on the high level at the rear of the seats. There are four mains, each supplying one quarter of the Arena section, and these are controlled by valves which can be conveniently operated by chains from the ground floor level.

During evening performances, when the house is crowded, it is found desirable to anticipate the possible overheating, and cut off practically all of the radiation immediately after the audience has assembled and then to gradually turn on the necessary heat to keep the building from becoming chilly.

The heating in the Arena could probably have been controlled by automatic thermostats, if funds had been available for a complete installation, although it would have been found difficult to locate the thermostats so as to control the different sections of the building at the proper time to prevent draughts or over-heating.

Steam Plant

A brick power house building, 46 ft. by 64 ft., with brick chimney, is located 20 feet from the east corner of the Coliseum. This building has a boiler room, pump room and in addition a room for housing the electric transformers for this section of the park.

The following steam generating and auxiliary equipment was installed.

Four 72" by 18' 0" H.R.T. Boilers, constructed for 125 lbs. working steam pressure.
Four sets oil burners and furnaces.
One 5' 0" by 5' 0" smoke breeching, constructed of No. 10 gauge steel.
One 7" by 4½" by 8" duplex heavy duty boiler feed pump.

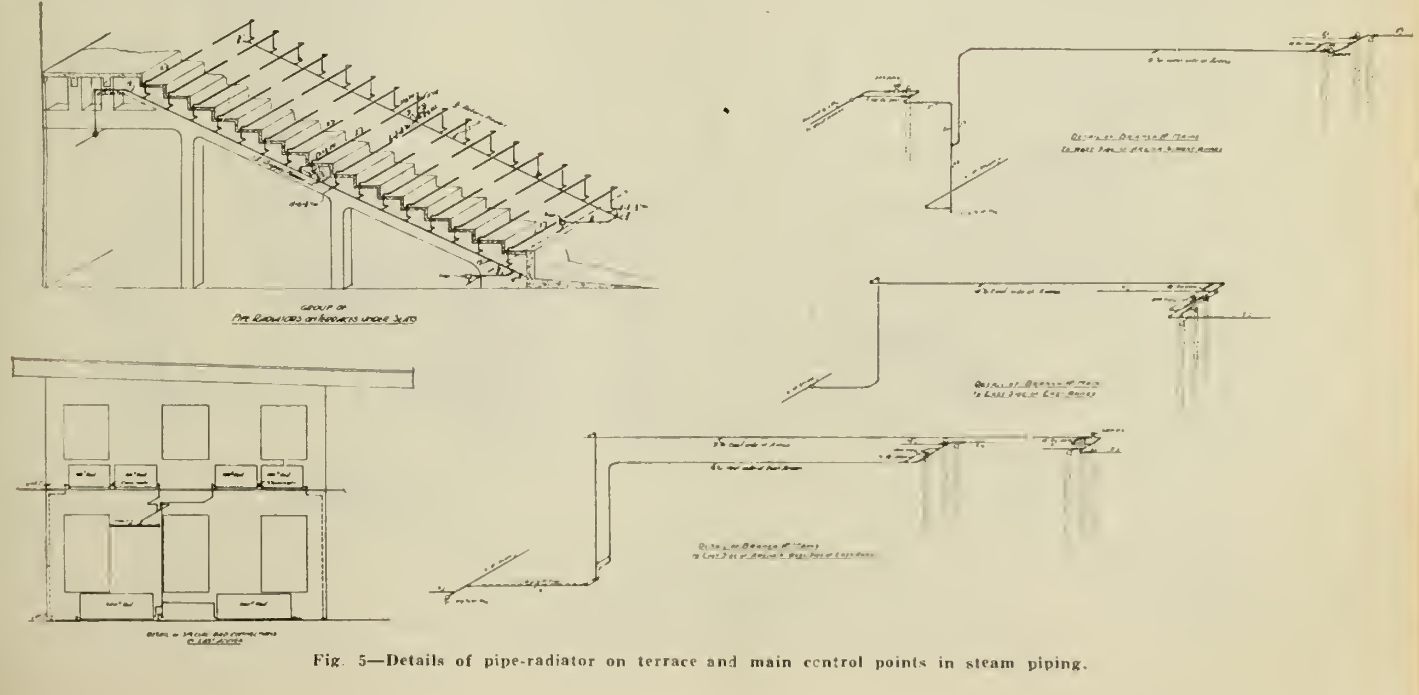
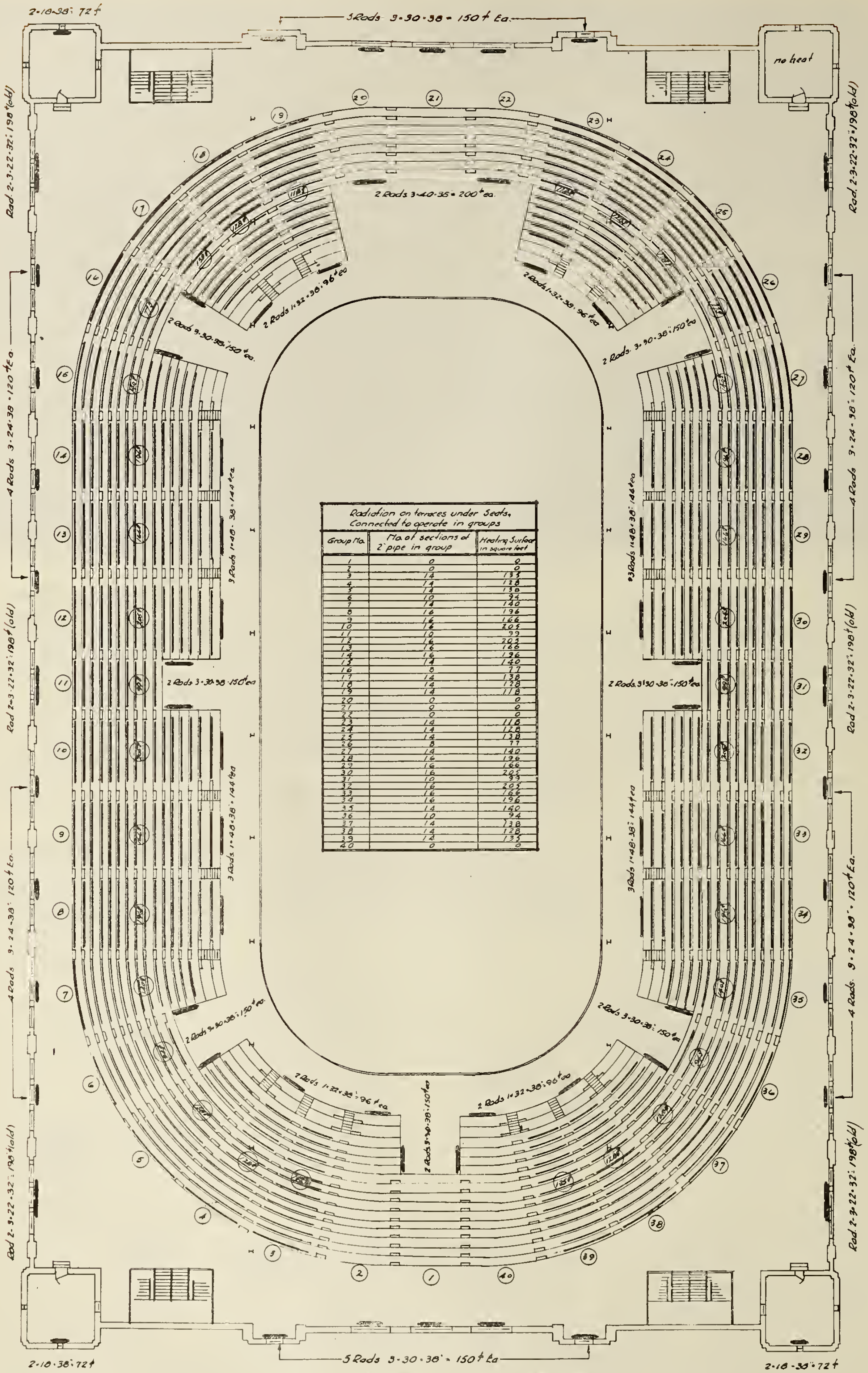


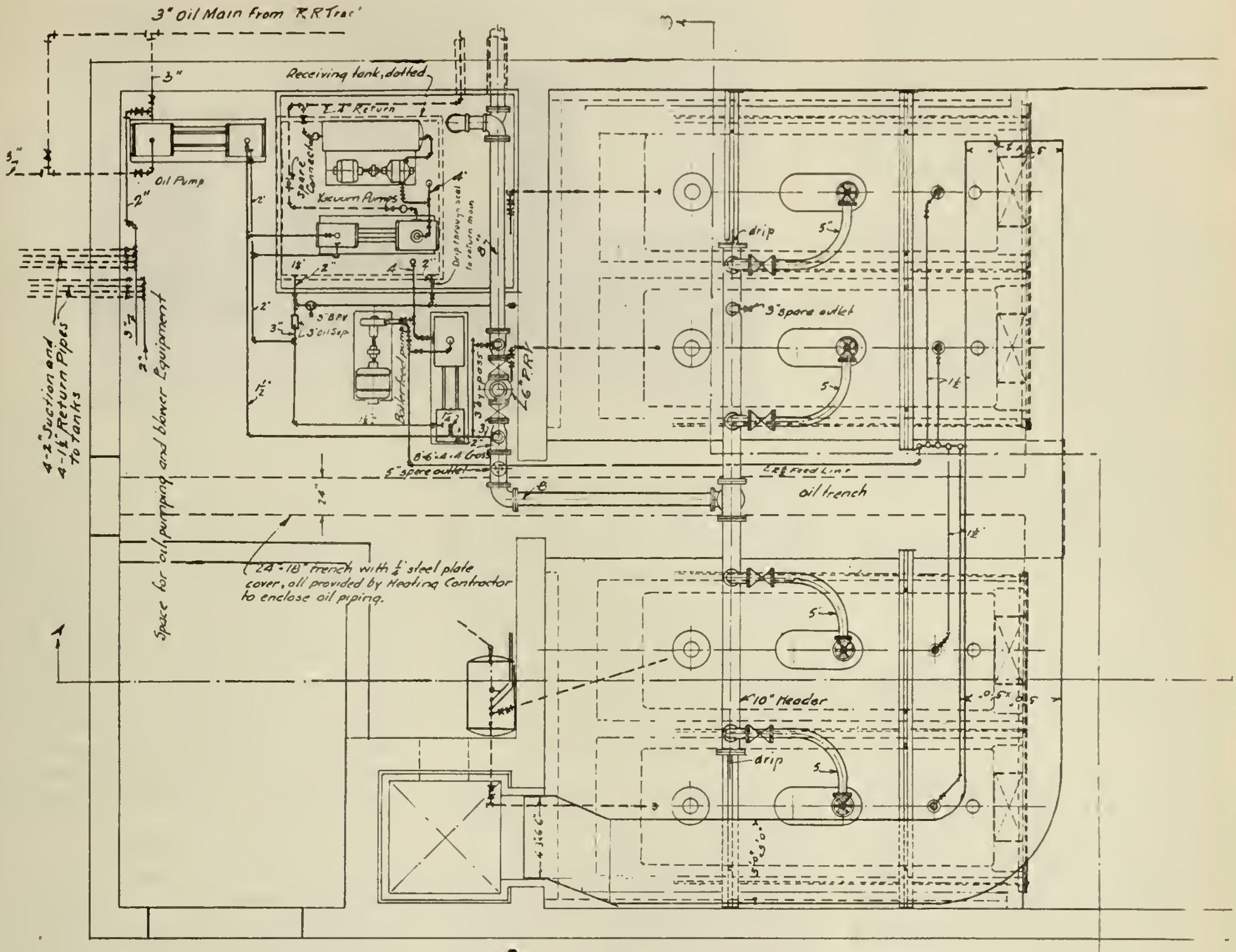
Fig. 5—Details of pipe-radiator on terrace and main control points in steam piping.



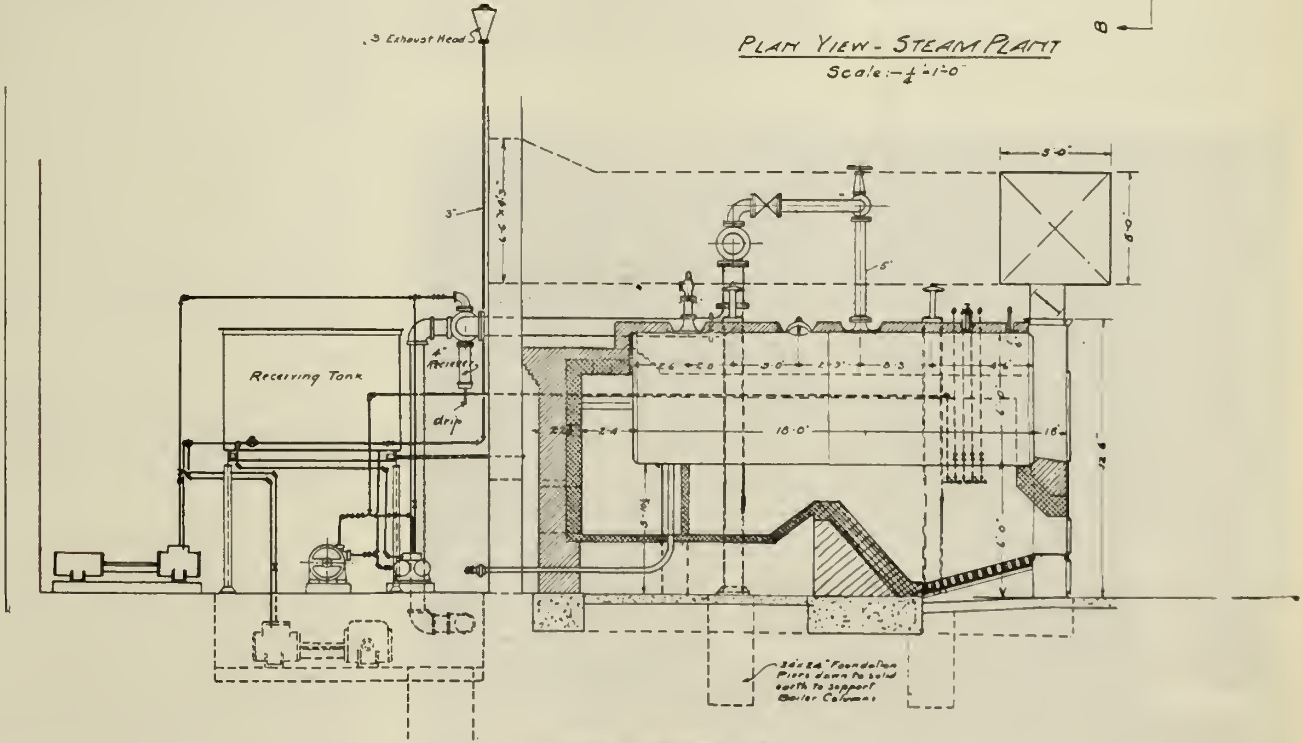
Radiation on terraces under Seats,
Connected to operate in groups

Group No.	No. of sections of 2" pipe in group	Heating Surface in square feet
1	0	0
2	0	0
3	14	135
4	14	128
5	14	138
6	10	94
7	14	140
8	16	196
9	16	166
10	16	205
11	10	99
12	16	205
13	16	166
14	16	196
15	14	140
16	8	77
17	14	138
18	14	128
19	14	118
20	0	0
21	0	0
22	0	0
23	14	118
24	14	128
25	14	138
26	8	77
27	14	140
28	16	196
29	16	166
30	16	205
31	10	99
32	16	205
33	16	166
34	16	196
35	14	140
36	10	94
37	14	138
38	14	128
39	14	135
40	0	0

Fig. 3—Plan showing radiation for heating Arena, Coliseum.


3" Oil Main from R.R.Trac'
3"
3"
Receiving tank, dotted
1½" Return
Spare Connection
Vacuum Pumps
Oil Pump
2"
Drip through seal to return main
4-2" Suction and 4-1½" Return Pipes to Tanks
Space for oil pumping and blower Equipment
3" BPV
3" Oil Sep.
Boiler feed pump
3" bypass
6" P.R.V.
8"6" A.A Cross
5" spare outlet
1½" Feed Line
oil trench
24"
24"×18" trench with ¼" steel plate cover, all provided by Heating Contractor to enclose oil piping.
drip
3" spare outlet
5"
10" Header
drip
4'3"×6'6"
B

PLAN VIEW - STEAM PLANT
Scale:—¼"=1'-0"


3" Exhaust Head
3"
Receiving Tank
4" Receiver
drip
5"
18'0"
12'6"
34"×24" Foundation Piers down to solid earth to support Boiler Columns

SECTIONAL ELEVATION A-A

Fig. 5—Plan and section showing arrangement of equipment in Power House.

Fig. 1—Exterior View of Coliseum.

One "Westco" Boiler Feed Pump, direct connected to a 10 horse power electric motor.

This pump has a capacity of 40 Imperial gallons of water per minute against 150 lbs. pressure, and is controlled by a push button operated contactor.

One 10" by 12" by 12" steam operated vacuum pump.

One 65,000 sq. ft. capacity Jennings electric motor driven vacuum pump.

One 8" by 6" by 8" duplex general service oil pump.

This pump is used to draw oil from the tank cars in cold weather and to transfer oil from one tank to another when desired, and the piping is also arranged so that it can be used to supply the oil burners, should the other units be out of service.

One Albany oil pump with direct connected motor to supply burners.

One small duplex steam driven oil pump to supply burners.

One Sturtevant positive air blower, operated by motor to supply air under pressure for starting the oil burners when there is no steam pressure.

General Arrangements

The general arrangement of the equipment is shown on Fig. 5, except that the oil pumping and distribution appartus is not shown.

The plant was designed to allow one reserve boiler, where all the heating system is in operation, and to have duplicate pumping and auxiliary equipment.

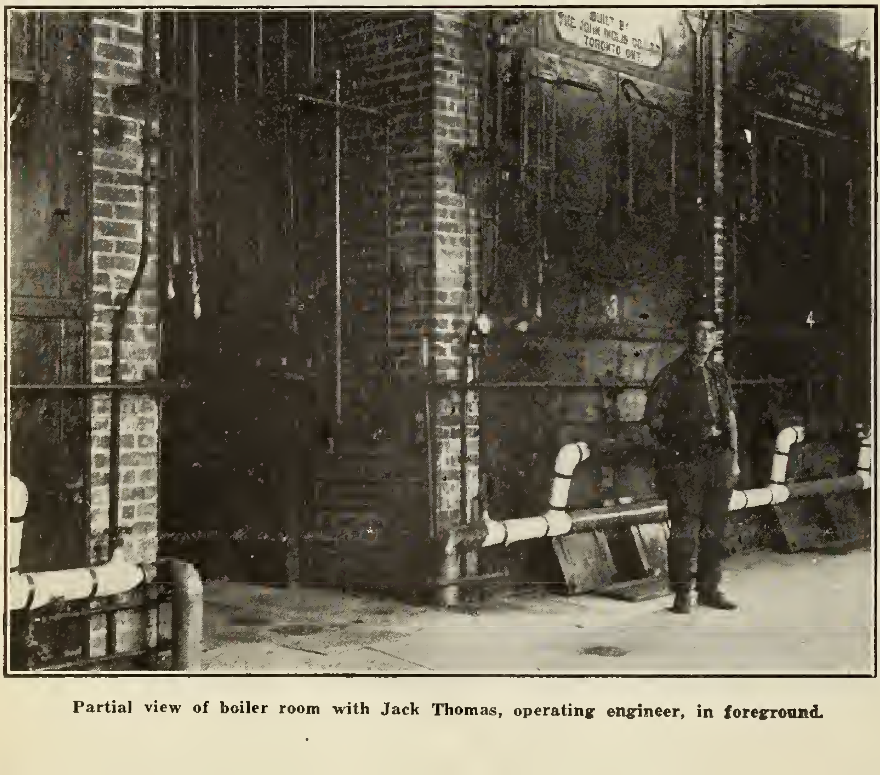
Oil as a fuel was selected, because of its convenience, small amount of labor, quick starting and stopping, easy regulation, and convenient storage underground, where it does not detract from the appearance of the park.

Four cylindrical steel tanks, having a total capacity of 48,000 Imperial gallons, were placed underground near the power house and piped so that oil from tank cars on the siding, 300 feet away, flows by gravity to the storage tanks, or if the oil is slow in running in cold weather, the large service pump is used to empty the tank car.

A system of piping from the tanks to the pump room allows oil to be transferred from one tank to another and to be supplied to the burners from any one of the tanks.

Two Cunerty Burners

The oil burning equipment consists of two Cunerty air or steam atomizing burners in each furnace. These burners operate satisfactorily with an air pressure of 3 to 5 lbs. per sq. in., or with low pressure steam. At this plant the air is used as a means of bringing up the steam pressure on one boiler, after which steam at a reduced pressure of 15 lbs. is supplied to the burner and there further throttled to give the desired rate of combustion.



Partial view of boiler room with Jack Thomas, operating engineer, in foreground.

An important feature of the oil burning furnace in this plant is a fire brick grate through which the air to support combustion is allowed to pass. This, however, is not necessary to prevent smoke, as it was found possible to obtain a perfectly clear flame immediately when starting the burners in a cold furnace. The oil burning equipment has proven satisfactory, and can be easily regulated by using one burner to give less than 25 per cent. of the capacity of the boiler, or by using both burners to exceed the over-load capacity of the boilers and force the water out through the steam piping.

Distribution System

The boilers are operated at 75 to 100 lbs. gauge pressure.

The power house steam piping consists of the ordinary layout of a main header, connected to each boiler with a double system of valves, all of extra heavy material. To the header are connected branches to the various services. There is a small amount of steam distribution to the milk testing building and to four barns. These have separate pressure reducing valves and connections.

The main steam supply for the Arena and annex buildings passes through a primary pressure reducing valve, and is delivered to the mains at a pressure of 5 to 20 lbs., as is necessary to supply the demand.

The pipes pass underground through steel casings covered with concrete, from the power house to the east annex building where they enter a tunnel which extends 496 ft. under the east annex and Arena building.

Branch mains rise from this tunnel and extend to four main distribution points in the east annex and Arena, and from the end of the main, a main rises to serve the old heating system in the West Annex. At the distribution points, secondary pressure reducing valves are installed and the pressure of the steam reduced to 1 to 5 lbs. as is required to supply its demand under any given existing load condition.

The low pressure steam is distributed around the ground floor ceiling, and at each distribution point there are three main valves fitted with sprocket wheels and chains so that they may be conveniently operated from the floor.

The distribution system to the radiation is in accordance with ordinary standard practice for a vacuum heating system, arranged generally so that the condensation will flow in the same direction as the steam to definitely determined drip points.

Each radiator and drip point in the piping is controlled by a thermostatic trap and the drips from the medium and high pressure piping are generally controlled by bucket type traps.

By-Pass Saves Time

It was found that too much time was required to clear the underground main through an ordinary trap when the system was being started up quickly, so to allow the large volume of condensation and air to pass quickly into the return piping, a 2 in. by-pass was provided to be operated by an attendant, who "stands by" until the main is clear, when steam is to be turned on quickly.

Of course, under ordinary conditions, the steam would be turned on to the main slowly, and time allowed for the vacuum pump to clear the system through the drip traps.

Of the radiation return piping, 2.800 ft. is locted in tar-coated wood boxes below the concrete floor. All of this piping is supported on rollers, clear of the enclosing boxes, and is extra heavy, genuine wrought iron. The main return pipe is located in the pipe tunnel and passes through a steel-lined pit in the pump room, where it is connected to the vacuum pumps. The vacuum pumps discharge into a large receiving tank located overhead, and from this tank water flows to the boiler feed pumps. When the steam vacuum and boiler feed pumps are in operation, the exhaust steam from them passes through a coil submerged in the receiving tank, where practically all of it is condensed and reclaimed.

The total radiation in the Arena and two annex buildings, is approximately 48.000 sq. ft., to which must be added about 10 per cent. for uncovered and partially covered piping included in the computations as a part of the heating system. In addition to this load, there is about 2,500 sq. ft. of direct radiation in the barns and milk testing building, and during the Royal Winter Fair. there is a heavy load for heating water and for washing stock.

A Rush Job

The writer was instructed on July 14. 1922, to prepare plans. Contractors had access to the plans on August 3, 1922, and submitted tenders on Aug. 10. The contract was at once awarded to Purdy-Mansell Ltd., under an agreement that the system should be ready to operate for the Royal Winter Fair on Nov. 22 of the same year.

That the work could be planned and installed. and put into operation within such a brief period of time, was due in large measure to the constant co-operation between the Parks Department, representing the City of Toronto as owners, the contractor, and the engineer.

Power Notes

A. B. Stewart, Town Clerk of Estevan, Sask., will soon be calling for tenders in connection with a $22,000 electric lighting plant.

The Imperial Oil, Ltd., 56 Church St., Toronto, is preparing plans for the construction of steel storage oil tanks and pumps in Oshawa, Ont.

The Florence Mining Co., Ltd., Ainsworth, B.C., are calling for tenders for the erection of a $175,000 electric power plant. No closing date has been set.

The Dorin Construction Co., Ltd., 104 Sparks St., Ottawa, have been awarded the contract for the $30,000 water power plant to be built at Buckingham. Que.

The Ottawa River Power Co. Ltd., 145 St. James St., Montreal, Que., is in the market for extensive development equipment, including transmission and power machinery.

The Hydro Electric Power Commission is beginning work on the construction of twenty miles of new lines in London Township, Ont. The estimated cost of the project is about $40,000.

The Hamilton Hydro-Electric Commission are having plans prepared for a $45,000 sub-station on Hamilton St. N. Hamilton. B. H. Prack, 1 Main St. E.. Hamilton, is the architect.

The Haileybury Town Council is planning to install pumping equipment, including stage motor driven centrifugal pumps, for fire protection. The estimated cost of this work is $20 000.

The Northern Ontario Light & Power Co. is now doubling the power supply to Kirkland Lake. The present line, which will be paralleled in part by the new transmission line, is stated to be good for 5,000 h.p.

R. Morrissette, Three Rivers, Que., is in the market for a centrifugal pump, 2½ in. discharge, capacity 125 gallons per minute, and one electric motor. 5 h.p., automatically controlled by the level in the reservoir, 250 ft. from the pumping plant.

At the annual convention of the Association of Electragists (International) held in Vancouver. W. G. Murrin was chairman of the "Electrical" banquet. The principal speakers were Lawrence W. Davis. director of promotion and development in the Association, and Jas. R. Strong, W. Small. W. W. Fraser and others well known in the electrical world.

Installations of a Leonard fire box boiler was made in the North Huron School, Toronto, by John Ritchie Co., Toronto.

John Inglis & Co., Ltd., 14 Strachan Ave., Toronto, are contemplating the installation of an electric travelling crane, sand mixing machine, etc.

The Ford Motor Co. of Canada, Ltd. Ford City, Ont., have under construction a new power and screen house. These are being erected at a cost of $300,000.

The Leonard tubular boilers have been installed in the Leslie St. school, Toronto, through the Arthur S. Leitch Co., Kent Building, Toronto, by B. J. Miller, contractor.

The Arthur S. Leitch Co., Kent Building, Toronto, have supplied the Provincial Paper Mills, at Mille Roche, Ont., with a Jennings exhaust vacuum unit as manufactured by the Nash Engineering Co., together with twenty Armstrong steam traps.

The Chairman, Board of Control, City Hall, Toronto, will receive tenders up to Tuesday, October 9, 1923, for an 80-million-gallon centrifugal pump, 25-million-gallon pumping engine, generator, supply of cast iron pipes, stop valves, and special castings.

The Purdy-Mansell Co., 63 Albert St., Toronto, contractors for the Coco-Cola Company's new building, will equip it with a size "C" Jennings duplex hytor-vacuum heating pump and a Sim's storage heater, through Arthur S. Leitch Co., Kent Building, Toronto.

Laclede-Christy, of St. Louis. have issued a new bulletin describing the Stowe Stoker, which in principle is a combination of the underfeed and the chain grate, the distinctive features being the stationary tuyeres alternating with moving chairs; and a fuel retarding assembly at the ash discharge

Following the visit of Lawford Grant, Montreal, managing director of the Eugene Phillips Electrical Works, Ltd., to Brockville, Ont., it has been announced that work on the construction of the second unit of the company will be proceeded with shortly. The first unit of the company's plant, which is to be removed from Montreal, was erected last year in the form of a rod-rolling mill.

Representatives of the Calgary Power Co. have been in Edmonton conferring with the Edmonton City Council with reference to the furnishing of a supply of electric power. The Calgary Power Co. has a plant on the Bow river, just west of Calgary. and this plan would necessitate the construction of a power line from Calgary to Edmonton, a distance of 196 miles. Changes and improvements would be necessary in the power plant, but if a market for the power can be found in Edmonton they are prepared to make the expenditures.

Toronto No. 1, C.A.S.E. On Frolic at Kew Beach

A Hundred Members With Their Families Enjoy Ball Game "Full o' Pep" as a Fitting Conclusion to Keenly Contested Race Program

MANY members of the Canadian Association of Stationary Engineers were unable to attend the picnic on Thursday, June 28, at Exhibition Park, Toronto, which brought to a close the thirty-fourth annual convention of the association. For this reason, those who did not attend the first picnic, and many who did, met at Kew Beach on Saturday afternoon, August 11, and spent the afternoon in the usual manner of "picknickers."

There were well over a hundred members with their families and friends present, and it is certainly superfluous to comment on the enjoyment shared in by all, for it was very evident. The weather man played his part, and everyone was in the best of spirits, having left dull care behind.

The usual races were run, though perhaps there was more energy and "vim" displayed than usual, due to the interest shown in reaching goal first, and determination not to be left behind brought success to many.

And the children! Did anyone ever see a livelier crowd with such tireless spirits? Races, why they'd have run them from noon till dark without a let-up, and then have been quite ready for more, though it is very doubtful if they would have allowed the supper hour to pass by unnoticed, for certainly none of them forgot to enquire carefully time and again about the hour and whereabouts of the "tea." And they certainly did justice to it, sandwiches, cake, fruit and other refreshments making a rapid disappearance, and keeping the committee and helpers busy.' Yet it wasn't surprising that their appetites seemed larger than usual, for the spot chosen, right by the lake, and the exercise they had had all afternoon, for racing or not they were never quiet, was certainly conducive to hunger, apart from the fact that the viands themselves were most appetizing.

Smokers Are Happy

Every smoker present was given a package of Honeysuckle tobacco and a Bachelor cigar, so they were quite happy. W. M. Ismond. the Toronto factory representative of G. F. Sterne & Sons, Brantford, dispensed orangeade to the thirsty, and was kept busy.

The ball game was "full o' pep," and we expect the professional Toronto team to be making bids for some of the participants. The teams, however. did not seem to be evenly divided as the score of 24-11 proves but the spectators enjoyed the game from the first inning to the last. and heavy hitting was a feature from beginning to end.

The line-up of the teams was as follows:—

Winners—Thompson, c.; Mosely, p.; Burgess, 1b.; Stevens, lf.; Murphy, 2b.; Armstrong, 3b.; Holt, cf.; Quinlan, ss.; Ivers, rf.

Losers—Truelove, c.; Wright, p.; Burgess, 1b.; Brown, 2b.; Dunton, 3b.; Thomas, ss.; McLaren and Giles, rf.; Paton, lf.; Scarfe, cf.

Umpire—George J. Soucy.

The following are some of the races and their winners:—

Girls, 7-12—1, Violet Harvey; 2, Florence Harvey.

Boys, 7-12—1, Willie Glockling; 2, George Brown.

Girls, 12-15—1, Hazel Scharf; 2, Muriel Harvey.

Boys, 12-15—1, Harry Harvey; 2, Willie Glockling.

Girls, 15-18—1, Phyllis Brodie; 2, Jennie Stevens.

Men's Guessing Contest—1, W. Truelove; 2, J. Quinlan.

Engineer's wives balloon race—1, Mrs. E. Wright.

Among those present were John Thompson, of the Dearborn Chemical Co., immediate past president of the Supplymen's Association; C. B. Turner, past president of the Exhibition Committee; R. McLaren, president Toronto No. 1 and vice-president Grand Lodge C.A.S.E.; W. A. Truelove, I.P.P., Toronto No. 1; L. W. Thomas, D.K., Toronto No. 1; Mrs. Mosely, whose husband, the late Charles Mosely, was Grand President of the Grand Lodge and chairman of the Engineer's Examining Board; also Mr. Mosely, Jr., a prominent engineer; Mr. Blackgrove, past grand secretary of the C.A.S.E.; A. Lamoreaux, an honorary member of Toronto No. 1 (who incidentally ran in the race with the 12-year olds, although over 80 years of age); G. A. Brown, recording secretary of Toronto No. 1; Ed. Golightly, vice-president Toronto No. 1; Geo. D. Fowler, one of the trustees of Toronto No. 1, and past president of London No. 30; W. G. Blackgrove, past grand president, and Geo. J. Soucy.

OFFICERS, TORONTO NO. 1, C.A.S.E.
G. J. Soucy, Grand Lodge Secretary; E. Golightly, vice-president; W. A. Truelove, I.PP.; R. McLaren. president; G A. Brown, secretary; John Quinlan, conductor.

Hamilton Council No. 60 U.C.C. Stages Frolic

By N. C. SHATFORD

Thunder and Rain Fail to Mar Festivities at Black's Grove, Ancaster, on August 11—Unusual Prizes Donated Provoke Keen Contests in Sports Events

Left to Right:—P. R. Laver, M. L. Miller, G. R. Brown, S. E. Cosford, Alex. C. Leckie, (Worthy Chief), Wm. Pattison, Bert Stephenson, George Dennison, W. A. Sweet, L. J. Cudbird (Toronto Council) R. B. Hornby, H. McLaren.

THAT members of Hamilton Council, No. 60, Universal Craftsmen Council of Engineers, were disappointed in the weather on the occasion of their annual picnic at Black's Grove, Ancaster, on August 11, is expressing their feelings in mild terms, for after bright sunshine had presaged an ideal day for just such an outing, thunder made itself heard and rain fell in a determined manner.

To a casual observer it certainly did not seem to worry the children a great deal that they had to remain in the grandstand for most of the afternoon, though the liberality of S. E. Cosford in handling the candy, ice cream, and soft drinks may have played a large part in keeping them from becoming restless.

Young George Crosswell kept track of the cones carefully "put away" by Archie Leckie, but George himself had no room for repartee when an interested grown-up remarked it would be impossible for him to compete in the races. However, George showed them what he could do, and won the very first race.

About 4.30 p.m. the rain decided that it had had its innings, and proceeded to clear the track for action. Mr. Cosford, armed with a megaphone, took up the task of letting everyone know where to start, and how, and with the aid of members of the committee, duly placed the eager contestants in line in the various positions adopted for getting up the most speed in the least possible time, and then they were off—some arriving first, some second, and some—well, while they may have come in a little behind time, they did their best.

A unique feature of the prizes was the fact that all were donated by the following firms and individuals:—Robt. Fitzsimmons Co., Ferry Coal Co., Crescent Oil Co., Electric Supply Co., Wood, Alexander & James Co., Barton Electric Works, Canadian Westinghouse, Crane Co. Ltd., H. W. Petrie Co., Chadwick, Carroll Co., Tallman Brass Co., McPherson Shoe Co., Milqo Co., Woodward Chemical Co., Garlock Packing Co., Power House, Duff & Son, Gordon Thomson, Ltd., Standard Sanitary Co., Mark's & Co., Wilkinson & Kompass Co., Kent, Garvin Co., S. E. Cosford, and Metal Studios Co.

Left to right, back row:—Archie Leckie, Jim Leckie, William Pattison, Eddie Lee. Second row—Dorothy Paddock, Marjorie Brown, Kenneth Bull, George Crosswell, Rosalie Leckie, Peggy Lvaer, Kathleen Lee. Third row:—Norma Leckie, Jack Miller, Kathleen Bull, Raymond Bradley, Kathleen Laver, Robert Smith. Front row:—Lois McLarn, Murray Brown, Trafina Parklow.

The entertainment committee consisted of Bert Stephenson, general chairman; S. E. Cosford, chairman, sports committee; and H. Hornby, chairman, refreshment committtee.

The following is the list of races and winners:

Children's Race—1, George Crosswell; 2, Norma Leckie; 3, Edward lee.

Girls' Race, 8 to 10 years—1, Peggy Laver; 2, Rosalie Leckie.

Boys' Race, 8 to 10 years—1, Wm. Pattison; 2, Kenneth Bull.

Girls' Race, 17 years and under—1, Jean Barkley; 2, Frances Beattie.

Boys' Race, 10 to 15 years—1, Jim Leckie; 2, Archie Leckie.

Single Ladies' Race—1, Geraldine Cosford; 2. Jean Barkley.

Wives of Council—1, Mrs. D. R. Laver; 2, Mrs. M. Miller.

Members of Council—1, M. L. Miller; 2, J. McLaren.

Fat Engineers' Race—1, John Grimes; 2, Wm. Pattison.

Wheelbarrow Race (changed to running)—1, Tom Brown; 2, E. Campbell; 3, Bert Stephenson; 4, R. Bradley .

Smoking Race, lady and gentleman—1, Mrs. Leckie & Mr. R. Gill; 2, Mr. & Mrs. J .G. Wilson.

Among the special feature races were the following:

Boot & Shoe Race—1, E. Campbell; 2, D. R. Laver.

Married Ladies—1. Mrs. Cudbird (Toronto); 2, Mrs. Partlow.

Officers Race—1, M. L. Miller; 2, Bert Stephenson.

Boys under 17—1, Jim Leckie; 2, Archie Leckie.

Cake Contest—1. Mrs. Cosford. Tied for 2nd—Mrs. Pattison, Mrs. Laver, Mrs. Knowles.

Averting Loss in Ammonia Compressor Operation

*By S. F. SMITH

A Discussion of the Conditions Controlling the Losses in the Machine with Suggestions for Their Solution in Canadian Plants

IN DISCUSSING the economy of ammonia compressors the term volumetric efficiency is freely used, usually implying the overall efficiency of the ammonia compressor. Engineers and manufacturers frequently quote values which are far apart. This is due to the fact that no specified statement is made of the losses involved, or conditions under which the gases enter and leave the compressor. In this article, the writer has endeavored to point out the losses as they occur, and the conditions which control same. The information given is not new to the engineer, but it is believed the emphasis placed on these points in their proper place will be of some value in the economical operation of Canadian plants.

The losses which occur in the compression machine are as follows:

1. Clearance or re-expansion loss.
2. Pressure loss through suction valves.
3. Loss due to superheating of gas from cylinder walls.
4. Loss due to superheat in suction-gas.
5. Loss due to ammonia liquor entrained in suction gas.

The first two losses are controlled by the design of the compressor and valves; the remaining three losses may be controlled from sources outside of the compressor machine. There is, in addition to the losses at the compressor, an inherent loss of refrigeration, which is the cooling of the ammonia liquor from the temperature at which it leaves the condensers to the temperature at which same evaporates in the refrigerating coils. The loss, even though inherent, may be somewhat reduced.

Basis of Discussion

As a basis of discussion we will take the set of compressor operating conditions as follows:

Absolute suction pressure, 29.7 pounds.
Absolute condenser pressure, 199.7 pounds.
Double-acting compressor.
Adiabatic expansion.
Heat content of suction vapor 537 B.t.u.
Total heat of compression, 123 B.t.u.
Heat content of gas after compression, 660 B.t.u.
Net refrigeration effect per pound of ammonia, 504 B.t.u.

The first loss stated as a result of re-expansion of the high pressure gas which remains in the clearance space of the discharge head of the valve manifold, is apparent from indicator diagrams. Under the conditions of the example taken it will be found that this loss will not exceed five per cent. in the case of double-acting compressors; the suction and discharge pressure corresponding to the example stated.

The total displacement of the compressor, less the re-expansion loss is usually called the apparent volumetric efficiency. This re-expansion loss will be increased at least 15 to 20 per cent. in the case of operating with wet compression.

Wet Compression

By wet compression we refer to a nearly saturated discharge gas having a temperature of around 95 degrees. Careful laboratory tests have been made by numerable ammonia compressor companies, and it is found that where the wet gas is carefully controlled that there will be a difference of about 15 per cent. in this loss. In a plant where machines are operated by this method it is apparent that the loss will be greater as laboratory manipulation cannot be accomplished. Tests have been made to show that with a suction pressure of 31 pounds absolute, and condenser pressure of 200 pounds absolute, that there was an overall loss by the wet compression system of 27 per cent. as compared to dry compression. This may easily be conceived when diagrams are taken from indicator cards operating on the wet compression system.

The second loss is that resulting from the drop in pressure through the suction valve and manifold, same to be governed by the design of the compressor valves. We find to-day that manufacturers usually are furnishing more liberal areas in the suction valves and that the loss is greatly reduced so that same is almost negligible. It would not be uncommon to find a pressure drop of 1½ pounds. Loss resulting from this drop would be in the vicinity of 4 per cent.

A Definite Loss

It will be apparent that the pressure drop is a definite loss, inasmuch as additional work will be required to compress from the pressure, and the capacity of the machine correspondingly reduced.

To effect an equivalent production of refrigeration it is evident that a given machine will have to be correspondingly increased in speed to overcome this loss, as the ammonia pressure at the refrigerating coil is designated to a point where no additional reduction in pressure or increase of volume produces any more effective refrigeration. A similar loss would occur in the case of the installation of a small suction line from the cooler to the machine.

The third loss mentioned, resulting from superheating of the suction as by the cylinder walls, is a loss which is seldom mentioned and referred to. Careful analysis shows that even with the operation of water jackets on ammonia compressors the total loss due to radiation and water jackets is only 30 per cent. of the heat given up by the cylinder walls directly to the ammonia gas in the cylinders. These tests show that the loss resulting from the superheating of the gas by the cylinder wall ranges from 13½ to 22.7 per cent., according to difference in temperatures corresponding to discharge and suction pressures with dry compression.

Controlling Factor

The conditions which control this loss apparently are temperatures corresponding to suction and discharge pressures. Inasmuch as no control can be made of the suction gases, the only place for correction will be in the discharge pressures and volume handled. This is a field which has been entered by the manufacturers of multi-stage compressors. The big loss which is reduced by the various types of compressors is the elimination of some of the superheat, and the lowering of the condenser pressures.

In the case of the two-stage ammonia compressor, the discharge leaving the low-pressure cylinder is cooled to a saturated condition by means of the injection of ammonia liquor through an expansion valve. This, on the surface, would appear as lifting one's self by the boot straps. However, power required to produce refrigeration is governed principally by volume and pressures, irrespective of weight of gas handled. Accordingly it will be apparent that a given volume of superheated gas will result in a smaller value if a given weight of ammonia liquor is expanded into same.

Tests were made three years ago in a two-stage compressor, and it was found that ammonia liquor was expanded into intermediate receiver between the two cylinders, and that the ammonia discharge temperature was 144 degrees with a condenser pressure of 105 pounds gauge. With the same operating conditions and the expansion of ammonia omitted from the intermediate receiver, the temperature of the discharge went to 184 degrees.

It is apparent that the heat of compression resulting from the changed

---

*Testing Engineer, Armour & Co. An address before the Mountain States Ice Manufacturers Association.

operating conditions was greatly increased, as the discharge temperature was steadily on the rise, and it was found unsafe to continue to operate this machine in this manner, and it was found necessary to start the operation of the ammonia liquor expansion valve cooling the liquid in the intermediate receiver.

May Increase Saving

These tests indicated that there was a saving of about 12½ per cent. as compared to ordinary single-stage operation, whereas theoretically saving should be 14 to 15 per cent.

The two-stage compressor no doubt has a good field for low-pressure work. The writer, however, would emphasize the saving effected in the proper use of ammonia liquor expanded into suction side of single-stage compressor, as the liquor injected into the suction-side of the machine will remove some of the superheat resulting from compression, thereby increasing the capacity of the machine and the effected tons of refrigeration produced, which will mean a net saving in tons of coal per ton of refrigeration. It is difficult to specifically state how much ammonia should be added, but a line may be had on same by watching the reduction of ammonia discharge temperature, as in the test referred to the discharge temperature was reduced from 180 degrees to 144 degrees when the ammonia liquor was used for cooling the suction gas. The entire loss cannot be reduced as effectively in a single-stage machine, but a large part of this loss can be recovered.

Relative to the fourth loss. As previously mentioned, the increasing volume of ammonia leaving the refrigerator coils performs no effective work, and, therefore, proper insulation must at all times be provided on suction lines, so that there will be no superheating of the gas from the return system. In the example stated there will be a loss of 1.2 per cent. resulting from a superheat of 3 degrees F. on the suction line. Should a 20 degree superheat exist on the suction line of the example mentioned, there will be a loss of 5.8 per cent.

Relative to the fifth loss. Inasmuch as this loss may be a variable quantity depending on how much liquor is carried back to the compressors, no specified value can be mentioned. There can be no argument against the removal of heavily entrained ammonia. The installation of accumulator trap will no doubt remove all such conditions in the various plants where this condition would exist.

Summarizing the losses as mentioned in the example there will be a total loss of 32.7 per cent., making the net overall efficiency 67.3 per cent., which corresponds very closely with tests made by numerous manufacturers which indicate efficiency of about 70 per cent. for the conditions mentioned.

Tabulation of value of losses existing in example mentioned:

Clearance loss	5.0%
Suction valve loss	4.0%
Compression loss	22.5%
Suction superheat loss	1.2%
Total loss	32.7%
Net comparison efficiency	67.3%

As already mentioned the inherent loss in cooling the ammonia liquor from the temperature at the condenser to the temperature in the cooler will be in the vicinity of 12 degrees for back-pressure of about 5 pounds gauge. In the case of low back-pressure, it is apparent that the cooling of the liquor from the temperature corresponding to the condenser pressure to the temperature corresponding to a 20-lb. back pressure could be effected by means of high pressure suction gas passed directly to high back-pressure machines as the h.p. per ton will be less for the ammonia compressors operating from a high back-pressure to a given condenser pressure than from a low back-pressure to the given condenser pressure.

In other words, about 50 per cent. of the cooling of the liquor in the case of freezer operating may be effected more economically by cooling the liquor by means of high-pressure suction gas, leaving only the balance of the liquor cooling to be performed at the lower back-pressure in the freezer refrigerating coils.

In This Issue

The Editorial Page 21
By Campbell Bradshaw
Heating Canada's Coliseum 22
By Melvern F. Thomas, M.M.E.
Power Notes 27
C.A.S.E. Frolic at Kew Beach 28
Toronto No. 1 Stage Picnic
U.C.C. of E. No. 60 on Frolic 29
Hamilton Engineers at Ancaster
Averting Ammonia Compressor Loss 30
By S. F. Smith
U.C.C. of E. Notes 31
Louis J. Cudbird
Treatment of Feed Water 32
By Arthur Murphy
Announcements 33
The Use of Superheat 34
By M. Barry Watson, B.A. Sc.
Pipe Lines 35
Power House Electricity 36
By J. A. Burnett, M.E.I.C.
Practical Ideas 37
Oil or Coal
Trueing A Shaft
Lubricating Rams
Efficiency C.A.S.E. Goal 38
By George J. Soucy
Power House Problems 39
Dairy Refrigeration
Pressure Lubrication
Testing Ammonia
Pressure Falling Off
Ice and Salt
Setting Pump Valves
Pressure Gauges
Personals 40
New Equipment 42
McClare-Brooks Stoker
An Oilgear Pump
Power Plant Comments 44
By J. J. Sullivan and Geo. A. Brown
C.A.S.E. Notes 46

U.C.C. of E. Notes

At the twenty-first international convention of the Universal Craftsmen Council of Engineers, held at the Powers Hotel, Rochester, N. Y., from August 6 to 10, the following officers were elected for the ensuing year: Grand Worthy Chief, George G. Brown, Pittsburgh; Assistant Chief, W. W. Law, Princeton, N.J.; Grand Secretary, Theodore Jones, Washington, D.C.; Grand Treasurer, John L. O'Brien, Chicago; Warden, Walter Damen, Springfield, Mass.: Grand Guard, Louis J. Cudbird, Toronto; Chairman, Board of Trustees, William Clark, Cleveland; Trustees, John R. Hass, Chicago; and J. L. Lambert, New York City.

LOUIS J. CUDBIRD,

Chief Engineer, City Hall, Toronto, elected "Grand Guard" of the Universal Craftsmen Council of Engineers at the twenty-first annual convention held in Rochester, N. Y., Aug. 6—10.

It was decided that the convention for 1924 would be held at Chicago.

At the third annual convention of the ladies' grand council of the Universal Craftsmen Council of Engineers, held in conjunction with the twenty-first annual convention at Powers Hotel, Rochester, N. Y., August 5-10, Mrs George Aldridge, 38 Rowntree Ave., Toronto, was elected "Grand Chaplain."

Eugene Tanguay, managing director of the Quebec Power Co., of Quebec, previously the Public Service Corporation of Quebec, has been appointed general manager of the Quebec Railway, Light, Heat & Power Co.

Preventing Scale by Treatment of Feed Water

*By **ARTHUR MURPHY**

A Description of the Impurities in Water Causing Scale—The Meaning of Hardness—Common Methods of Softening—The Value of Chemical Analysis

THE production of steam at low cost is, in the last analysis, dependent on the condition of the interior of the boiler, which in turn is influenced by the quality of the feed water.

In a modern plant employing the latest methods of burning fuel, high efficiencies are obtained in the furnace, but unless the boilers are kept clean and free from scale, the overall efficiency may be considerably reduced as a result of the heat insulating properties of scale.

In spite of frequent cleaning, either by turbining or other mechanical means, a boiler remains clean for only a relatively short time. Scale begins to form again as soon as operation is renewed and continues to increase in thickness until the boiler is cleaned again, the result being equivalent to a constant layer of scale having half the thickness of the layer at the time of removal.

For years engineers were content to allow the scale to form before by tedious labor, removing it. When it was seen that modern chemistry was of use outside of the laboratory a more logical method of dealing with scale forming water was developed, namely the removal from the water of scale forming substances or their transformation into compounds which are not scale forming.

Contaminated by Refuse

With some feed waters, more especially those in districts where the supply has been contaminated by refuse from factories using acids or acid forming compounds in their processes, excessive corrosion of the interior of the boiler often develops and since the results are not apparent except by careful examination, considerable damage may be done to the boiler.

The first step in purifying feed water which gives trouble in the boiler, is to find out the nature and the amount of each scale forming substance carried by the water. This necessitates a proper chemical analysis by one familiar with boiler feed water treatment.

Partial success sometimes results from the use of home recipes, but unless the impurities in the water and their amount are known, it is difficult to give the proper treatment for scale prevention. Under treatment will still leave a certain amount of scale while over treatment is wasteful and sometimes the cause of priming or foaming.

The ideal water for use in steam boilers would be distilled or pure rain water, then boilers would be free from scale and require but infrequent cleaning. Unfortunately such water is seldom available, the nearest approach being in large central stations or heating plants where the condensate is returned to the boiler.

There is every good reason why only pure water, or at least water free from scale-forming constituents, should be used in steam boilers. And fortunately it is not difficult to obtain such a supply of water no matter what the nature of the natural supply. Where the natural water is such that it cannot properly be softened, there is still the opportunity to use a distilling plant, or evaporator, to supply distilled water for boiler feed.

Many plants are faced with the problem of having to use practically 100 per cent. make up and where the water contains scale-forming compounds great difficulty is experienced in keeping the boilers clean.

The presence of scale forming compounds in the water is known as hardness and the rapidity with which the boiler scales up is a rough measurement of the degree of hardness. On boiling, some compounds precipitate from the water, others require chemical treatment for their removal. Hardness, which can be removed by boiling, is known as temporary, that which remains is called permanent, the sum of the two being called the total hardness.

The chemist measures the degree of hardness by the amount of standard soap solution required to produce a permanent lather.

All natural waters contain some impurities, about two degrees of hardness being the minimum. In addition to the dissolved compounds, sediment, mud and finely divided materials are frequently carried in feed water.

Hardness in water is caused chiefly by the presence of calcium and magnesium salts occurring in the form of bicarbonates, carbonates, sulphates and chlorides.

Calcium Present

The presence of calcium carbonate is the chief cause of temporary hardness, most of the other compounds causing permanent hardness which is not removed by boiling. Calcium carbonate or limestone ($CaCO_3$) though to a slight degree soluble in water, in the presence of carbon dioxide, is changed to calcium bicarbonate which is readily soluble in water.

The process of treating water to render it suitable for boiler feed purposes may be divided into two classes. the mechanical and the chemical.

The mechanical treatment, called filtering, is a means of straining any particles floating in the water is in use for removing sediment, mud and vegetable matter. The chemical means for the treatment of hard water for boiler feed may be divided into

(a) The introduction of compounds directly to the boiler by way of feed water.

(b) Introducing softening compounds into the water in large outside settling reservoirs.

(c) Passing the water under pressure through a mass of softening medium.

Use of Filter

Filtration, though closely connected with the chemical treatment of feed water is in reality a mechanical operation, consisting in the removal from the water of any finely divided materials floating or carried in suspension. A filter may be considered as a screen with very fine mesh.

Water that to the eye seems perfectly clear may carry a considerable amount of foreign material which the filter will remove, especially when in the form of a light colored, finely divided precipitate. Large settling tanks used in conjunction with the lime-soda treatment of water leave a certain amount of the precipitate in the feed water and being the finest precipitate, a filter is the most practical method of removing it. From the nature of the action of the filter, unless some means of cleaning at regular intervals is provided, the capacity steadily decreases until the filter becomes so clogged that it often can no longer be used.

The usual method employed is by back-washing or reversing the flow of the water for a short time. In this operation the velocity of the water should be much greater than when it is being used for filtration. By using high velocity for a short time much more effective cleaning is affected than by use of the same amount of water at a lower velocity. In back-washing filtered water only should be used, the use of raw water leaves a deposit which will be carried to the boiler as soon as normal operation is resumed and furthermore any deposit left during the back-washing period has a tendency to permanently clog the filter.

---

*Editor of Power House.

In many power plants, the first method, that of adding a boiler compound to the feed water and allowing the reaction to take place within the boiler is in general use with satisfactory results.

Heating water drives off any carbon dioxide and also changes the soluble calcium bicarbonate to calcium carbonate, which, being practically insoluble, precipitates, collecting on the tubes and the boiler shell as scale, unless the boiler is blown down at frequent intervals.

Lime and Soda Used

The chemical treatment of a water containing calcium bicorbonate is usually accomplished by means of milk of lime or water containing an excess of lime. The reaction depends on the fact that the excess carbon dioxide is removed by the lime, turning the soluble bicarbonate into the insoluble carbonate.

Soda ash or sodium carbonate is required by some waters to soften them, others require both the soda and the lime.

Magnesium bicarbonate is treated with lime to form magnesium hydrate. As magnesium carbonate is soluble it will not precipitate until boiler concentrations are reached.

Calcium sulphate is treated with sodium carbonate, resulting in the formation of calcium carbonate and sodium sulphate, the calcium carbonate being insoluble, precipitates, the sodium sulphate remaining in the water in solution as like all sodium compounds, it has no scale forming properties.

Magnesium sulphate requires both lime and soda for treatment. A double reaction occurs, the lime causing calcium sulphate to be formed, which in turn is acted on by the sodium carbonate, resulting in the formation of calcium carbonate which, being insoluble, is precipitated.

For the removal of calcium chloride, sodium carbonate alone will suffice, forming calcium carbonate. Magnesium chloride requires both lime and soda.

The amount of lime and soda used should always be slightly in excess of that theoretically required. too little will leave some hardness in the water. an excess unduly raises the concentration of the water in the boiler.

Two Types in Use

For the chemical softening of water by the lime soda process there are two methods, the hot process and the cold process. The chemical reactions in each process are identical but as the reactions take place much more rapidly at high temperatures, smaller tanks and settling chambers are required with the hot method.

The essential parts of the chemical softener are:

(1) A tank or tanks for the reactions and the precipitation of the insoluble compounds formed during the reactions.

(2) A suitable means of automatically adding to the water the correct proportions of the chemicals.

(3) A filter to remove any precipitate which has not settled out in the settling tanks to prevent it being carried to the boiler.

Various automatic devices are on the market for controlling the amount of the chemicals fed to the water, but as the hardness in water may vary from day to day, the companies often furnish small testing equipment by means of which the engineer can sample the feed water from time to time and determine the proper amount of chemical to be used.

The hot process is favored by some engineers, especially where the feed water is heated by exhaust steam before entering the boiler. In this way the feed water heater and the hot process for softening the water can be combined.

Reactions in the lime soda process are almost instantaneous in water over 200 deg. F., whereas with cold water several hours are necessary to insure completion.

The advantages claimed for the hot flow treatment are numerous, the driving off of practically the whole of the dissolved gases, preventing corrosion in the boiler, the saving due to exhaust steam heating the water which otherwise might be wasted; complete reaction within the tanks preventing scaling of the boiler feed pumps and pipe lines, the fact that the sludge formed is insoluble in hot water, so that when the water enters the boiler it has a very low residual hardness, and the small tanks required for the reactions.

On the other hand the cold process offers better control of the reaction and more time for the precipitate to settle.

Blow Down Losses

Blowing down is essential to keep a boiler clean, and when compounds are used, to keep the concentration down to a point that will insure freedom from priming and foaming. No more blowing down than is necessary should be resorted to, however, as it is wasteful.

Assume that in a modern boiler room supplying steam for industrial purposes at 200 lb. gauge and at 388 deg. F. the water rate is 12,000 lb. per hour., with boiler feed at 60 deg. F., If 5% is a normal amount for blow down then

Water blown down per H.P. hr.=60 lb.

Heat lost per H.P. hr. in blow down .60 x (361-28)=200 B.t.u.

Useful heat in one lb. of coal 9 x 1171 =10,539 B.t.u.

Coal consumed per hour in blow down

$$\frac{200}{10{,}539} = .019 \text{ lb.}$$

If the coal cost $7 a ton at the plant and $1 to get it from the yard to the furnace and to fire it, the cost of blowing down per year for the 1 000 H.P. boiler room is

$$\frac{1000 \times .019 \times 8760 \times 8}{2000} = \$665$$

Exchange

The latest method of softening water for boiler feed purposes consists of a tank containing a thick bed of artificial or natural mineral, more or less finely ground.

This mineral turns the hardening salts in the water into others which are not scale forming. The principle involved is the transference of the salts of calcium and magnesia into the non-hardening salts of sodium by contact with the filter bed. As the water is passed through the filter and discharged as softened water, the sodium salts in the bed are gradually changed to calcium and magnesium salts.

The rate of flow through the filter has little or no effect on the reaction provided, of course, that sufficient time is given for the exchange to take place. As it is solely a matter of exchanging sodium salts for calcium and magnesium, then after each regeneration only a definite amount of water can be softened. The frequency of regeneration is then dependent on two factors, the hardness of the water, and volume.

Announcements

The name of the Quebec Railway, Light, Heat & Power Co., has been changed to the Quebec Power Co.

E. Laurie Co., 243 Bleury St., Montreal, has been awarded the contract for furnishing a 6,000,000 gal. pump for the Notre Dame de Grace pumping station.

Fraser & Chalmers of Canada, Ltd., Canada Cement Building, Montreal, have received an order from the Corporation of the City of Swift Current, Swift Current, Sask., for a 700 gallon centrifugal pump direct connected to a 67 K.V.A. synchronous motor, together with necessary starting equipment and control panels.

Through Arthur S. Leitch Co., Kent Building, Toronto. the following installations have been made recently:—

Two duplex condensation pumps, one motor-driven and the other with coppus steam turbine, in the Ford assembly plant, Toronto. Long & Edwards, New York, contractors.

A Sim's heater in Trinity College school. Port Hope Ont., Bennett & Wright, 72 Queen St., E., Toronto, contractors.

A Sim's heater in the Hamilton Hospital, Hamilton. E. J. Madden, Hamilton. contractor.

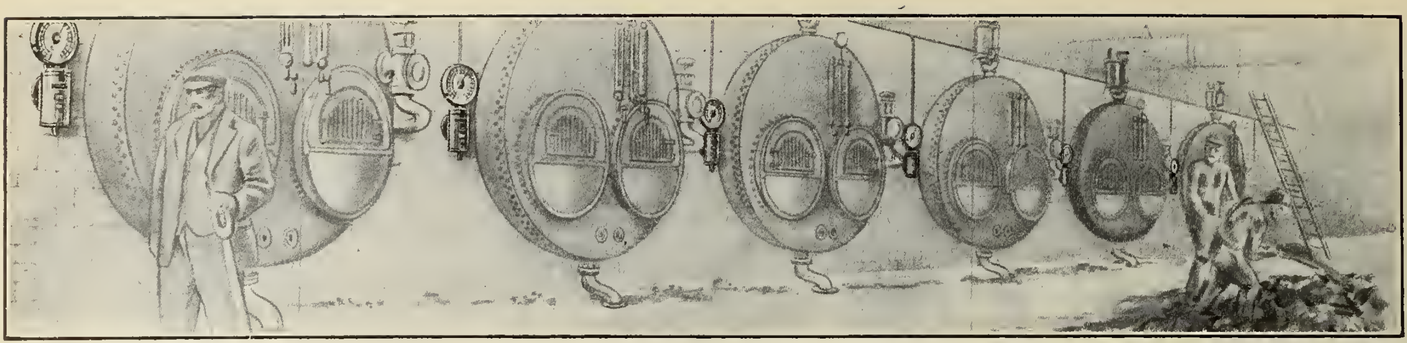
Sim's heaters. and Armstrong traps. for the Toronto Housing Commission. Bennett & Wright, 72 Queen St., E., Toronto, contractors.

Jenning's pump, for hytor vacuum heating system. in the Silverthorne School, Silverthorne, Ont.

Kieley reducing valves. and Armstrong traps in the plant of the Reg. N. Boxer Co., Foy Building, Toronto.

Jennings hytor-vacuum heating pump in the Courthouse at Portage la Prairie. Man.

Sim's heater and generators at the Weston Sanitorium. Weston. Ont.



Easy Engineering Lessons in the Power House

By **M. BARRY WATSON, B.A.Sc., M.E.**
Director of Engineering, Central Technical School, Toronto.

THE USE OF SUPERHEAT

THE extensive use of superheated steam in power generation is a comparatively modern practice, although for many years previous to its general adoption engineers had appreciated its value in increasing steam engine economy. The chief reasons for the delay in its practical adoption were due solely to mechanical difficulties in its production and use, and the increased cost of maintenance consequent on its use.

In recent years the above mentioned difficulties have been largely overcome, so that to-day superheated steam is used extensively in all large plants, and is quite usual in locomotive practice.

What Superheat Means

Before going further it may be well to give a short explanation of what superheat means as applied to the generation and use of steam. Water, when heated in a closed vessel, commences to turn into steam, which as long as there is still some water remaining, is known as saturated steam. If more heat is added to the vessel, more of the water will be turned into steam without any increase in temperature if the pressure is kept constant.

There is always a definite relation between the temperature and pressure of saturated steam. That is, saturated steam at any particular pressure always has the same temperature. However, if some of the saturated steam is allowed to flow into another vessel where no water is present, and heat is added to it, the temperature of the steam will rise even though the pressure is held constant. This steam of a higher temperature than that corresponding to its pressure, is known as superheated steam.

Temperatures in engineering work are measured in degrees Fahrenheit, while amounts of heat are measured in British thermal units. Superheat is measured in degrees F. and while engineers very often speak of the "amount of superheat," it would more correctly be spoken of as the "degree of superheat." However, the "amount" or the "degree" of superheat is expressed as the number of degrees F. by which the temperature of the steam in question exceeds the temperature of saturated steam at that pressure.

For example, let us suppose our steam gauge reads 140 lbs. per sq. in. pressure while our steam thermometer reads 480 degrees F. By reference to a steam table, we find that the temperature of saturated steam at 140 pounds gauge pressure is about 361 degrees F. Thus the steam in question would be said to have 480—361=119 degrees of superheat.

How Superheat is Obtained

The superheating of steam is accomplished by passing the steam after it is drawn from the boiler through a series of tubes which are in contact with the hot gases from the fire. These tubes may be incorporated as part of the boiler unit as shown in Figure I, where the hot gases come in contact with them after having come through the first pass of the boiler; or they may constitute an independent unit known as an independently fired superheater.

In the separately fired superheater there is sometimes a separate section functioning as a boiler operated in conjunction with it and which adds its steam to that of the other boilers supplying the superheater. The purpose of this boiler section is to take the first intense heat from the gases after they leave the fire, because steam alone in the tubes will not absorb heat fast enough from the tubes to keep the latter from burning if the temperature of the gases circulating around them is much over 1,500 degrees F. whereas water has good heat conductivity and will keep the tubes sufficiently cool to prevent burning with even the hottest fire temperatures on the other side of the tubes.

Burning Out Tubes

In connection with the final statement above, it is sometimes asked why it is that boiler tubes have been known to burn when there was water in the boiler. The answer is that there could not have been water in contact with the tube that burned, and there are two causes for such a possible condition to exist.

First, and most usual cause, is a thick coating of scale on the tubes which keeps the water out of contact with the tubes, and itself being a fairly poor

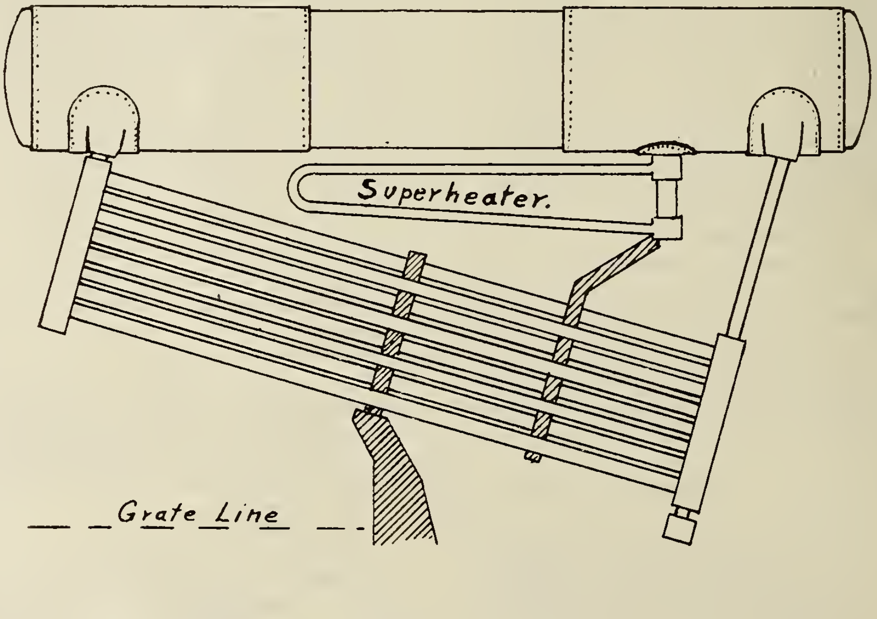


FIGURE I.

conductor of heat does not keep the tube below the burning temperature of the steel.

Secondly, the circulation of water in the tubes of some boilers may become so poor, usually on account of dirt in the boiler, that the steam may not be able to rise into the body of the boiler as fast as it is made, and may therefore fill a tube with nothing but steam, when of course there will not be water in contact with the tubes.

Another type of superheater consists of a number of close bent tubes, one of which is illustrated in figure II. The two ends of each bend connect to headers in the smoke box while each bend extends into one of the fire tubes of a fire tube boiler. This type is extensively used in locomotive practice. Its chief objections are the extra resistance to the draft, and the fact that the superheaters must be removed when the tubes are to be cleaned.

Why Superheat is Used

The primary object of using superheat in steam power work is of course economy of fuel. We shall now try to understand at least some of the reasons for this increase in efficiency with the use of superheat. In the first place the thermodynamic efficiency of the steam engine depends on the difference in the temperatures between the entering and the exhausting steam. The writer will not try to explain this fact in this short lesson, but will try to show that by the use of superheat we will get a greater difference in temperature between the live and exhaust steam, therefore from the above stated fact it will be seen that the efficiency of the engine will be increased.

Let us look for a moment at the action of steam inside an engine cylinder. If the steam is saturated, when it first enters the cylinder it starts to warm up the walls of the cylinder, thus some of the steam condenses and makes room for more to be forced in from the valve chest. In the case of superheated steam, a small loss of heat will lower the temperature without causing condensation, therefore there will be less of the superheated steam used per stroke with the same pressure and valve setting. At the same time it is found that superheated steam will not conduct heat nearly as well as saturated steam, therefore the cylinder walls will not be able to absorb so much heat, even though the temperature of the steam is higher. When the steam has expanded and its temperature has gone down, the water that was condensed in the case of the saturated steam is now cooler than the cylinder walls and re-absorbs some of the heat which it gave up and turns back into steam, too late, however, to produce any power worth considering, but raising the exhaust temperature and pressure. In the case of the superheated steam there is really less steam in the cylinder, there is no water to absorb heat and evaporate, and the conductivity of the superheated steam is so poor that it does not asborb enough heat from the warm cylinder walls to seriously increase the temperature or pressure of the exhaust steam. Thus the engine is seen to use less steam per stroke, and to have a lower exhaust temperature when using superheated steam, increasing the efficiency in two ways.

Besides the above advantages of superheat there is the advantage of having no drips or condensate from the steam mains or headers to take care of as the loss of heat from the piping merely reduces the superheat instead of condensing part of the steam. Also the steam arriving at the engines is always perfectly dry which precludes the necessity for separators and traps and prevents knocking in the engine, or pitting of turbine blades.

There is also a considerable saving in boiler capacity, or a bigger load may be carried on given boilers when superheat is used, because so much less superheated steam is used than when saturated. The same applies to the condenser and vacuum pump equipment. These represent a considerable saving in a large plant, not to mention the saving in cooling water and boiler feed equipment which may be effected.

Objections to Superheat

The chief difficulties met with in the use of superheat were in the maintenance of packing and lubrication. However, packing and oil manufacturers have now on the market goods which give perfect satisfaction and reasonable life with superheats higher than those most common in steam plants. Some engineers used to be of the opinion that the working of steam at such high temperatures and the freedom from water in the steam might weaken the piping, etc., sufficiently to cause extra hazard. However, as the majority of plants do not carry more than from 100 to 200 degrees of superheat, this is not a serious matter. Where high pressures and high superheat are used, however, the very best steel piping and fittings etc. must be used to have the requisite mechanical strength.

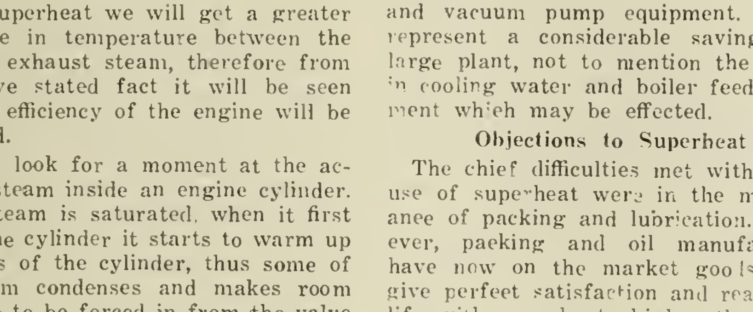


FIGURE II.

PIPE LINES

UNCOVERED IN ANY OLD SPOT

She—"Is there an art in kissing?"
Galt Fireman—"The only art is—Art thou willing?"

* * *

When connected in a circuit never leave the secondary of a current transformer (instrument transformer) open-circuited. Excessive voltage will be induced in the secondary and may break down the insulation or cause the transformer to heat excessively. If it becomes necessary to remove the instrument which the transformer serves, short-circuit the secondary with a jumper before disconnecting the instrument leads.

* * *

Engineer (trying to cut steak at Rochester convention of U C.C of E.)—"Say waiter, how was this steak cooked?"
Waiter—"Smothered in onions, sir."
Engineer—"Well, it died hard."

* * *

All solid foreign matter can be removed from transformer oil by putting it through about three thicknesses of bolting cloth. The best method for removing moisture is to pass the oil through a filter press. Transformer oil is considered in good condition when it does not break down at less than 40,000 volts impressed on ⅜-in. spheres, set 150 mills apart.

* * *

A Hamilton engineer was out still hunting last Saturday but after mooning around all afternoon all he succeeded in getting was a couple of swallows.

* * *

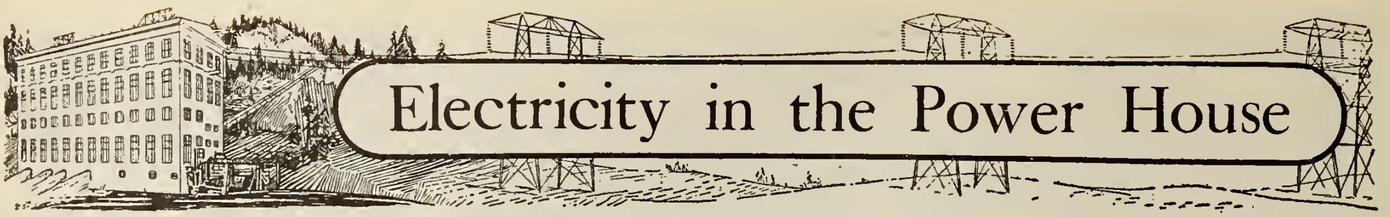
Although an oil-cooled, oil-insulated transformer is one of the most simple pieces of electrical equipment, it nevertheless should not be expected to operate continuously after being put into service without attention. An inspection should be made about once every six months. This should include a test of a sample of the oil drawn from the bottom of the tank and an examination of the interior of the tank.

* * *

Although many engineers insist that Adam was born in the morning, it is now generally believed that he was born a little before Eve.

* * *

When a battery is to remain out of commission for several months, give it an overcharge before allowing it to stand idle, and then, if possible, a freshening charge for about two hours every two months. If this cannot be done, the battery may be allowed to stand for not over six months without charging. Then the battery should be charged for about 50 hr. at half normal rate.



Electricity in the Power House

By J. A. BURNETT, M.E.I.C., Consulting Engineer, 513 New Birks Bldg., Montreal.

THE induction motor as installed and in daily service, is a remarkable development of recent times. Simple, reliable and reasonable in cost, it runs day in and day out. As made by standard companies, with good iron, insulated coils, and decent bearings, it requires little attention.

The design of the motor may be compared to a transformer, but with a moving (rotating) secondary. By the "primary" of an induction motor is meant, that part which receives energy by direct connection to the source of electric energy; the other member being called the "secondary." That member which remains stationary is called the "stator," and the revolving member is called the "rotor."

A "squirrel cage" rotor is one in which the conductors are straight bars of copper, connected together at each end of the rotor by copper rings. The windings comprising the primary are so grouped that, in case of a three-phase motor, there ensues a rotating field of energy, caused by the polyphase nature of the entering current, and as these phases rise and fall in value, the combined effect of the three groups of windings is merely to cause a rotation of these polar regions in the iron frame.

Number of Poles

The "number of poles" is always equal to the number of bands of conductors into which the total winding of each phase is divided. The bands of conductors forming one phase usually overlap the bands of conductors forming the other phase, there being then two or more conductors per slot. Now, when a three-phase voltage is impressed in the primary winding, the resultant magnetic flux in the iron remains constant in value at all times, but travels around the air gap with a speed of $N = \frac{120 F}{P}$ r. p. m. where f is the frequency of supply and p the number of poles.

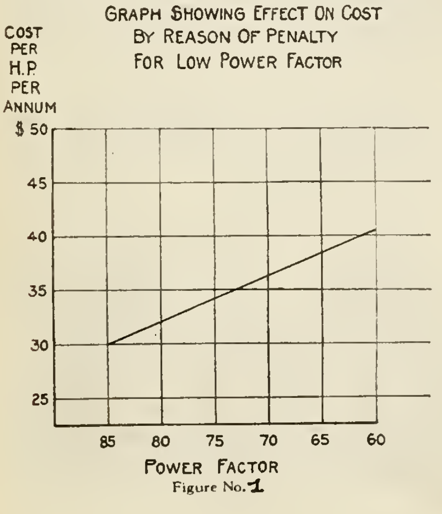


Figure No. 1

The speed of rotation of the air-gap flux, namely, the speed N given by the above formula is called "synchronous" speed. At light loads the speed of the motor is very nearly equal to this speed. The slip of an induction motor is the ratio of the difference between the actual speed (N_1) of the rotor and the synchronous speed (N) to the synchronous speed (N) or $S = \frac{N - N_1}{N}$. The slip is usually expressed as a percentage. The slip at standstill is unity; at no load it is very nearly zero.

Proportional to Slip

The electromotive forces in the secondary of the polyphase induction motor are induced by the rotation of the flux produced by the currents in the primary windings. The rotor electromotive force is therefore proportional to the slip and has a frequency equal to the product of the slip by the frequency in the primary. A noticeable feature is that the force on each conductor is always in the same direction and the total force acting on all the conductors is practically constant for a given value of the slip.

The current set up in the secondary of an induction motor produce a rotating flux, which travels with the same speed with respect to the primary, and in the same direction as the flux set up by the current in the primary, but the direction of this secondary flux at any point in the air gap is opposite to the direction of the primary flux. When there is current in the secondary the resultant flux is equal to the difference of these two fluxes. The primary current which would be necessary to produce this resultant flux is called the "magnetizing" current.

The rating of an induction motor should be the load in horsepower which it will deliver continuously at the shaft with a maximum rise in temperature of any part not exceeding 50 degrees centigrade by thermometer. However, certain motors for intermittent work, such as hoists, elevators, cranes, and swing-bridges, are rated in accordance with the output they will give for one hour. Any motor should be able to carry momentary overloads without "breaking down," as it is called, which means gradually decreasing in speed to a standstill when the load is excessive. The maximum output of the motor should be 50 per cent. greater than the rated output.

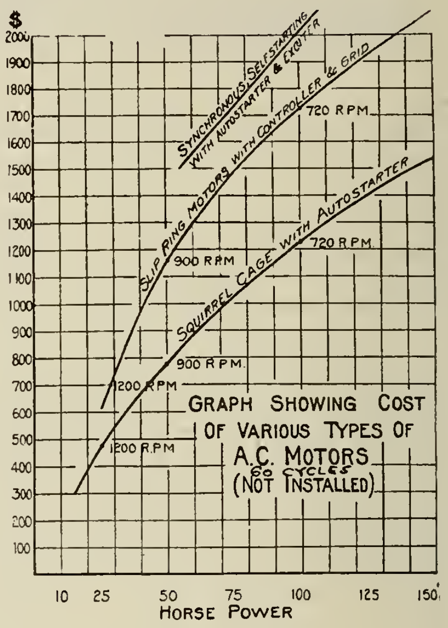


Figure No. 2

Prevailing Voltage

The prevailing voltage in Eastern Canada is 1 h.p. to 100 h.p., 550 v., and for 100 h.p., and up, 2200 v.

The prevailing frequency in Eastern Canada is 60-cycles per second. The Hydro-Electric system of Ontario is mainly 25 cycles. The 25-cycle motors cost about 10 per cent. more than 60-cycle motors owing to the larger amount of iron and copper required.

The designers of induction motors endevor to produce motors with as small an air gap, between rotor and stator, as may be consistent with mechanical operation. The air gap is generally one mil for each inch of rotor diameter, to be more exact:

Rotor Diameter	Air Gap
12 to 26	.032 in.
26 to 50	.050 in.

It can be seen, therefore, that in order to obtain a good power factor, (kilowatts ÷ kilo-volt-amperes) a motor with a fairly small diameter rotor is desirable. Thus the favorite speeds may be taken as follows:

Motor Rating	
0—10 h.p.	1800 r.p.m.
10—30 h.p.	1200 r.p.m.
30—50 h.p.	900 r.p.m.

Low Power Factor

Owing to the fact that the standard form of electric power contract exacts a penalty from the consumer for low power factor, this feature is now receiving the attention of power users. This

(Turn to page 43)

Practical Ideas From Practical Men

*OIL OR COAL

MANY Canadian engineers, confronted with the problem of discarding coal as a fuel in favor of oil, are interested in determining whether or not such a "change over" will prove economical in their plant, and the accompanying chart may prove of value in deciding the question.

To use the chart it is merely necessary to zigzag across as indicated by the dotted lines and column G, which is pointed at by the arrow at the top, tells the number of B. t. u.'s there are to each ton of coal or gallon of oil purchased. That is, column G applies to both oil and coal.

In figuring the oil begin at the left and zigzag toward the right to column G. In figuring coal begin at the right and zigzag toward the left to column G. If the oil, for instance, contains 20,000 B. t. u.'s, and the specific gravity is 0.9, and if the boiler efficiency with oil fuel is 80 per cent., the zigzag dotted line respective figures show that each cent will buy 24,000 B. t. u.'s.

Begin at the 5c. column A, and run through the 80 per cent., column B, with a straight line. This locates the intersection with column C. From this intersection in column E go through the 0.9 column F, and the final intersection with column G gives us the answer—24 000 B. t. u.'s for each cent.

Now comparing with coal, we begin at the right. If coal costs $8,00 per ton of 2,000 lbs., and if the boiler efficiency, using the same boiler as above is 70 per cent. with coal, and if each lb. of coal contains 11,000 B. t. u.'s, each cent will buy about 19,200 B. t. u.'s, as shown in column G.

As will be noted, the $8.00 is found in column L, 70 per cent. boiler efficiency is in column K. Run a straight line through both points and locate the intersection in column J; run a straight line through the 11,000 in column H, and the intersection with column G gives us 19,200 B. t. u.'s.

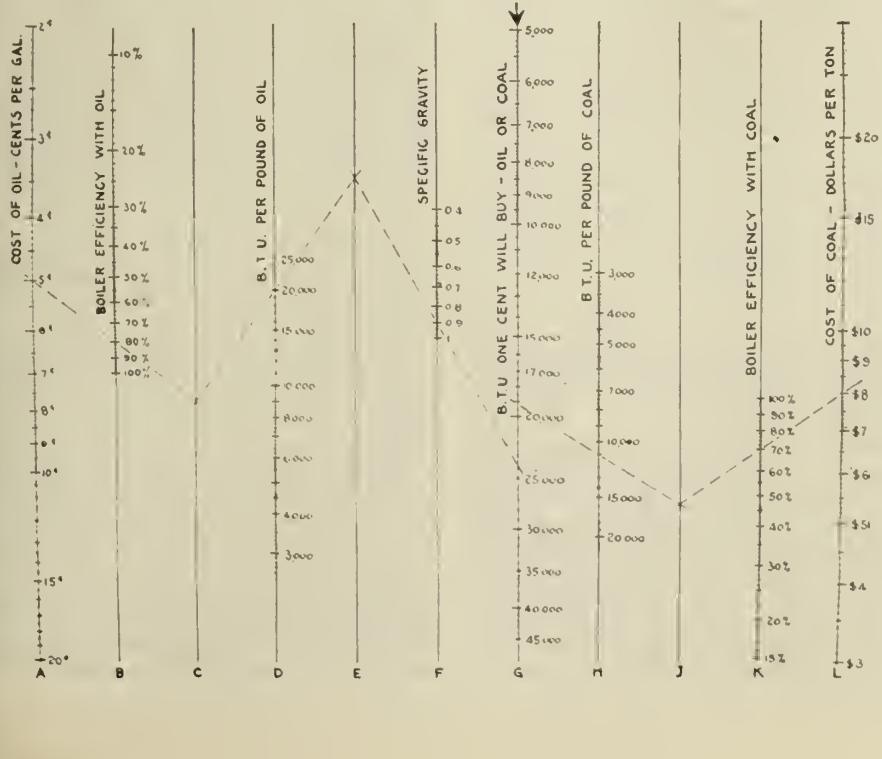
In other words, the solution of this problem indicates that the use of this oil at 5c. per gallon will furnish nearly 5,000 B. t. u.'s more for each cent than will coal at $8.00 per ton.

In using column A the cost per gallon should include all costs—cost of hauling, cost of storing, etc.

It is well known that boiler efficiencies with oil are usually greater than with coal. The difference, it has been claimed, is as much as 10 per cent., as in this problem where we use 80 per cent. column B and 70 per cent. in column K.

Specific Gravity

Regarding specific gravity, given in column F, an easy way in which to determine this is to take any vessel, such as a pail, jug, or bottle, and weigh it. Then fill it with water and weigh again. Subtracting the weight of the vessel gives us the weight of the water. Now do the same with oil and the exact weight of the oil by the weight of the water. The quotient is the specific gravity. The less delicate scales used for weighing the greater should be the size of the vessel.



Where a sample of the oil is not available and where the density of the oil is given in degrees, Baume, the following table will be found useful in connection with column F:

Degrees Baume	Specific Gravity
10	1.0
15	0.97
20	.93
25	.90
30	.88
35	.85
40	.82
45	.80
50	.78
55	.76
60	.74
65	.72
70	.70
75	.68
80	.67
85	.65
90	.64
95	.62
100	.61

To calculate the specific gravity, knowing the degrees Baume, simply add the degrees Baume to 130 and divide the sum into 140. The quotient is the specific gravity.

As for the cost of coal, column L, this is similar to column A and must include all costs, such as hauling, storing, pulverizing, and, if purchased some time ago, the interest on the purchase price.

Solves Other Problems

This chart may be used in several ways for solving various problems. Thus, by zigzagging clear across from left to right from column A to column L; knowing the cost of oil and all the necessary intermediate factors, column L gives the equivalent cost of coal. Or zigzagging toward the left from column L we get the equivalent cost of oil.

Thus, with coal at $6.00 per ton, and the boiler efficiency at 70 per cent., we would find that a heat value of 10,300 B. t. u.'s per pound of coal would give us no advantage in using oil as regards cost of oil. But oil has other advantages, such as less labor required for firing, less storage space required, etc.

All of these points must be given consideration before one can decide whether oil should be used in preference to coal.

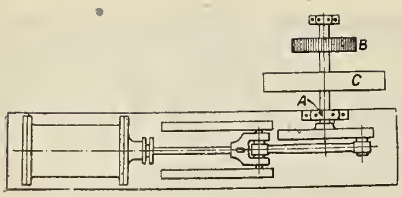
TRUEING A SHAFT

The following sketch shows a simple horizontal steam engine, 10-in cylinder diam. by 18-in. stroke, which once became uncoupled while running, owing to the crosshead cotter working out. As would be expected, considerable damage was done, and among other things the crankshaft was bent at the journal A, giving a "wobble" of about 2½ in. at the perimeter of the disc crank.

On the crankshaft was a steel gear wheel B, in halves, which transmitted

---

*Copyright 1923 by W. F. Schaphorst.



Trueing a Shaft.

the drive, also a heavy solid flywheel C, which had practically "grown on" the shaft, and which defied all attempts at trying to move it. As the job was making slow progress, the following method was tried:

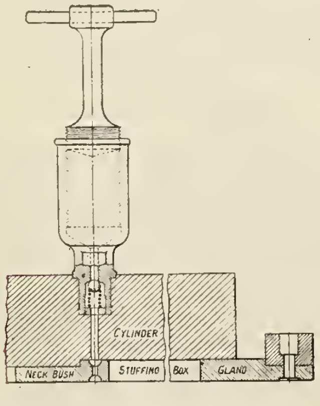
First, the steel wheel B was removed, then the brasses in the bent journal pedestal were "let down" until there was a slight amount of "nip," the big and little end cotters were eased back. The engine now having no load, was run sharply for five minutes, during which time the cap bolts at A were tightened, and thus nipping the shaft, until it was thought to be sufficiently hot. The engine was then stopped and a screw jack placed against the full part of the crank case, and it was pushed back until it ran practically dead true.

The journal was afterwards filed up, and the brasses refitted, and the engine ran for some years after the above incident, without any further trouble.

LUBRICATING RAMS

Provisional protection has recently been granted in Great Britain for a system of lubrication which will be of interest to engineers generally.

It is a well-known fact that so long as the packing contained in any stuffing-box can be kept lubricated, so long will the packing last and thus prevent the scoring of the ram. The idea consists in the placing of a lubricator on the inside or pressure side of the stuffing-box. The flange of the neck bush is grooved round the outside and inside and a number of holes drilled to connect both. The lubricator, which is provided with a non-return valve, is fixed so that the grease finds its way round the outer groove through the drilled holes into the inner groove and from there on to the ram or rod and through the packing.



Lubricating Rams.

The ram and packing are thus lubricated during the no-pressure stroke, while during the pressure stroke the pressure itself forces the lubricant through the stuffing-box.

This system was installed three months ago on a set of high-pressure hydraulic pumps which had been giving the usual trouble met with on this class of machinery, viz., scoring of rams and continual re-packing.

When the pump had been running two months all the packing was taken out for inspection and found to be as good as new and well saturated with grease. Naturally, working under such conditions, no scoring of the rams had taken place. Ordinary hemp packing was used, which, besides being much less expensive, absorbs the grease better than the more expensive fabric packings.

Efficiency Now C.A.S.E. Goal

Executive Secretary Lauds Educational Value of Melvern F. Thomas Article in Power House

By GEORGE J. SOUCY

QUITE recently an excellent and timely article appeared in Power House, written by Melvern F. Thomas, on the subject of Power Plant Efficiency, which tended to show that this much-desired result was dependent on the engineer. I would urge all engineers who have not read this article to obtain a copy of the June 20 issue of Power House and consider all the points set forth in it. Every engineer would then come to the conclusion that he should avail himself of any opportunity offered to acquire the knowledge and competency which will enable him to operate a power plant efficiently.

The Canadian Association of Stationary Engineers of the Dominion of Canada encourage the technical education of stationary engineers and propose to supplement same wherever the opportunity offers by forming classes under the guidance of practical engineers to demonstrate the practical application of technical education. The C.A.S.E. was a pioneer in the matter of technical education in Canada and it is to be noted that the first industrial board formed in Toronto for the technical education of the workers was championed by the founders of the C.A.S.E.

While the C.A.S.E. has not made the progress it should have, it still has opportunity to serve ambitious engineers, and if it renders that service there need be no doubt as to its future popularity.

Raps Lack of Interest

In regard to the lack of interest in the question of power plant efficiency, there is no need of avoiding the issue. Many engineers make no effort to equip themselves with the necessary knowledge and training to operate a power plant efficiently because they feel that "no substantial encouragement has been offered them," and that they "are merely a necessary evil to plant operation." Further, they conclude wrongly that no amount of saving in fuel or maintenance cost will elevate their position or gain recognition from their employers.

That, of course, is an entirely wrong conclusion, for as soon as an employer is brought to realize, by articles such as that written by Melvern F. Thomas, that the engineer should be encouraged to operate his plant more efficiently, he will see that every opportunity is afforded his engineer to acquire the necessary knowledge and training to enable him to operate it efficiently. In fact, it will soon be recognized as a national duty by both the employer and the engineer to conserve our fuel resources, and that means the efficient operation of power plants.

To Extend Branches

As soon as there is manifested the demand in any locality for instruction and training, the C.A.S.E. will rise to the occasion and extend its branches. It now invites all those who are fitted by experience to instruct others to join the ranks and offer their service for the general uplift of their fellows, and to be ready to meet the demand which is sure to come soon for classes of instruction in practical operation.

Any information required will be furnished gladly by George J. Soucy, executive secretary of the C.A.S.E., 48 Moore Ave., Toronto.

Trade Catalogs

The Combustion Engineering Corporation, Limited, of Canada, have issued a new bulletin describing the Coxe Traveling Grate Stoker, emphasizing its performance in burning small sized anthracite coals and coke breeze. The special features claimed for this stoker are the control of the air to the fuel bed by means of compartments, rugged construction and ease of drive, special construction of the grate eliminating ash at the forward end of the stoker.

The Underfeed Stoker Company of Canada have issued a bulletin describing the new Riley Underfeed Super Stoker.

The advantages claimed for it are, long travel of the fuel, control of the air by dividing the underfeed section into two air zones with a separate zone for the overfeed section, a two speed gear box, the use of flared retort sides and moving high side tuyeres to control the fuel bed, a renewable wearing strip in each retort cylinder and the addition of a rotary clinker crusher.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

DAIRY REFRIGERATION

I desire information in regard to the different types of refrigeration and ice-making machinery now on the market. The particular installation in question is in connection with a small dairy plant. It will be necessary to make ice in moderately small quantities.—B. K.

Answer:—Usually small horizontal double-acting ammonia compressors, or small vertical single-acting enclosed type compressors are used for producing refrigeration for dairies. These compressors may be actuated by any type of prime mover. However, the best type seems to be the electric motor, and, then, after that, the steam engine.

Mechanical refrigeration in dairy plants is generally produced by the direct expansion of ammonia in coils which are submerged in brine. The brine is then in turn pumped to the rooms or apparatus where refrigeration is required. In a smaller sized plant, the storage brine and the size of the refrigeration plant is such that the machine need only operate eight to twelve hours per day and still maintain the required temperature. In slightly larger plants, the storage capacity of the brine is smaller and the ammonia compressor is relatively smaller, and the plant is made to operate throughout the twenty-four hours.

The design and specification of a refrigeration plant for a small dairy is a technical problem which can be solved after all of the factors are known. The most efficient manner of proceeding with this work is to ask for competitive bids from prominent manufacturers of refrigeration apparatus. You will find many advertisements of the manufacturers of apparatus in the columns of Power House.

PRESSURE LUBRICATION

A footstep bearing, on a vertical shaft 8 in. in diameter and about 50 ft. long, has been giving trouble. Suggestions would be welcomed for the lubrication of this by pressure, if it be possible, or would ball or roller bearings be feasible?

Ans.:—Under ordinary conditions it is, as a rule, not advisable to load plain footstep bearings to a greater pressure than 200 lbs. per sq. in. If special attention is paid to lubrication, this may be increased to 400 lb. per sq. in.

One of the methods of reducing the tendency to seize is to place a number of steel discs between the bearing surface of the shaft and the bearing itself. These have oil channels in the usual way, and are kept lubricated in the usual manner. The idea is that, if the lubrication between any pair of discs becomes faulty, there are still other surfaces adequately lubricated.

Although forced lubrication could, no doubt, be arranged, the cost of this would be very little different from the cost of having a roller bearing fitted, and the latter would soon pay for itself in the decreased attention required.

If the work is very heavy, the cylindrical type with divided rollers would, probably, be the best to install, but, under lighter conditions, the conical type would suffice.

TESTING AMMONIA

Will you advise us a simple method of testing anhydrous ammonia for purity.—J. T.

Answer:—The purity of anhydrous ammonia may be tested in a number of practical ways. The most common as well as the most effective test is that one of evaporation. To test a sample of liquid ammonia it is best to use a flat bottomed boiling flask with a wide neck, which can be obtained from any dealer in chemical supplies.

Some manufacturers supply these flasks and also a piece of bent pipe for withdrawing the sample. Care should be taken when the sample is being drawn that moisture is not allowed to get into the sample. Thus, care should be taken that frost from the connection or moisture from the atmosphere does not get into the sample. It is best to draw the sample on a clear day. It is advisable to evaporate the sample by immersing the flask in a pail of water. This allows an even boiling and allows one to see into the flask. If, as the evaporation continues, the liquid assumes a cloudy appearance and this becomes more pronounced before the end of the test, it is usually an indication that traces of lubricating oil are present.

After the liquid has been evaporated, any residue remaining in the flask constitute the impurities in the ammonia.

If water is present, it can be detected by the small globules or drops that adhere to the inside of the flask.

If the flask becomes perfectly dry after the evaporation, this indicates that there are no liquid or solid impurities in the ammonia. The evaporative test, however, does not disclose the presence of gaseous impurities.

The presence of foreign gases may be detected in the following manner:

A shipping cylinder containing liquid ammonia is stood on end with the valve uppermost. A short piece of ¼-inch pipe is connected to the valve on the drum and the opposite end is placed in a pail of water. When the cylinder valve is opened slightly, bubbles will appear on the surfaces of water if permanent gases are present. If these bubbles appear intermittently with a cracking sound, this indicates that a mixture of ammonia and permanent gases are leaving the drum. These, then, are the simple and practical methods of determining the presence of impurities in ammonia.

PRESSURE FALLING OFF

Indicator diagrams taken from a 10 x 16-in. D slide-valve engine with throttling governor show considerable falling off of the pressure during admission. Could not the engine develop more power if fitted with a shaft governor?—G. BROWN.

Answer:—The falling away of admission pressure when the engine is loaded, to obtain the lowest running position of the present throttling governor, may be due to contracted steam ports and passages, and there would be the same defect of diagrams made with a shaft governor and balanced valve. The cut-off could not occur so late in the stroke, and although there might be better speed regulation and higher pressure during admission, less power could be developed than from the later cut-off with the throttling governor.

ICE AND SALT

The writer would like to know why the temperature drops when ice and salt are mixed.

Also how low a temperature can be reached with a combination of salt and ice?

Could sugar be used as well as salt? The writer has been told that sugar will cause a lowering in temperature.—G. D. A.

Answer:—The reason for lowering of temperature in a mixture of ice and salt or any other substance lies in the latent heat of fusion or the heat required to be taken up in order to cause a solid body to assume a liquid form. Heat is required to make a liquid body pass to a gaseous form and is also required to pass a solid body to a liquid form just as heat is taken up when water is boiled into steam, and also heat is taken up when ice is changed from a solid state to a liquid (water).

Most substances when mixed or dissolved one in the other give out a little heat called the "heat of association," but in many mixtures the heat of fusion is greater and the net amount of heat that has to be added is greater (refrigeration). This heat required to fuse ice plus the heat required to melt salt or reduce both to a liquid state (brine) is greater than the chemical affinity of water and chloride of sodium—hence heat has to be taken from the substances that compose the mixture and so its temperature is lowered.

But the quantity of heat taken up available for refrigeration is small (although on a low plane of temperature) and the use of a mixture to produce low temperatures is only of service where small quantities of heat are required to be taken up at a low plane of temperature and it may be inconvenient or expensive to procure an apparatus to take up the heat (or produce refrigeration) at a much lower operating cost per unit of refrigeration produced. Where considerable quantities of heat are to be taken up it is cheaper to use another method.

The use of ice and a salt produces lower temperatures in the mix than a mix of a solid and water, though the latter can be used for the procurement of fairly low temperatures as a mix of nitrate of ammonia and water. In the first case it is evident that the ice already has a low temperature and contributes its heat of fusion as is also the heat of fusion of salt contributed, and the lowering of the temperature of the ice water and the lowering of the temperature of the salt (a small matter) to the final temperatures of the solution is not so great as it might be in the second case where the original temperature of both the salt and the water might be higher than ice. It must be remembered that the temperature obtained can never be lower than the freezing point of the solution. A mix of ice and water for example, cannot be finally lower than 32 as a mixture of 1 lb. of ice and 1 lb. of water at 176 F. will result in a mixture containing 2 lb. of water at 32 degrees.

A mix of 3 lb. of salt and one pound of ice can be made and a temperature of —5 F. obtained, which is about the lowest temperature that can be obtained by a mix of ice and salt considering the heat of fusion, the specific heat and the heat of association of ice and chloride of sodium. One pound of each will make a mixture that will go to about zero.

Sugar can be used mixed with ice to produce low temperatures, but the results will be slightly different on account of the slight differences of heat of fusion and the specific heat of sugar compared to salt.

Refrigerating effect is only obtained by the rise in temperature of the mixture. Chloride of calcium added to water produces heat in the mix—added to snow or ice it produces as low a temperature as —436, if mixed in the proportion of 2 lb. calcium chloride to 1 of ice, because of the original low temperature of the ice and the combined heat of fusion of ice and chloride of calcium which considerably overcomes the heat evolved by what might be called the chemical "heat of association."

The expense of boiling off the water of the solution in order to recover the salt so it can be used over again is vastly more than the expense of reducing an amount of gas to a liquid which by evaporating again to a gas will take up the same amount of heat (i.e., produce usable refrigeration).

SETTING PUMP VALVES

What is the method of setting the steam valves of a duplex pump?—WINNIPEG.

Answer:—The general rule for setting the valves is to place the pistons of both sides at the centre of the stroke and set the steam valves centrally over their ports. As there is lap, the outer edge of the valves will be on line with the inner edges of the steam ports. In that position the valve-rod clearance or lost motion of each valve must be evenly divided so there will be the same amount of lost motion for movement of the valve in either direction.

To place the pistons at the centre of the stroke, move them to contact first with one head and then with the other and mark the positions of each on its piston rod against the piston-rod gland. Then place a mark on each rod midway between the marks made at contacts and move the rods until the central marks come against the ends of the glands. The pistons then will be in central positions and the valve-motion arms should stand perpendicular to the piston rods. If that is not the case, the crosshead spools must be disconnected and the positions corrected. Next remove the steam-chest covers and place the slide valves centrally over the ports and adjust the lost motion so each valve will have the same clearance for movement in either direction.

PRESSURE GAUGES

In checking up a pressure gauge on a steam line, it is found that the gauge shows 10 lbs. higher than the actual pressure. Under the conditions is it proper to say that the gauge is heavy or that it is light?—O. N.

Answer:—A pressure gauge is said to be "heavy" when the pressure which it indicates is higher than the true pressure, and is said to be "light" when the pressure indicated is lower than the true pressure. The indications of a pressure gauge rarely are the same amount higher or lower than true pressure throughout the whole range of pressures indicated and a statement that the gauge is 10 lbs. heavy or light would be inexplicit unless coupled with a statement of true pressures at which the error occurs. When compared with a calibrated test gauge, the indications may be correct for the true pressure of 5 lb., but 10 lb. "heavy" or "light" for a true pressure of 50 lb. per square inch.

Personals

A. G. MacLachlan has been appointed assistant engineer with the Bancroft Power Co., Bancroft, Ont., with the hydro-electric power development.

H. P. Stephens, 2004 Dundas St., W., Toronto, has announced that he is in the power plant field as a consulting specialist in feedwater treatment for steam boilers.

Ewart G. Horne, formerly vice-president and manager of Lockwood, Greene & Co., of Canada, Ltd., has opened an office at 10 Cathcart St., Montreal, as consulting engineer.

C. J. Oliver, a 1923 graduate of McGill University, Montreal, has taken a position on the engineering staff of the Central Region of the Canadian National Railways, Toronto, in the mechanical and electrical engineering department.

A. S. Mansbridge has been transferred from the head office of the Trussed Concrete Steel Co., of Canada, Limited, Walkerville, Ont., to the Vancouver office of the company.

P. C. Ahern, a graduate in electrical engineering from McGill University, has been appointed to the engineering staff of the Canadian Westinghouse Co., Hamilton, Ont.

Brian R. Perry, formerly with Peter Lyall & Son Construction Co., has taken the position of representative of the MacKinnon Steel Co., Ltd., in Montreal.

It is reported that the directorate of the new Ottawa & Hull Power Co. will be composed of the following:—Sir Henry K. Egan, J. B. Fraser, John A. Cameron, and E. R. Bremner, all of Ottawa, and J. B. Woodyall, vice-president of the Southern Canada Power, and A. J. Nesbitt, of Montreal.

G. I. Hambly, manager of the sales department of the Imperial Oil, Limited, Toronto, has retired, and Col. E. A. Olver, who has been manager of the Ottawa office, will succeed him. D. S. Bell, formerly connected with the Imperial Oil, in Halifax, N. S., has been appointed manager of the Ottawa office.

K. C. Mason, formerly with the Edison Illuminating Co., Brockton, Mass., has been appointed Light and Power Department Superintendent of the Nova Scotia Tramways & Power Co., Ltd., Halifax, N.S., and J. B. Bulley, formerly superintendent of the Tramway department of the Cape Breton Electric Co., Ltd., has been appointed superintendent of the Tramway Department of the Nova Scotia Tramways & Power Co., Ltd., both positions being left vacant by the appointment of M. C. Smith as manager of the Cape Breton Electric Co., Sydney, N.S.

POWER PLANT EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA
TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK & WILCOX, LIMITED

Toronto Office
Bank of Hamilton Building

ST. HENRY—MONTREAL

Progress in New Power Equipment

A NEW STOKER

A new mechanical stoker of interesting design, for all grades of bituminous coal and lignite, heads a list of several new products announced by the McClave-Brooks, of Scranton, Pa.

The stoker is equipped with section-top grates having horizontal air space, designed to prevent sifting of fine unburned fuel. The kicker bars are so arranged that in operating there is a complete seal on the heel as well as on the front end of each bar. The kicking movement is automatically controlled, and any kicking position from minimum to maximum can be obtained by a simple adjustment on the front operating shaft. It is also possible to operate the bars in sections, so that any part of the fire can be worked independent of the remainder.

The coal pushers or feeders are operated mechanically, and the length of the stroke is not varied in the usual way, but is kept constant. The interval between feedings is regulated by a specially designed and patented timer, which enables a practically infinite variation of the feeding time.

Coal is fed from side wall to side wall. A pre-heated air arch is used, eliminating the need for special arch brick and supplying the requisite amount of oxygen where it is most needed—in the coking zone—to drive off the volatile gases and eliminate smoke.

The stoker is designed to be driven by steam engine, steam turbine or electric motor, and is equipped with a four-speed gear reduction. In addition, the speed of the driving engine or motor is independently controlled, permitting further variation in operating.

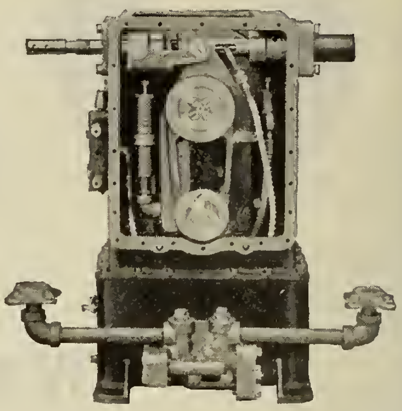
One interesting feature of this stoker is the provision made for hand operation in case of emergency. A clutch disengages the power drive and converts the stoker into a hopper-feed hand stoker in a few seconds, enabling manual operation of the coal pushers and kicker bars. This feature permits the stoker to be kept in service despite power failure of other accident to the mechanism.

A VARIABLE DELIVERY PUMP

The Oilgear Company of Milwaukee has recently perfected a variable delivery pump known as the Oilgear Type W. This pump is designed especially for hydraulic presses and similar service. It has a maximum capacity of 3,060 cubic inches per minute. The maximum working pressure is 1,000 lbs. per square inch.

According to the manufacturer, the flow of oil is steady and free from pulsations. The amount of oil delivered to the press cylinder is controlled by means of a single handle or lever attached to the stroke-changing mechanism through a hydraulically-operated control cylinder. The pump responds instantly and smoothly to the operation of the control handle. This instantaneous response applies both to varying the amount of oil delivered and to reversing the direction of delivery.

The design and construction of the essential parts of this new pump are similar to those in the Oilgear Type QC control pump. These parts include the revolving driver carrying the cross heads and plungers, the cylinder barrel and plungers, the ground ported pintle upon which the cylinder barrel rotates, and the swinging arm by means of which the revolving barrel may be shifted relative to the driver, in order to regulate the length of the pump stroke.

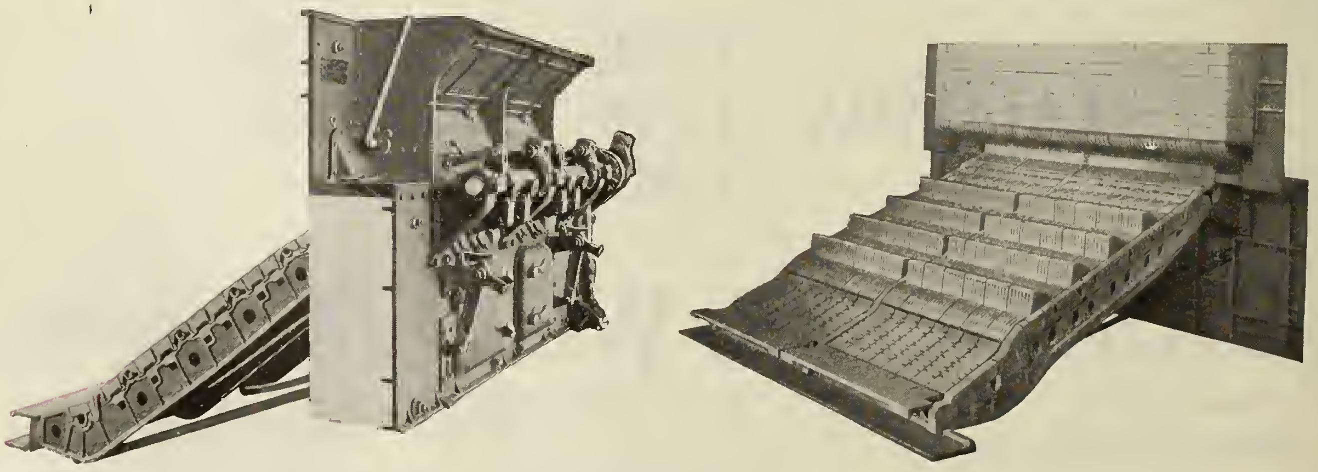


The assembly of the plungers and the cross heads differs from that in the type QC in that the plungers are closely coupled to the cross heads. This provides a suction action that makes it unnecessary to depend on a large auxiliary geared pump. The type W is equipped with a small gear pump to keep the running parts well lubricated and to operate the control cylinder.

The hydraulic control for regulating the stroke of the main pump consists of a double-acting hydraulic cylinder and a piston which is attached to the stroke-changing arm by a cross yoke and two links. These are so arranged that a heavy spring holds the pins at all times against one side of their bearings in the links, cross yoke and arm, thereby preventing any play in the joints.

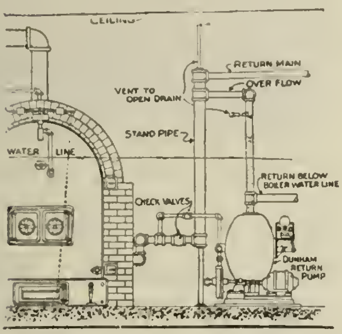
Oil pressure to the control cylinder is regulated by a small balanced piston valve that admits oil to one end of the cylinder and at the same time allows it to flow from the opposite end. This construction provides a hydraulic dashpot which holds the arm rigid in any position.

The oil is delivered from the ports through the passages in the main pintle down through one of the two passages provided in the casting which forms the arm on which the pump unit rotates.



New McClave-Brooks Mechanical Stoker.

Dunham Return Pump
Type R.L.P.
and its application.



The Dunham Condensation Pump is Economical and Automatic

THIS Dunham Return Pump is an automatic, electrically operated centrifugal pump that returns the condensate from heating systems or process work back to the boiler, heater, hot well or other storage.

It eliminates the waste of condensate from heating systems where returns are below the water line and as the return is made as the condensate accumulates improved heating and a saving of fuel result. Being electrically driven, there are none of the difficulties caused by low pressure steam pumps when fires are banked for the night. The Dunham Return Pump operates without attention day and night. It is stopped and started by a float switch.

WRITE FOR FULL DETAILS

C. A. DUNHAM CO., Ltd., Toronto, Ont.

Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary.
London, Eng.: 18 St. Thomas St., S.E.1.

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE

(MADE IN CANADA)

ELECTRICAL POWER

(Continued from page 36)

penalty, as illustrated in Fig. 1, may reach 15 per cent. of the total bill for electric power. It, therefore, behooves all users to carefully investigate this feature and to see what measures may be taken to correct low power factor.

The remedies available are:

1. Rearrangement of motors, so that any underloaded motors may be replaced by fully-loaded motors.
2. Sell the underloaded motors and install suitably loaded motors.
3. Take out one of the larger underloaded induction motors and install a self-starting synchronous motor and exciter.
4. Install an oil-immersed static condenser, as an adjunct to the equipment.

A great deal may be said as regards these methods, but, briefly, remedy No. 1 has the merit of small cost for re-arrangement, but very few installations will permit of this being successfully carried out; remedy No. 2 has the difficulty that in case, say, 250 h.p. of induction motors are released and sold, and 150 h.p. motors are required, it will be found that, contrary to expectations, a considerable sum of money must be expended.

This is due to the fact that the responsible dealer who buys the motors will necessarily inspect and overhaul the old motors, and as a year's guarantee is expected for the incoming lot of motors (of smaller size) the dealer will charge an appreciable figure for the change.

Remedy No. 3 will generally be found the best all around arrangement. The manufacturers have developed a self-starting synchronous motor, almost as simple as an induction motor, and at a reasonable cost. This motor may be brought to speed by an unskilled attendant or by an attendant who is trained in some process work in the plant, and with no electrical knowledge.

Figure No. 2 shows the relative cost of various types of A. C. motors.

In analyzing such conditions, each case must be taken on its merits, and the services of a qualified engineer are often of advantage to the user.

Miscellaneous

The Canadian Barrels & Kegs, Ltd., Waterloo, Ontario, will equip their dry kiln plant with Jennings hytor vacuum pumps and Armstrong traps.

The Canada Electric Co., 175 King St. E., Toronto, have been awarded the contract for electrical work in connection with the $80,000 addition to the Earl Haig School, Toronto, and the new school being built on Turnberry Avenue, Toronto, at a cost of $100 000, by the Board of Education, Toronto.

H. M. Clark, president of the Clark Gold Mines Corporation, has completed arrangements for the electrification of the Montague Mines, Mount Uniacke, N.S., and other properties which his company recently acquired. A complete plant will be installed at the Montague Mines, and when the work of installing the power to the properties in question is finished, a number of other properties will be operated.

The Sarnia Oil & Gas Company, Sarnia, Ont., has announced that it has accepted plans for a factory to be built at Brantford, to convert natural gas into carbon black. The plant will be of automatic design, and the first unit to be erected will produce approximately two tons of carbon black and 1,000 gallons of absorption gas per day.

In an interim report of the Dominion Fuel Board, regarding the fuel situation in Canada, considerable space is devoted to the supply of peat that could be obtained from the provinces of Ontario, Manitoba, Quebec and New Brunswick. It is stated that out of the 37,000 square miles of peat bog in Canada, 12,000 lie in these provinces and would produce the equivalent in heating value of 5,400,000,000 tons of good coal. The board contends that this peat should be utilized to supply a part of Canada's fuel needs, especially in the Spring and Fall when the maximum of heat is unnecessary.

Comments in the Power Plant Field

LAUDS POWER HOUSE

Power House, Toronto, Ontario.

Campbell Bradshaw, Managing Editor

Dear Sir:—

In reply to your letter of July 26th I wish to say that you have been correctly informed as to our future plans regarding the C. A. S. E.

It is the intention of the present Grand Lodge officers to start an aggressive campaign to increase our membership, also bolster our morale.

The members of the C. A. S. E. in the future will win the esteem of all concerned by meriting it, and to merit esteem we are going to study, in order to advance in our chosen profession, the honorable one of stationary engineering.

Education and more education is our slogan from now on.

We are very fortunate in having as chairman of our educational committee, this year, F. S. Rutherford, organizer of technical education for Ontario.

I wish to sincerely thank you on behalf of the C. A. S. E. for the interest you are taking in regard to our future welfare, and hope to have the pleasure of meeting you in the near future.

I will forward my photo as soon as possible for publication. I certainly would like to meet each and every member of the C. A. S. E., but it is impossible at this time. But I pledge to do my level best to make a greater and better C. A. S. E.

I feel sure that with the help of Power House, yourself, and others, we will make it come true.

I accept your invitation to write your paper every two weeks and will mail a message soon. Enclosed please find cheque for one year's subscription.

With best wishes for the future success of Power House and the C. A. S. E., I am, very truly yours,

JAMES J. SULLIVAN,
Grand President.
20 Jeanne D'Arc St., Hull, Quebec.

EXAMINATION TACTICS

The Editor, Power House:

I was greatly astonished at statements made by the chairman of the Ontario Engineers' Examining Board at the dinner of the Canadian Association of Stationary Engineers, during the recent convention of that organization in Toronto.

J. M. Brown, the chairman of the board, said:

"I am endeavoring through my department to raise the status of the engineers in Ontario by making the examinations of such a nature that the answers will classify the applicants as efficiency engineers."

Continuing, Mr. Brown said: "Last year there were about 8.000 engineers' certificates issued in Ontario, of this number about 70 were first-class certificates, and of the total number who sat for examination, in all grades, about 70 per cent. failed to pass. I was surprised at the number of men who hold British Board of Trade papers, who fail in our examinations.

"You need not worry that there will be a surplus of engineers, as I watch the employment situation, and when positions are scarce for engineers I make the examinations more difficult."

Mr. Brown then went on to state that a good many applicants when writing for information generally want to know how they can obtain an engineer's license. Engineers have certificates, he said, and should treat them in a dignified manner by always calling them certificates, and not licenses.

Unjust to Engineers

I do not think that Mr. Brown is fair, and the above statements, which are the gist of the words he used, prove beyond doubt, in my opinion, that he has been unjust to some engineers.

First, the British Board of Trade certificate is issued to an engineer on his length of service in a machine shop as a mechanic with a certain period at sea, to prove his ability to overcome troubles at sea, as the engineer at sea is more of a blacksmith and machinist than an expert in the chemistry of engineering. The British Board of Trade rules and regulations for engineers are for the upkeep and maintenance of the mechanical side of engineering, and the ship owner like a good many stationary plant owners will see to it in time that the engineers will be more efficient by installing the necessary equipment, for economy, etc.

How very naive Mr. Brown is when he said:

"Do not worry, there will not be a surplus of engineers, as I watch the employment situation, and when there is a scarcity of engineering positions, I make the examinations harder."

Bless his innocence, he forgets that if he makes the examinations harder at one time, then he must make them easier when there is a demand for engineers. Is that fair to the profession? Does it raise the status of an engineer to know there are two sets of examinations, one for good times of employment, which is easy to pass, and another, when employment is scarce, which is harder to pass.

Imagine Bill Jones going to work with his new engineers' certificate, as proud as a peacock of the fact that he had passed the examination for the higher grade certificate, meeting a fireman or engineer that he knows, and saying: "Look at my new certificate, I have just passed for a higher grade. Good for me, eh George"? George replies: "Well, I don't know about that, Bill, I see in the papers that they want umpteen engineers all over the country." Poor Bill!!

This is not fair to the average engineer. The certificate should be issued upon a standard examination that is not governed by the employment situation.

Not a License

Now, in regards to the license being a certificate, and not a license. I would like to point out that the average engineer works long hours, especially those with the lower grade certificates, some working 11 to 13 hours, according to whether he is working in the day time or at night. He goes home when he has put in his hours at work dead tired, a dog's life at work, with a certificate. When he gets home his wife scolds him about his long hours at work, and the marriage certif—, I mean license, becomes a cat and dog license.

Efficiency experts tell us that a man working long hours cannot be efficient, therefore, it seems to me, that the first thing for Mr. Brown's examining board to do is to reduce the hours of the engineer if he wants to make them efficiency engineers. Railroad engineers have stated hours to work, in their rules and regulations. Then, why not the steam and stationary engineer?

The next thing to do is not to fill vacancies by making easy examinations and disappointments, because the pulse of the engineers' labor market is beating low.

In conclusion, it seems to me the engineer's path is by no means a rosy one, if anyone asks me I would say it is full of third rails.—GEORGE A. BROWN,
459 Shaw St.,
Toronto, Ont.

BOILER INSPECTION

Aug. 9, 1923

The Editor,
Power House.

In Power House of June 5, you draw a picture of conditions as they exist in Ontario as regards the inspection of boilers. It is a rather dark picture, but I believe it is true to the facts.

It contrasts very unfavorably with another picture which appeared in Power House on November 5, 1922, by "Inspector."

According to "Inspector" everything was lovely, everybody was satisfied and the country safe.

Laws had been amended as required by the advances in the arts and industries and far in advance of our present industrial requirements. Even the mill owners and factory managers were satisfied and the engineers who usually fig-

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and **Operation** of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator --Lubrication --PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers.--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught —HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now—today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________________
Occupation ____________________
Employed by ____________________
Residence ____________________
Reference ____________________

POSITIONS WANTED

FACTORY SUPERINTENDENT—OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

POSITIONS VACANT

STATIONARY STEAM ENGINEER WANTED—familiar with water tube boilers and Turbo Blowers and Generators. Must be an all round competent man, capable of taking charge of plant of about 2,400 B.H.P. Must have first class certificate. State in first letter salary wanted, age, experience, and when you can report. Apply P. O. Box 720, Port Colborne, Ont.

WANTED — SALES ENGINEER — EXperienced in steam specialty lines. University graduated preferred. Write stating experience and salary. Apply Box 109, Power House.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—With house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

TAYLOR SAFE FOR SALE
Inside dimensions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110, Power House.

·LIQUID·FUEL·
FOR · HEAT · AND · POWER
·HOW·TO·USE·IT·
SEND FOR IT ··· NO CHARGE
LAUGHLIN'S PRODUCTS, LIMITED.
WELLAND · CANADA

M. BARRY WATSON
B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer
Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W

J. A. BURNETT,
M.E.I.C., P.E.Q.

CONSULTING
& APPRAISAL
ENGINEER

Room 301—205 St. James St.
Telephone Main 6737. Montreal.

GEO. CALLARD
Builder and Contractor
Furnace and Boiler Work a Specialty
Highest References from All the Leading Engineers of the City.
Phone: Uptown 1590
210 Quesnel Street, Montreal

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you.

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

ure in the mortuary statistics when a boiler lets go, 'weren't doin' any kickin,."

As I have stated that your picture of June 5 is true it must be evident that I do not agree with "Inspector." "Inspector" says that laws are amended as required by advances in the arts and industries. We may assume then that the amendment transferring the inspection of operating boilers from the Steam Boiler Branch to the Factory Inspection Department was intended to be an improvement—that it was expected to result in better enforcement and greater efficiency.

Should Heed Facts

No doubt "Inspector" knows how his department functions and how it has always functioned, and no doubt it was with this knowledge in mind that he stated the law had been amended as required by "advances in the arts and industries."

In Power House of April 5, 1922, there was editorial comment on a fatal accident a short time previously in a Toronto factory. Some facts brought out at the inquest were cited as follows:—"No copy of the factory act had been exhibited in the place for over five years. It was over a year since there had been a factory inspector in the place.

"One factory inspector said the place used to be in his district, and that when it was under his jurisdiction he had ordered guards placed around shafts and pulleys. He admitted visiting the factory after the accident but did not notice whether his recommendations had been carried out or not. The inspector now in charge of the district admitted that he had not made any visit to the place before the accident, giving as his reason the fact that he did not know of the existence of the factory. He stated that when an inspector took over a district he had to hunt out the factories in it, AS THERE WAS NO LIST PROVIDED."

The final paragraph of the report reads: "What seems to be needed is a factory inspection department that will inspect."

"Inspector" At Sea

And "Inspector" wants us to believe that laws are amended as required by advances in the arts and industries. He must think we are as credulous as he would like us to be. Would we be wrong if we inferred in view of the fact that no list was provided, that often when an inspector has just been long enough in a district to become somewhat acquainted with it, he is transferred.

In Power House of April 20, 1922, there is a letter from a correspondent who says, "I think it is about time that the factory inspection department realized that the factory workers of Ontario are entitled to some degree of protection. It is criminal the way the factories of the province are inspected. I was employed by a concern where a new plant was built and put into operation and nearly four years passed before a factory inspector showed up, and then he might just as well not have come for all the good he did. There were a great many things that needed his attention, but all of them went unnoticed by him. What we want are men who are wide awake to the interests of the people employed in the factories of the province and not men who just merely draw their salaries."

Deplores Inspection

What chance has boiler inspection in a department that functions the way the factory inspection department functions? "Inspector" can tell us. I was in charge of my present plant for over four and a half years before I saw a factory inspector in my department.

I am not going to say who prompted the amendment to the Steam Boilers Act, but whoever did it must have known that it was "safe" under the factory inspection department.

If "Inspector" will tell us who opposed the Mother's Pensions Act, the amendment to the Workmen's Compensation Act, and the Minimum Wage Act, and other humanitarian legislation enacted in the last four years, we might be able to guess who prompted the amendment.

As for inspection by engineers, I don't approve of it. Boiler inspection should be independent and impartial, and we can't be sure of impartiality when it is done by "any licensed engineer," as provided by the so-called Inspection Act.

A C. A. S. E. PRESIDENT

C. A. S. E. Notes

At the regular meeting of Kitchener Lodge, No. 9, of the Canadian Association of Stationary Engineers, on Friday evening, Aug. 10, the following decisions were reached:—

That the twin pop safety valve is better than the single, as it is possible to repair one and still have the other one ready for use.

That the size of safety valve for a certain sized boiler is calculated by the formula in the rules and regulations for the construction and inspection of boilers; or, the area of opening should be such that when the boiler is worked at its maximum capacity the steam may escape as fast as it is generated at a velocity of not over 6,000 feet per minute at the working pressure and before expansion.

That the safest position of dampers and doors in blowing tubes in a return tubular boiler with a hand lance is to have the top damper open and ashpit doors closed, because the soot blown would drop to the combustion chamber owing to there being no through draft, also, better results are obtained by having a bright fire.

The second annual week-end excusion and picnic for members and their families was held recently at Port Dover, about 200 making the trip, and a pleasant time was spent at the beach in boating, bathing and sight-seeing. Mr. Turner and family, of the Toronto branch of the association, and Mr. Elles and family, of the Hamilton branch motored down.

Bro. Merritt, president of Kitchener Lodge, No. 9, who is in charge of the mechanical end of the Kuntz Brewery Co., Waterloo, has installed a new water softening system at his plant, and is well pleased with results.

Bro. Eumrich, of the Dominion Button Company, is on the sick list, and has been off duty for the past ten days.

C. OTT, 202 Breithaupt St.,
Kitchener, Ont.

George J. Soucy, Executive Secretary and General Organizer of the Dominion Executive Council of the Canadian Association of Stationary Engineers will go to London, Ont., on Aug. 17, to invest G. F. Galloway with the Past President's Jewel as authorized by resolution of the Grand Lodge on June 28, 1923. A delegation from Woodstock is expected to attend the ceremony, and the annual picnic in Spring Bank Park on Saturday, Aug. 18.

Convention Notes

The entire first floor of the Grand Central Palace, New York City, has been engaged by exhibitors for the second national exposition of power and mechanical engineering, for the week of Dec. 3 to 8, 1923.

The first exposition drew an attendance of 47,580 representative engineers, operating men, and executives, as well as technical students and their instructors.

The conduct of the exposition is supervised by an advisory committee, headed by Irving E. Moultrop, of the Edison Electric Illuminating Company, of Boston. Among his colleagues are John Lule Harrington, president of the American Society of Mechanical Engineers; Calvin W. Rice, secretary of the American Society of Mechanical Engineers; John H. Lawrence, chairman of the 2 Power division of the American Society of Mechanical Engineers; Frank W. Smith, president of the National Electric Light Association, and Fred Felderman, national president of the National Association of Stationary Engineers.

The Electrical Contractor Dealers of Toronto, held a very succesful picnic at Woodbridge on the afternoon of August 8, a crowd of about 400 attending. About $800 worth of electrical goods were contributed by manufacturers and jobbers as prizes for the many races and contests, among them being a vacuum cleaner, handsome table lamps, and many valuable appliances.

Boiler Setting *Service*

THE Gates Engineering Co., Limited, are in a position to contract for and specify on all boiler brick work with the least possible delay. Our Engineering Department is qualified to look after your interests, having made a close study of Combustion Problems.

Our Motto—Service and satisfied clients. The confidence of those who use Gates' Patented Air-Cooled Arch, etc., is unqualified, and is retained, because of the low maintenance cost and the guaranteed results.

Ask for our Descriptive Catalog.

Gates Engineering Co., Limited

314 Notre Dame Street W., Montreal

Solving the Dust Problem

Since their introduction eight years ago, MID-WEST AIR FILTERS have become firmly established as the standard Air Cleaning equipment for all purposes where clean, dust-free air is needed.

YOU ARE INVITED to attend the demonstration of Mid-West Air Filters at the Toronto Exhibition.

Don't miss this—it will interest you.

North-West Corner of Machinery Hall

Although simple and inexpensive to install and costing next to nothing for operation and maintenance, they have a higher cleaning efficiency than any other industrial air cleaning devices in existence.

MIDWEST AIR FILTERS

Executive Offices:

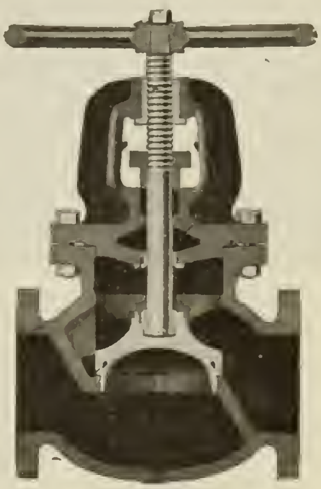
MIDWEST CANADA LIMITED

83 Craig St. W., Montreal.

Branches in principal cities.

EDWARD *Extra Heavy* Cast Steel Stop Valves

Designed to offer the least resistance to the flow, with full sized opening through seat, with body, bonnet and gland made of Electric Steel and flanges drilled in accordance with American Extra Heavy Standard of 1914, these EDWARD Stop Valves will give satisfaction under the most severe service.



Superior Valves for Exacting Duty

THE EDWARD PROTECTED SEAT AND DISC

This positive protection of the most vital organ of the valve—the seating surface — is used only in Edward Valves. It prevents cutting from wire drawing, especially under high pressures and temperatures where very small leaks rapidly grow owing to the terrific erosion action.

Send for descriptive catalogue of the Edward line.

The Edward Valve & Manufacturing Co.

General Office & Works: East Chicago, Ind.

CANADIAN AGENTS: Lytle Engineering Co., Limited, Montreal; Valve Engineering Company, Toronto.

HINTS TO BUYERS

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

ENGINEERS!

Remember to Order
GENUINE
"V." PILOT
PACKING FOR ALL PURPOSES
KIRBY & COMPANY
50 LAKE ST. TORONTO MAIN 4443
SPECIALIZING IN
Engine and Boiler Room Supplies of Every Description.
Adamant Gauge Glasses Ideal Tube Cleaners
Kirbyco Boiler Scale Remover
QUALITY SERVICE

Be Rid of Boiler Furnace Lining Troubles

Arches and Furnace Linings in one piece. No brick, no joints. Any handy man installs it without special forms or tools.

Betson Plastic Fire Brick kept on hand for emergency repairs and for use in building sloping baffles always proves profitable. **Write for instructive booklet.**

Betson Plastic Fire Brick Co., Inc. P. O. Box 386-6, ROME, N. Y.

CANADIAN DISTRIBUTORS: International Chemical Co.,
26-8 Adelaide St. E., Toronto, Ontario, Canada

YORK Ice Making & Refrigerating MACHINERY
For Every Practical Purpose
Consultation on any Refrigerating Problem invited.
CANADIAN ICE MACHINE CO., LIMITED
Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

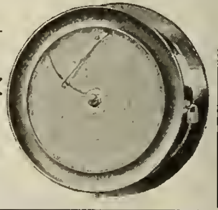
THE BROWN INSTRUMENT CO., PHILADELPHIA, PA., U.S.A.
Largest Pyrometer Manufacturers in the World.

Brown

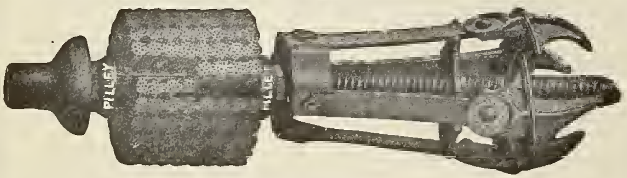
For Province of Quebec: La-Chapelle Eng. Co., 137 Mcgill Street, Montreal, Que. For Ontario: Brown Instrument Co., 1421 Ford Building, Detroit, Mich., U. S. A.

Send for Catalog No. 63

Thermometers



The Simplest and best cleaner on the market is



PILLEY'S
Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

GARLOCK
Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS
THE GARLOCK PACKING COMPANY

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

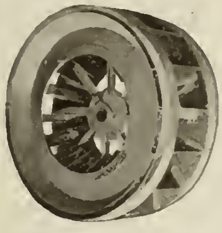
Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

Eliminate



the cinder nuisance quickly and efficiently by installing a Sturtevant Cindervane Fan. It also affords excellent induced draft.

Ask for Folder 609.

B. F. STURTEVANT CO.
OF CANADA, LTD.
Montreal Galt Toronto

OIL BURNING SYSTEMS.
INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.
LAURIE ENGINE CO.
(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.

Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

YOU REFRIGERATION ENGINEERS
— REMEMBER —
That "Sundh" (pronounced Sund) Refrigeration Electric Panel Control Equipment is sold by:
DOMINION ENGINEERING AGENCY, Limited
D. M. FRASER, Pres. and Gen. Mgr.
TORONTO 24 ADELAIDE ST. E. MAIN 6926

SIL-O-CEL *INSULATION*
PREVENTS HEAT PENETRATION

SAVES FUEL—Maintains Uniform Temperature. In world wide service on all types of high temperature equipment. Write for Bulletin W-6C
CELITE PRODUCTS LIMITED
New Birks Bldg., MONTREAL, QUE.

I HAVE been treating FEEDWATER for steam boilers for 24 years and am in a position to investigate your feedwater problems.

I WILL give you a formula for your special plant and thus save you 10% to 20% of your fuel.

Send in Your S.O.S. to:—
H. P. STEPHENS
Feedwater Specialist.
Junc. 5642 2004 Dundas St. W. Toronto

A Reasonable Saving of 5 to 10%

Should You Expect More?

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee St. PHONE G. 3660 Toronto, Ont.

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse, Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR FILTERS
Midwest Canada, Ltd., Montreal, P. Q.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Kirby & Co., Toronto, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D. K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Gates Egineering Co., Ltd., Montreal, Que.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
A. E. Rule Co'y., Toronto, Ont.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
Refrigerating Engineers, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Bolco Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.
Combustion Engineering Corp., Toronto,
Jeffrey Mfg. Co., Montreal, Que.

COILS
Frick Co., Waynesboro. Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Refrigerating Engineers, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

COMPRESSORS, AIR FILTERS
Midwest Canada, Ltd., Montreal, P. Q.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COOLING AIR FILTERS
Midwest Canada, Ltd., Montreal, P.Q.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and draft in last pass.

It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

Write for Bulletin CF-131.

THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

FOXBORO
REG. U.S. PAT. OFF.
THE COMPASS OF INDUSTRY

5323

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

75% of all steam jet ash conveyors in Canada are American. Satisfactory and economical performance guaranteed. Ask for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Edmonton, Calgary.
WM. A. GOOLD, Winnipeg.
T. M. GRINDLEY Co., Vancouver.

CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

CARHARTTS

TRADE MARK

IN ALL THE WORLD
NO
OVERALLS
LIKE THESE

Do You Get 3-Year Service From Fire Brick Linings?

Many firms that have lined their furnaces with jointless Plibrico do. The letters below, received within a month tell the story. If you don't get long service, you need the book "Modern Furnace Building." Write for it.

March 2—Hall Printing Press Co.: "On November 16, 1920, we installed Plibrico under boiler No. 1*** has not required relining since."

March 8—Kinsey & Mahler Co.: "Have eliminated all furnace troubles, since installing this lining, which was put in three years ago."

March 26—Thomas Parisian Dyeing & Cleaning Works: "Lined two 310 h.p. boilers in 1920 with Plibrico****have only had to patch small places."

April 3—Gulf Coast Machine & Supply Co.: "Have not relined our boiler furnace a single time in three years."

April 6—Smith & Wyman Co.: "Have used Plibrico in three of our boilers for over three years."

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B. C.; Winnipeg Supply and Fuel Co., Winnipeg; Building Products & Fuel, Limited, Saskatoon, Sask.; Dominion Lime & Coal Company, Regina, Saskatchewan.

PLIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO.
1142 CLAY ST. CHICAGO

The *Importance* of
Water Softening and Filtration
In the Modern Power Plant
Is a *Proven Fact*
NOT AN EXPERIMENT

"PERMUTIT"

WATER SOFTENER AND FILTRATION SYSTEMS

Are Giving Universal Satisfaction

There are in Canada more than two hundred "Permutit" Systems, with a daily capacity of over 17 million gallons.

We Guarantee Results

W. J. WESTOWAY COMPANY, LIMITED
HAMILTON - ONTARIO

CUT ME OUT--Put this in an envelope addressed:

W. J. Westoway, Company, Limited, Hamilton, Ont. and they will mail for your files—a free booklet—"Reducing Fuel and Boiler Plant Operating Costs"

Name .... Address ....

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DUST FILTERS
Midwest Canada, Ltd., Montreal, P.Q.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co.,- Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Jeffrey Mfg. Co., Montreal, Que.
Bturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER PURIFIERS
Stephens Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erle, Pa

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome. N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.
A. E. Rule Co'y., Toronto, Ont.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Bexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati. Ohio.
Reading Steel Casting Co., Hartford, Conn.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Reading Steel Casting Co., Hartford, Conn.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS, STEAM, WATER)
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co. St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
Kirby & Co., Toronto, Ont.
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenhurg Mfg. Co., and American Bteam Gauge & Valve Co., Div- Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Ce., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamh, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Dominion Engineering Agency, Toronto, Ont.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Canadian Bteam Boiler & Equipment Co., Toronto.
Shell Bar Boico Bupply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Betting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelpbia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Bmart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa.

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Btorage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairhanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Bupply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Btoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Dominion Engineering Agency, Toronto, Ont.

OILS
Imperial Oil, Ltd., Toronto.

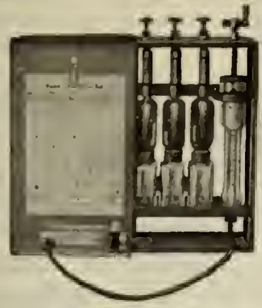
OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil. Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto.
Superbeater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.



Hays Improved Gas Analyzer.

Are You Wasting Fuel?

Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO_2, O_2 and CO; 1-chamber Analyzer for CO_2 only. Stocked by Canadian Agents listed below.

HAYS DRAFT GAGES, "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts and Draft Regulation."

P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
Michigan Citp, Indiana

General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

METALLIC CONDENSER PACKING

This "JOHN CRANE" Process is fully protected by U.S. Patent No. 1,387,901. August 16th, 1921. It is also fully protected by patents in other nations.

The easy application in this process is a marked advantage. Many engineers have told us they consider it easier and faster than fabric packings.

Special pin fits in tube. Packing is pushed into place with hand tool or air gun, then caulked. Illustration shows metallic ring going in.

INVESTIGATE!

Westinghouse, Wheeler, Worthington, Alberger and Elliott and others are now using this process.

Descriptive text (1923 edition) on request.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, B.C.

No ordinary regulator, and certainly no human water tender, can produce the

RESULTS

that you can get with the

COPES Feed Water Regulator

Every change in the true water level of your boiler is transmitted instantly by the powerful COPES thermostat to the balanced control valve.

We guarantee that every COPES Feed Water Regulator will pass the required amount of water at a given pressure drop. In tests over a 24-hour period, COPES' Regulation has been proved accurate to 1/5 of 1 per cent. In every case, the COPES is carefully fitted to the exact conditions under which the boiler operates.

We will be glad to send you charts, made in actual service, showing how the COPES' smooth feeding is saving from 2 to 8 per cent. in fuel and cutting down labor costs as well. Write for Catalog D.

The simplest and most reliable of boiler feed water regulators—just a rugged expansion tube and a balanced valve.

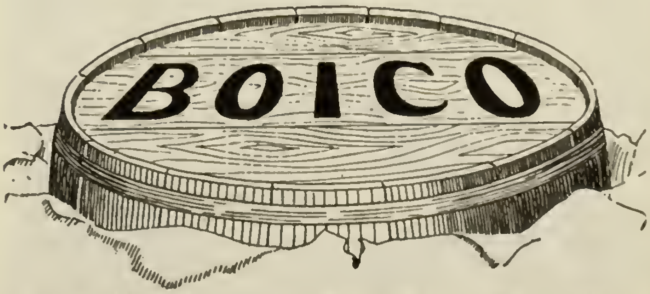
NORTHERN EQUIPMENT CO.
112 West 11th St., ERIE, PENN.
Branch Plants: Canada; England; France; Germany; Austria; Italy.

SYSTEM OF BOILER FEED CONTROL

Makes Short Work of Boiler Scale

In hundreds of plants BOICO has been adopted as the one sure clean-boiler insurance. The speed with which it removes the most stubborn scale formations is surprising. Hurts nothing but boiler scale. It's economical, too.

TRY IT FREE—let us send you a sample to convince you. Write us to-day—you've nothing to lose.



SHELL-BAR BOICO SUPPLY LTD.
1-15 SAUNDERS AVE. - TORONTO

SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ontario.

PACKING, AMMONIA, STEAM AND WATER

Beveridge Suppy Co., Montrea.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Gariock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, OIL

Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS

Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Kirby & Co., Toronto, Ont.

PAINTS

Shell Bar Boico Supply Ltd., Toronto, Ont.

PIPE COILS

Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER

Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto.

PIPE, BLACK AND GALVANIZED

Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS

Crane's Limited, Montreal.

PIPING AND FITTINGS

Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont

PIPING, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUMBING SUPPLIES

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS

Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)

Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS

C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES

C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC

Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES

C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL

D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH

Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID

Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX

The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE

Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL

Albany Pump Co., Toronto, Ont,
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY

Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO

Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCullcoh Co., Galt.
Laurie & Lamb. Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX

Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton,

PUMPS, (OIL AND GASOLINE) SELF-MEASURING

Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL

Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS

Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS

Crane's, Limited, Montreal.

RADIATOR TRAPS

C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS

Jas. Morrison Brass Mfg. Co., Toronto,
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES

C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS

Shell Bar Boico Supply Ltd., Toronto.

REBOILERS

Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa

RECORDING INSTRUMENTS

Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2

Sarco Company, Inc., New York.

REFRACTORY MATERIALS

Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
Refrigerating Engineers, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.
Wilson & Sons, J. L., Toronto, Ont.

REGULATORS, TEMPERATURE

Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER

Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE

Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto. Ont.

REFRIGERATING PIPE COILS

The Superheater Co., Ltd., Montreal.

REGULATING VALVES

H Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co. of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS

Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING

Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES

Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER

Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)

Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY

Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS

Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM

V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING

Engineering and Machine Works of Can. Ltd., St. Catharines. Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS

W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE

C. A. Dunham, Co.,
Laurie & Lamb, Montreal,

SMOKE BOXES

Babcock & Wilcox. Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT CLEANERS

Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET

Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS

Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

SPUR WHEELS

Goldie & McCulloch Co., Galt,
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL

Babcock & Wilcox. Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q

STEAM TRAPS

Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS

Smart-Turner Machine Co., Hamilton.

STEEL DRUMS

Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL

Can. Fairbanks-Morse Co., Ltd., Montreal

STRAINERS

Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK

Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES

Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS

Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF

Waterous Engine Works, Co., Brantford.

TANKS, BRINE

Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE

Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

TANKS, GASOLINE

Imperial Oil, Ltd., Toronto.

TANKS, OIL

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada

TRANSFORMERS

Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES

Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING

Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co., St. Louis, Mo.
Kirby & Co., Toronto, Ont.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER

Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Edward Valve & Mfg. Co., East Chicago, Ind.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lytle Engineering Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Reading Steel Casting Co., Hartford, Conn.
Shell Bar Boico Supply, Ld., Toronto.
Valve Engineering Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Underfeed Stoker Co., Toronto, Ont.
Wilson & Sons, J. L., Toronto, Ont.

WALKWAYS, (Irving Subway)

Irving Iron Works Co., Long Island City, N. Y.

Don't Forget This--

The usefulness of your furnace depends absolutely on the permanency of its joints. Once your brick shows wear at the joints, the end is in sight.

STERNSON No. 30

is the only strictly "Canadian-Made" High Temperature Cement that insures you against replacement losses by effecting absolutely permanent joints. It withstands heat up to 3,000 Deg. F., and protects the bricks at their weakest spot—the edges.

"Let a Technical Firm do a Technical Job."

G. F. STERNE & SONS, Limited
Chemical Manufacturers,
Consulting Chemical Engineers.
BRANTFORD - - - CANADA

DUNLOP
MECHANICAL PRODUCTS

DUNLOP

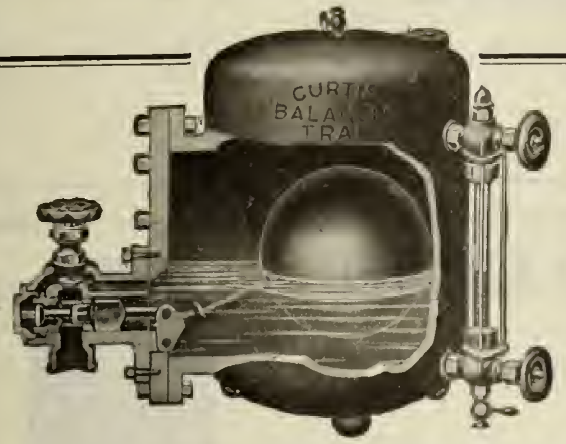
Rubber Products to Meet Every Need

Gibraltar Red Special Transmission Belting is known for its suitability for all purposes.

Gibraltar Conveyor and **Elevator Belts**—the Belts with the protective covering of Cord Tire Tread Stock that most effectively resists abrasive action.

DUNLOP **Industrial Hose, Packing** and **Mechanical Goods** of all descriptions.

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

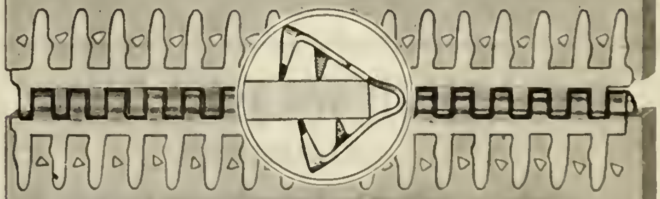
1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

Send for descriptive circular of this trap.

Sole Distributors for Canada:
DARLING BROS., 120 Prince Street, Montreal, P. Q.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.

ALLIGATOR
TRADE MARK REG. U. S. PAT. OFFICE
STEEL BELT LACING



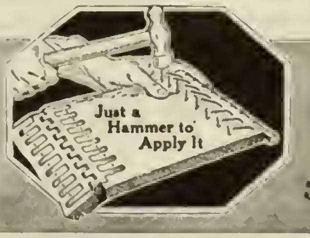
For Universal Service

To light machine drives whether slow, medium or high speed, a joint of Alligator Steel Belt Lacing properly applied is safe and long lasting Recommended also for heavy drives and for use with idlers, on mule and serpentine drives, flat conveyors, or for tape and extra light drives. It combines the essentials demanded of modern belt joint; strength, smoothness, flexibility and simplicity of application.

A universal joint for universal service—gives universal satisfaction.

FLEXIBLE STEEL LACING COMPANY
4669 Lexington St., Chicago, Ill.
In England at 135 Finsbury Pavement, London, E. C. 2

"Every Tooth A Vise"


Just a Hammer to Apply It

For Every Size and Kind of Belt

Established 1907 **POWER HOUSE** Member A.B.C.

B. G. NEWTON, Manager
S. S. MOORE, Advertising Manager

CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740. Montreal: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. Winnipeg: 810 Confederation Life Bldg., Tel. Main 3449.
UNITED STATES—New York: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. Chicago: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. Boston: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.
GREAT BRITAIN—London: The MacLean Company of Great Britain Limited. 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.
SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A

Audel, Theo. 45
Allen Feed Water Purifier Co... 18

B

Babcock & Wilcox, Ltd........ 41
Betson Plastic Fire Brick Co., Inc. 48
Brown Instrument Co. 48
Bristol Co. 6
Buyers' Directory 50, 52, 54
Business Newspapers of Can... 14
Bird Archer Co. 16
Burnett, J. A. 45

C

Callard, Geo. 45
Canadian Fairbanks-Morse Co., Ltd. 4
Conveyors Corp. of America ... 51
Cory & Sons, Inc., Chas........ 8
Combustion Enginering Co...Inside Front Cover
Cunerty Co., T. J. 18
Can. Allis Chalmers Co........ 3
Can. Steam Boiler & Equipment Co. 49
Celite Products 49

D

Dart Union Co. 8
D'Este Co., Julian 55
De Laval Steam Turbine Co..... 16
Detroit Stoker Co. 13
Dominion Belting Co. 56
Dominion Engineering Agency.. 49
Dunham Co., C. A........... 43
Durabla Mfg. Co. 4

E

Engineering and Mach. Works of Canada 10
Edward Valve & Mfg. Co...... 47

F

Fisher Governor Co. 7
Foxboro Co., Inc. 51
Flexible Steel Lacing Co....... 55
Flexible Metallic Packing Co.... 53

G

Garlock Packing Co. 48
Garth Co., The 48
Gates Engineering Co. 47
Goldie & McCulloch........... 20
Gutta Percha & Rubber Co...Inside Back Cover

H

Hays Corp., Jos. W........... 53
Hamilton Carhartt Cotton Mills 51

I

Imperial Oil Co. 5
Irving Iron Works... 12

J

Jeffrey Mfg. Co............... 11
Jamieson Cold Storage Door Co. 9
Jenkins Bros. ....Front Cover
Jointless Fire Brick Co......... 51

K

Kirby & Co. 48

L

Laurie Engine Co. 49
Laughlin's Products, Ltd....... 45

M

Magnolia Metal Co. 12
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncrieff, Ltd. 49
Mueller Mfg. Co. 17
McLaren Ltd., D. K............ 15
Midwest Canada, Ltd. 47

N

Northern Equipment Co........ 53

P

Pilley Packing & Flue Brush Mfg. Co. 48
Purdy & Mansell, Ltd......... 19

R

Refinite Co. of Canada........ 49
Rule, A. E. 18

S

Superheater Co., Ltd. 45
Sterne & Sons, G. F. 55
Sarco Co., Inc. 7
Sanford Riley Stoker Co....... 2
Shell Bar Boico Supply Co...... 53
Sterling Engine Co. 6
Sturtevant Co. 49
Stephen Chemical & Mfg. Co., Limited 45
Stephens, H. P. 49

T

Taylor Instrument Co., The.... 12
Thomson-Gordon, Ltd. 49

U

Underfeed Stoker Co. of Canada 2

W

Wall, W. J. 49
Waterous Engine Works Co..... 1
Watson & McDaniel Co........ 48
Watson, M. Barry, M.E........ 45
Westco Mfg. Co. 18

Y

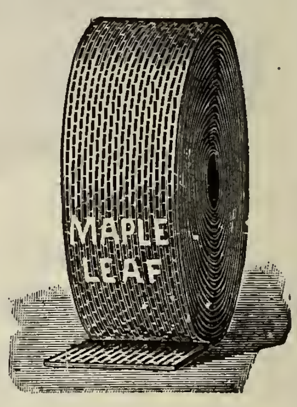
York Mfg. Co. 48
Young Pump Co. of Canada.... 10

DOMINION BELTING CO. LIMITED
HAMILTON - CANADA
Quebec Branch, 51 Duluth Bldg., Montreal

Sole Manufacturers:

"Maple Leaf" Brand Stitched Cotton
Duck Belting, Belt and Dressing

The demand for our products has steadily increased because the standard of quality has been strictly maintained. We make only one grade, the best that can be produced. Write for prices and further information.



When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast

The Power House Built on a Rock

A solid foundation alone is not sufficient proof against the storms of mischance that befall the modern power house. That engineer who would build his plant on a "rock" chooses Morrison Steam Goods. Fifty years of outstanding service insures their dependability under any emergency.

Morrison
Steam Goods

Stop and Check Valves
Safety and Relief Valves
Reducing Valves
Steam Traps, Injectors
Ejectors, Inspirators
Jet Pumps, Pressure Gauges
Pipe, Tools, etc
Gauge Board Outfits
Lubricators
Pipe Fittings
Whistles
Engine Indicators

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

Fostering Economy in the Development of Power for All Industries

POWER HOUSE

Vol. XVI, No. 17 — Published Semi-Monthly by The MacLean Publishing Company, Limited, Toronto, Ont. — September 5, 1923

How Canadian Power Plants are Cutting Ash Removal Costs

Over in Taber, Alberta, the Canada West Coal Company, Ltd., installed an American Steam Jet Ash Conveyor in their mine power house.

Instantly their ash removal costs were reduced 73 per cent. Instead of paying $16.46 per day, for ash handling labor, one man during his spare time now handles the ashes.

Other Canadian power plants are making like savings. Their costs have been cut in half through the installation of American Steam Ash Conveyors. They have paid for their equipment through savings afforded.

A booklet has been prepared describing in detail the ash conveyor system used in these plants. It shows how they were able to cut down their costs in such a remarkable manner.

If your ash handling costs are high—if you are still employing the old-fashioned gang of ash wheelers—if you are using expensively operated mechanical equipment, you will want to avail yourself of the present opportunity to secure a copy of this booklet. It will tell you how to do away with these useless expenditures—how to cut your overheads to the lowest possible figure per ton of ash handled.

The American Steam Ash Conveyors is not an experiment. It is successfully used in 1,500 progressive power plants. Hundreds of letters have been written by plant executives describing the economy and convenience of their equipment and endorsing its use. Solve the ash removal problem at your plant. Take the first step now. Send for the booklet, "Cut Ash Handling Costs." Study it carefully and note the exclusive guarantees which we offer.

The coupon below is for your convenience. Sign it now.

CONVEYORS CORPORATION OF AMERICA
326 W. Madison St., Chicago.

— Canadian Representatives —
Cleaton Co. (Canada) Ltd., Montreal.
Gormans, Limited, Calgary and Edmonton.
Wm. A. Goold, Winnipeg.
T. M. Grindley Co., Vancouver.

Send me a copy of your free booklet "Cut Ash Handling Costs" which tells how Canadian plants have cut ash handling costs.

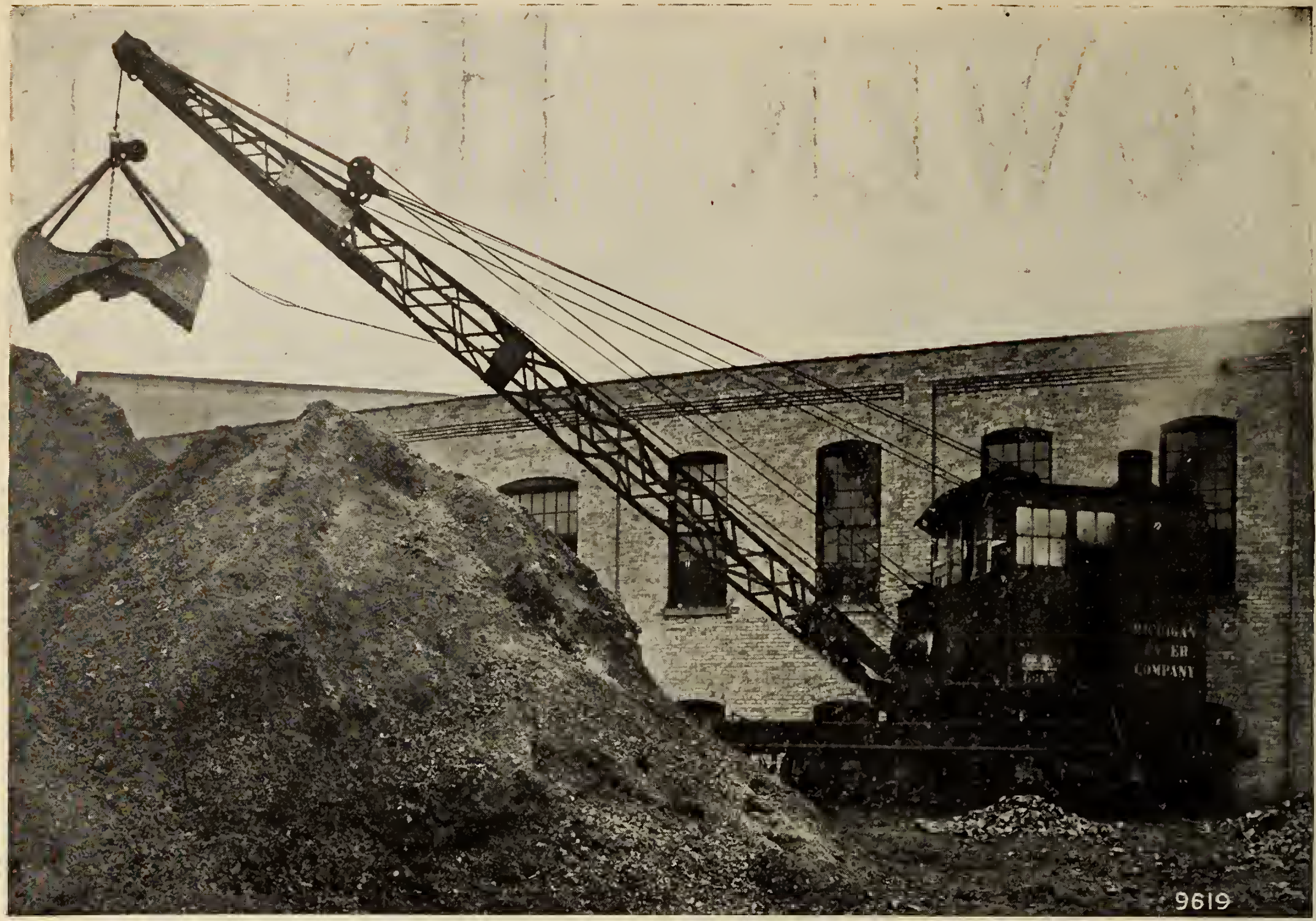
Name ....

Company ....

Address ....

....

15 Cents a Copy — *$2.00 a Year*



Why It Pays to Store Coal Now!

THERE are five good reasons why every consumer of coal should buy and store his winter's supply of coal NOW.

1—financial advantage
2—assurance of coal
3—better quality of coal
4—lowering coal prices
5—relieving the nation's transportation systems and helping stabilize a billion dollar industry.

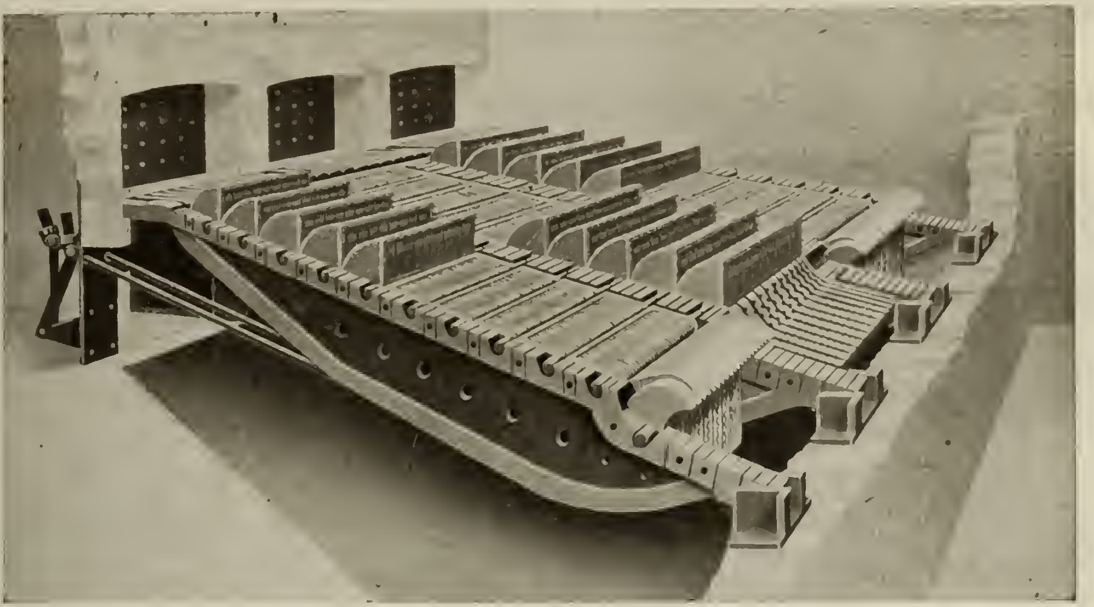
Five good reasons, four of which are purely individual and personal. Stored coal really means more money in your pocket—more heat in your fire-box.

How to store coal economically and profitably is something Link-Belt engineers have studied for many years. Let them show you how inexpensively and satisfactorily you can solve your winter's coal problem. Their wide experience and technical knowledge makes consultation worth while.

LINK-BELT LIMITED
(FORMERLY CANADIAN LINK-BELT LIMITED)
TORONTO—WELLINGTON AND PETER STS. MONTREAL—10 GAUVIN LANE

1314

LINK-BELT



THE FILES STOKER

Pays for Itself in One Year

Below is a copy of one of the many letters we have received, telling of the efficiency and economy of the Files Hand-Operated Stoker

Re FILES HAND STOKERS

Gentlemen:—

Frequently we receive letters from manufacturers, asking for information and our experience with the "Files Hand Stokers"—the most economical and efficient system of burning coal with the utmost conservation of labor.

As these inquiries are becoming more and more frequent, our better plan will be to furnish you with a letter to pass on, outlining our experience and satisfaction.

In September, 1920, we placed an order with you for two 150 H.P. Tubular Boilers, specifying our desire to have them equipped with "Files Hand Stokers." This we did on the recommendation of our United States Engineering Department, who had installed "Files Hand Stokers" in some seventeen plants, finding in them a decided saving and advantage over flat or shaking grates.

Speaking for ourselves, we have found them most satisfactory and economical, particularly so in regard to the elimination of smoke, rapid disposal of ash and clinker, thorough cleaning of fires without disturbing the active fire, and in maintaining an even bed of fuel.

We are able to keep a clean fire at all times, we have no cleaning period, for with the "Files Hand Stoker" the grate can be cleaned at peak load. It is only a matter of working one rod on each section, which can be done in less than two minutes.

The better the coal the better the result, but almost any kind of coal that will burn free can be used. With good coal, however, it is an easy matter to procure 150% boiler rating, which in reality is 12½ lbs. evaporation per pound of coal. Generally speaking, evaporation is around 7 or 8 lbs., and often as low as 5 or 6 lbs.

Our Files Hand Stokers have now been installed about two years, during which time they have paid for themselves twice over if we consider the saving in fuel.

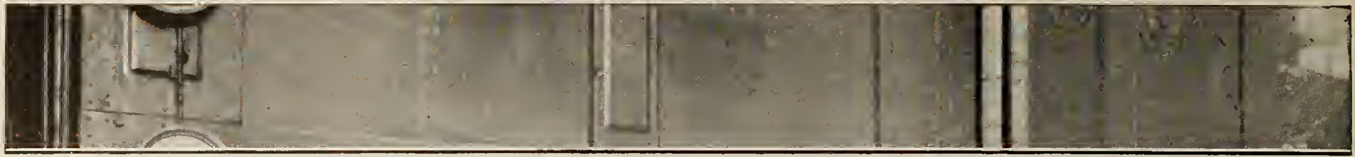
And what we have done and are doing with them others can do.

We know they effect a saving; we know they are a convenience; they have proved satisfactory in every particular, and we have no hesitation in recommending them.

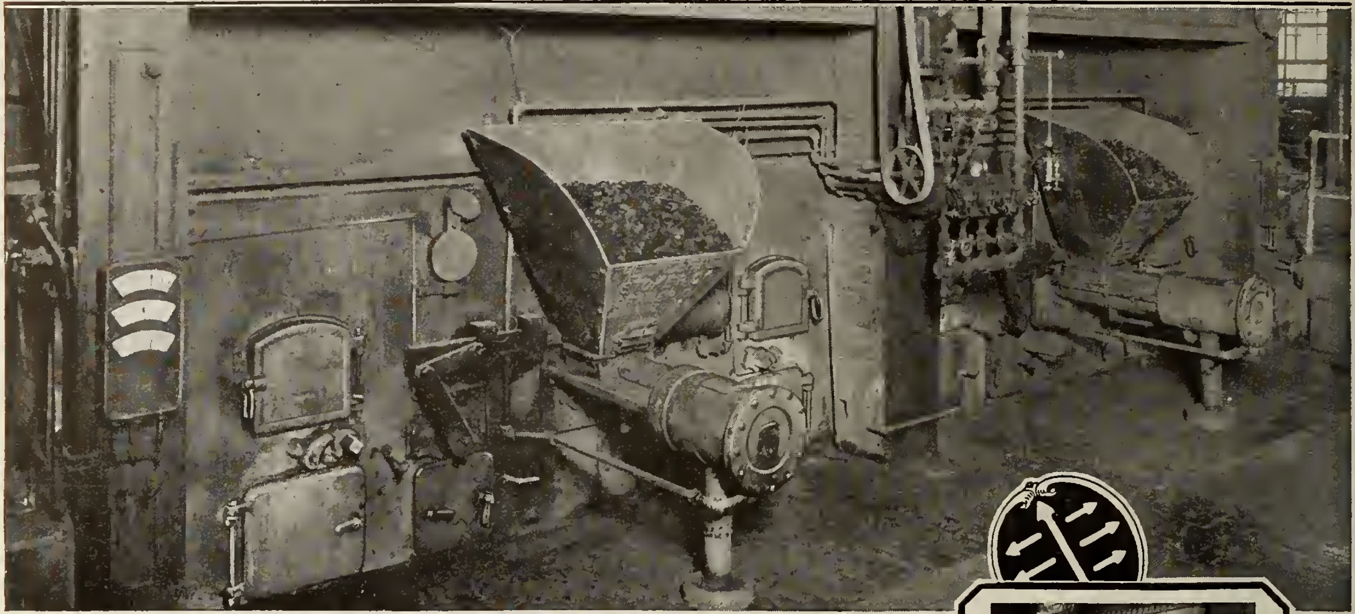
Yours very truly,
THE MERIDEN BRITANNIA CO., LIMITED.

Why not Profit by others' Experience?

Waterous
BRANTFORD, ONTARIO, CANADA



The only multiple retort side cleaning stoker



BEFORE the development of the *"Lateral Retort"* Stoker there was no stoker that combined the ease of installation of the side cleaning stoker with the high efficiency and overload capacity of the multiple retort type. Plants that did not consider the expense of the multiple retort type justifiable were forced to install inferior stokers.

Now the *"Lateral Retort"* has changed all this; now any plant can have multiple retort stoking!

This simple, single retort stoker rivals the efficiency and capacity of the multiple retort type; the illustration opposite and the description below it show how the high duty service of the multiple retort is obtained.

And yet the *"Lateral Retort"* can be installed at a fraction of the cost of a multiple retort. There is no need for basement ash pits; trenches 6 to 18 inches below the floor line are sufficient excavation. This makes the *"Lateral Retort"* easily adaptable to boilers already in service and does away with the maintenance costs of complicated ash discharging and dumping systems.

The new 8½x11 standard filing size bulletin describes this revolutionary stoker in detail—and shows illustrations of successfully operating plants in the United States and Canada. Your copy is ready—ask for it.

The Under-Feed Stoker Co. of Canada, Ltd., 146 King St. W., Toronto

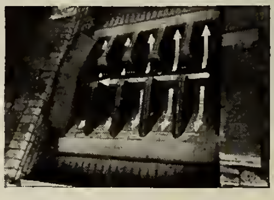
"Jones" Underfeed Stokers "Riley" Underfeed Stokers "Murphy" Automatic Furnaces

Alta. and West Sask.:
Mr. J. Twomey
Camrose, Alberta

Man. and East Sask.:
W. W. Hicks & Co.
Winnipeg

British Columbia:
E. A. Earle, Limited
Vancouver, B. C.

Quebec:
The Cleaton Co. (Canada), Ltd.
Montreal, Que.



How it works—

IN the **"Lateral Retort"** the coal follows the path of the arrows in the view above. It is underfed to the main retort—along the path of the large arrow—by a simple steam driven ram. An independently controlled moving unit underfeeds the fuel into the **"lateral retorts"** that branch off at right angles from the main retort. The ash is finally deposited on perfectly balanced dump plates easily operated by hand. The ash is dumped into shallow ash pits 6 to 18 inches below the floor line.

High air cooled front and rear tuyere blocks keep fire and clinker away from the front wall and bridge wall, practically eliminating clinkering and reducing furnace maintenance. Plate tuyeres that form the sides of the retorts reduce sifting and lower replacement costs.

The "Lateral Retort"

TRADE MARK

Trade Mark

RILEY JONES *The* UNDER-FEED STOKER COMPANY OF CANADA LTD. MURPHY

The Rapid Development of Steam Engineering

has carried pressures and temperatures to such a high point that rod packings which formerly gave service are no longer satisfactory.

"PALMETTO"

REG. TRADE MARK

PACKING

is especially designed to meet the most exacting requirements of present day conditions.

"Palmetto" is heat resisting, and perfectly lubricated. An ideal packing for compressed air.

Greene, Tweed & Co., Sole Manufacturers

109 Duane St., New York

CANADIAN AGENTS:

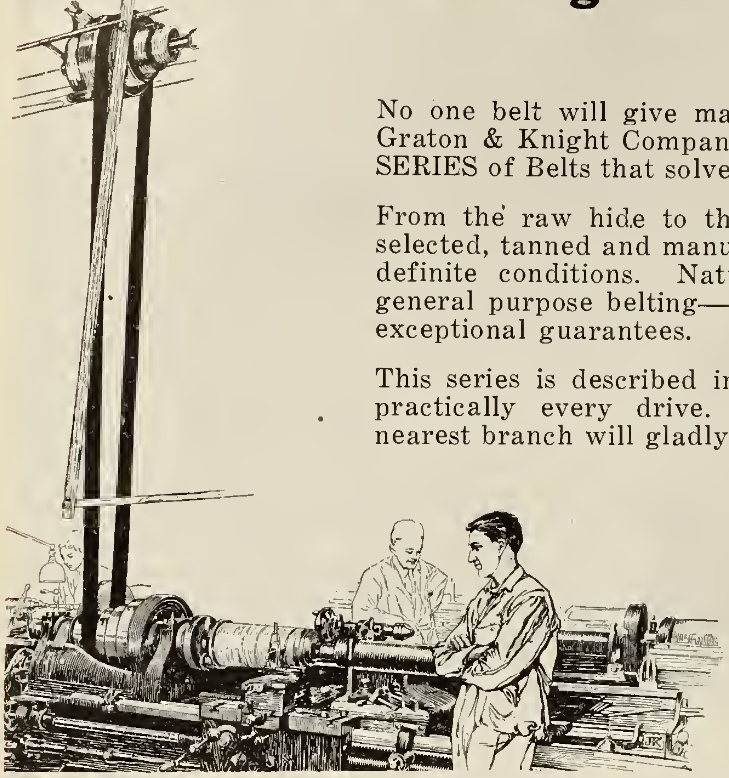
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto. Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

If you don't know "Palmetto" let us send you a working sample to test; No charge.

Graton & Knight

Standardized Series

Leather Belting



A Belt for Every Purpose

No one belt will give maximum service under all conditions, so the Graton & Knight Company, after exhaustive research, have evolved a SERIES of Belts that solve every belting problem.

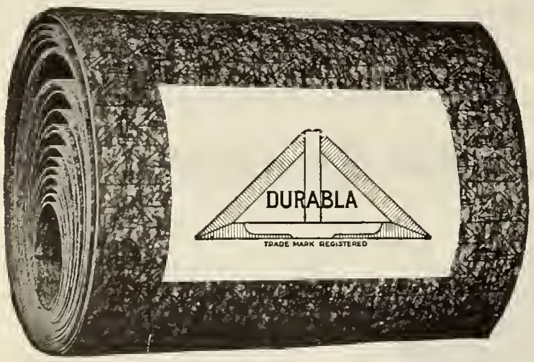
From the raw hide to the finished belting each piece of leather is selected, tanned and manufactured to perform a definite service under definite conditions. Naturally such belts give better service than general purpose belting—and naturally Graton & Knight Belts carry exceptional guarantees.

This series is described in a booklet that shows the proper belt for practically every drive. It contains invaluable information. Our nearest branch will gladly mail it to you.

The Canadian
FAIRBANKS - MORSE
Company, Limited
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver, Victoria.

56

Tight Joints



On Steam, Water, Air, Oil, Ammonia and Acids at all Temperatures

Place Durabla Packing in the next joints you make and be insured against costly shutdown.

Durabla Compressed Asbestos Fibre Gasket material is not affected by vibration or condensation. It will not burn out, blow out, or pulp at the joints.

Made in Canada in stock sizes 36″ wide x 150″ long in thicknesses of 1|64, 1|32, 1|16 and 1|8″.

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

KERR

"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville Ontario

Keeping Tabs on the Man who keeps Tabs on Temperature

The addition of a Time Punch device on Columbia Recording Thermometers eliminates spoilage and losses through careless inattention to the maintenance of uniform temperatures.

It gives absolute assurance that the man in charge of temperature control will inspect the chart at specified intervals. If he fails to push the button as instructed, the absence of punch holes on the edge of chart will show that he has been delinquent.

An operator can't be careless or neglectful and get away with it. The Time Punch trips him up every time. It is strictly impartial. When a man is a good worker, conscientious and careful, it gives him credit for it. If he's lazy, and inclined to be asleep at his post, the boss knows all about it.

Thus does the Columbia Recording Thermometer, with the new Time Punch and its day-and-night indelible record of temperature, insure uniform temperatures. And that means lower operating costs, less spoilage, greater efficiency. Two wonderful instruments in one for the cost of one.

Columbia Recording Gauges and Tachometers are also equipped with the Time Punch.

Interesting Booklet H-33 sent on request.

The Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO DIVISION

Brooklyn, N.Y.

Canadian Agency:
THE CANADIAN FAIRBANKS-MORSE CO., LTD.,
Montreal, Toronto.

Columbia
Recording
Thermometers

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast

UNDER ideal conditions, with plungers smooth and absolutely in line, the prevention of leakage at stuffing-boxes, when handling extremely hot water at high pressures, presents a definite problem.

When plungers are scored and out of line, a packing especially designed for such service will be found in Garlock Style No. 443 combination. This packing will prevent leakage and give lasting satisfaction; the rubber cushioned flax and diagonal rings reacting to any lateral movement of the plunger with minimum friction.

Try Style No. 443 on your feed pump plungers.

GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONTARIO

BRANCHES: Montreal, Que. St. John, N.B. Winnipeg, Man. Calgary, Alta. Toronto, Ont. Vancouver, B.C.

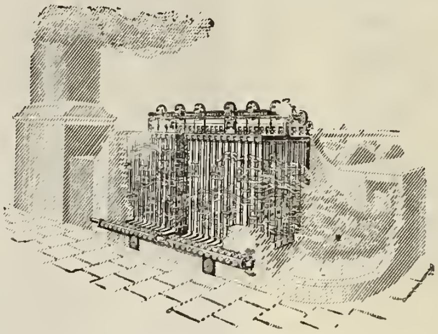
More Steam -- Less Coal

Up-to-date Boiler plants are saving thousands of tons of coal annually by the installation in the main flue between the boilers and the chimney stack of a

Green's Fuel Economiser

which by utilising high temperature flue gases

SAVES 15-20%

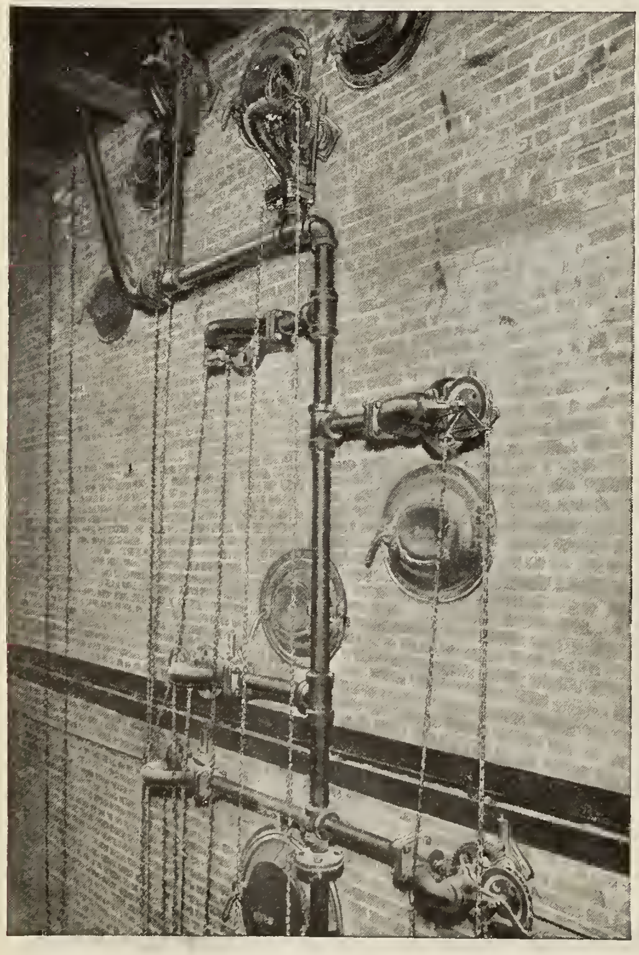


OF COAL

Write for illustrated and descriptive Catalogue D.J. to—

E. GREEN & SON, Ltd., Wakefield, England

Codes: A.B.C., 5th Edition; Bentley's Phrase; A1; Lieber's; Engineering; Western Union.



Diamond Automatic Valved Soot Blowers "VALV-IN-HEAD"

One of the best paying investments which the Power Plant executive can make is to install Diamond Soot Blowers on his boilers. They save 4 to 8% fuel, increase boiler capacity, and decrease labor costs. Compared to what they save their cost is small.

Hundreds of boilers in the Dominion of Canada are equipped with Diamond Soot Blowers. Among those which are using Valv-in-Head Soot Blowers may be mentioned:

J. R. Booth, Ltd., Ottawa, Ont.
Fraser Companies Ltd., Chatham, N.B.
Chateau Frontenac, Quebec, P.Q.
St. Lawrence Paper Mills, Ltd.
Lake Superior Paper Co., Sault Ste Marie, Ont.
Goldie & McCulloch, Galt, Ont.
Yeates Machinery & Supply Co., Montreal, Que.
Provincial Paper Mills Co., Ltd., Mille Roches, Ont.

Write for Bulletin 287

DIAMOND SPECIALTY LTD.
WINDSOR, ONTARIO

JENKINS

Extra Heavy Iron Body Globe and Angle Valves

Maximum strength and rigidity are rigorously preserved throughout in the design and construction of Jenkins Extra Heavy Iron Body Valves. This reserve strength amply meets the strains and stresses due to expansion and contraction of piping or other causes.

These valves are suitable and guaranteed for 250 pounds working steam pressure, or 400 pounds working water pressure—the margin of safety is wide, for each valve before it leaves the factory is tested to 800 pounds hydraulic pressure.

The bodies of these valves are made of high-grade cast iron; the spindles are manganese bronze, having a tensile strength from 50,000 to 60,000 pounds per square inch. Regrinding discs and seat rings made of durable steam metal.

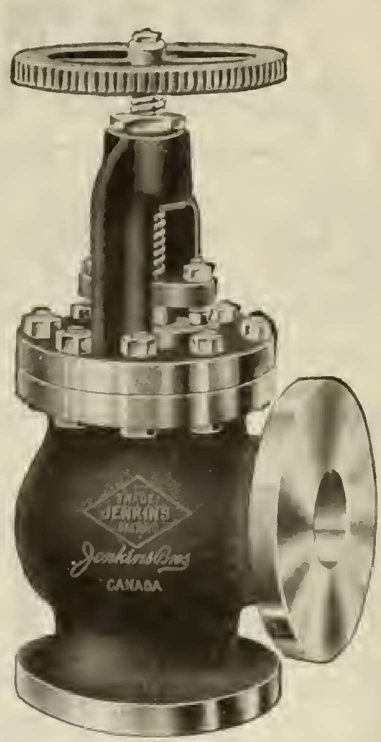


Fig. 163

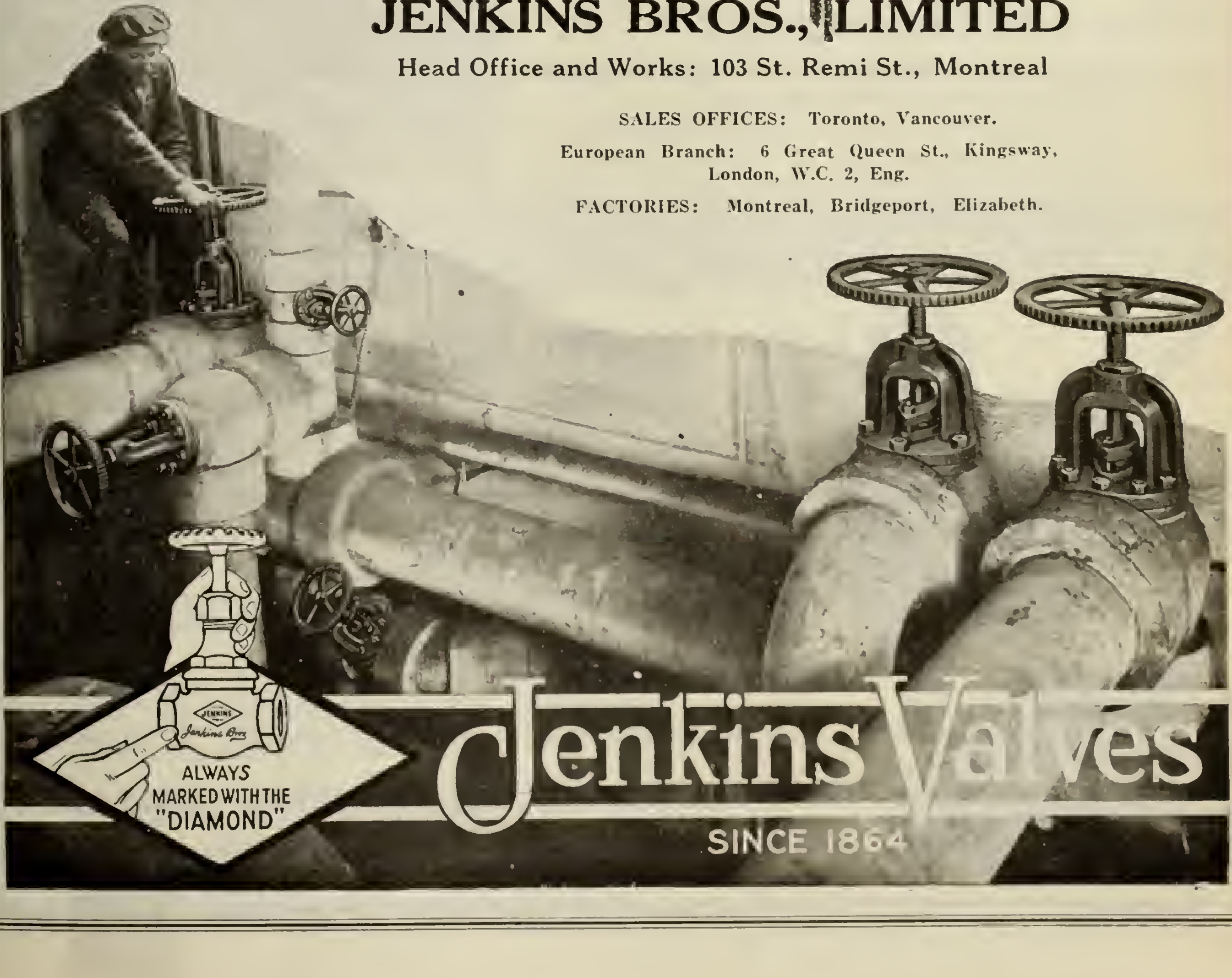
JENKINS BROS., LIMITED

Head Office and Works: 103 St. Remi St., Montreal

SALES OFFICES: Toronto, Vancouver.

European Branch: 6 Great Queen St., Kingsway,
London, W.C. 2, Eng.

FACTORIES: Montreal, Bridgeport, Elizabeth.



REFRIGERATION DEPARTMENT

LINDE

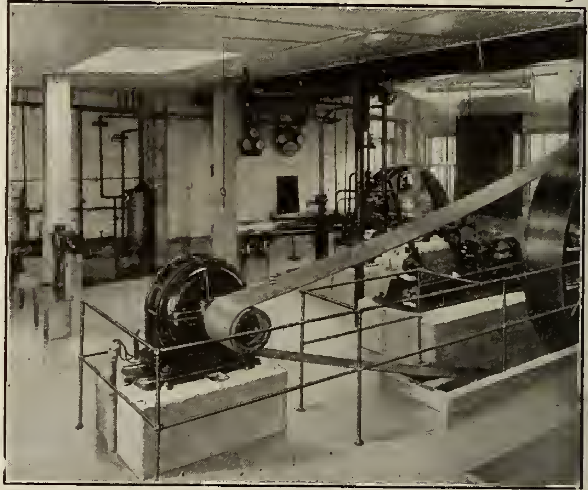
Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants Large and Small

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

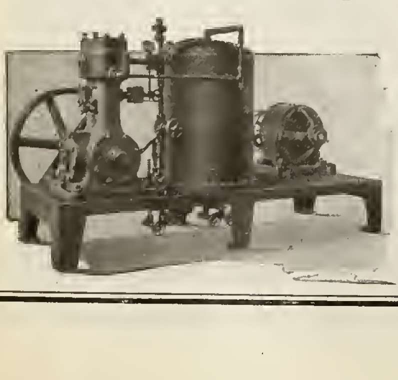
The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

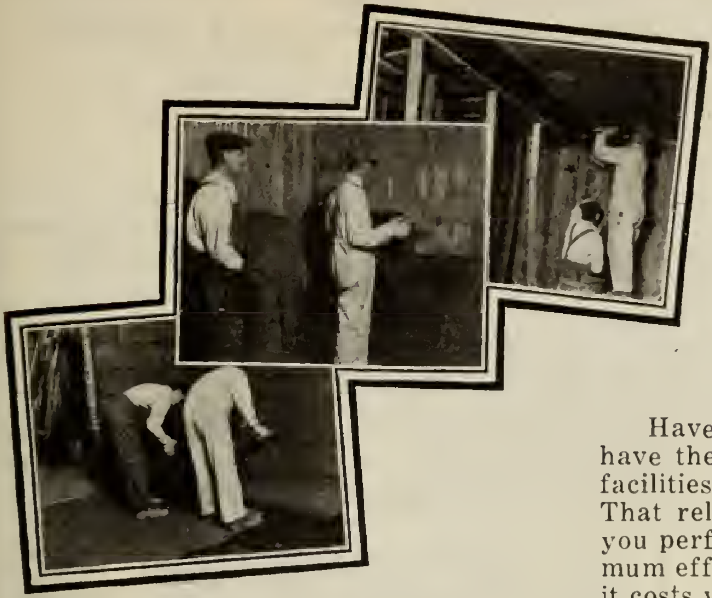
VILTER

ICE MAKING AND REFRIGERATING MACHINERY



A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada



It Looks Easy

DID you ever watch how deftly a paper-hanger strips the long, limp sheets into their exact places? Did you ever try it yourself?

It is the same with any job. Men with training and experience can do the work better, quicker, with less confusion and waste **and at lower cost.**

Have Armstrong erect your Nonpareil Corkboard. They have the skilled workmen, the proper tools and adequate facilities for planning and supervising your insulation. That relieves you of worry and responsibility. It assures you perfect workmanship, tight joints, even surfaces, maximum efficiency. It saves time and material and, in the end, it costs you less.

Experienced insulation erectors are maintained at all branch offices, ready to install Nonpareil Corkboard, as it should be installed. This Company is responsible to you for their work.

Full information and estimates are furnished without charge or obligation. Write for the book, "Nonpareil Corkboard Insulation," sent free on request.

ARMSTRONG CORK & INSULATION COMPANY, LTD., 902 McGill Bldg., Montreal, Que.
11 Brant Street, Toronto, Ont., Can.

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers, tanks and cold surfaces generally

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

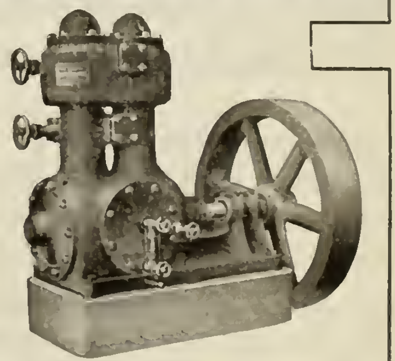
YORK MECHANICAL REFRIGERATION

The Key That Unlocks the Door to INCREASED PROFITS

THOUSANDS of York Machines have paid for themselves, and are now earning substantial dividends for their owners. These machines are designed for service, built of the best materials for the purpose, thoroughly tested and rigidly inspected before shipment. They are self-contained, require very little attention and do not require a skilled operator. There is probably no other equipment you can buy that will be a greater help in increasing your profits than a York Refrigerating Machine.

CANADIAN ICE MACHINE CO., Ltd.

TORONTO—Villiers & Munition Sts. Eastern Harbor Terminal.
MONTREAL—324 Craig Street West.
WINNIPEG—1415 Whyte Avenue
VANCOUVER—1158 Homer Street.



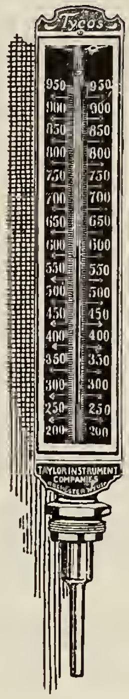
Representing

YORK MANUFACTURING COMPANY

Ice-Making and Refrigerating Machinery Exclusively.

YORK PENNA. U.S.A.

Tycos and Superheat



The degree of superheat may be determined at any time during the operation by glancing at a *Tycos* Superheated Steam Thermometer. A record of the performance of superheaters can be placed on your desk every day if a *Tycos* Bi-Record Recording Thermometer is used. This Recorder gives both the pressure and temperature of the superheat on one chart. The chart shows the amount of pressure and temperature simultaneously.

On exceptionally long superheated steam line *Tycos* Bi-Record Recording Thermometers (or *Tycos* Superheated Steam Thermometers) will show the amount of temperature loss due to pipeline radiation and also drops in pressure.

Taylor Instrument Companies

110-112 Church Street
TYCOS BLDG., TORONTO

There is a *Tycos* or *Taylor* Temperature Instrument for every purpose.

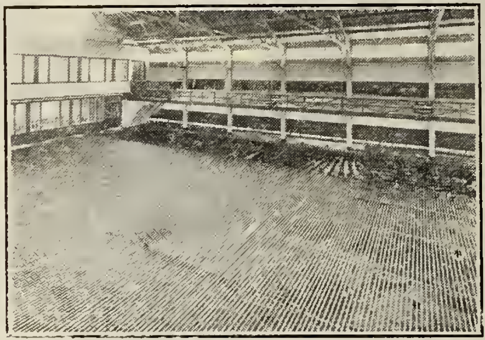
Tycos

Indicating,
Recording,
Controlling,

875

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING
Oil Burning Systems Installed
Full line of Power Plant Equipment and Supplies.
LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL

REFRIGERATION SUPPLIES
REPAIRS - FITTINGS
AGENT FOR FRICK REFRIGERATING EQUIPMENT
REFRIGERATING ENGINEERS
LIMITED
457 King W. TORONTO Adel. 7753



35,000 ft. of Pipe in floor of Toronto Skating Clu

Refrigerating Machinery.

Expansion Pipe.

Ammonia Fittings.

Calcium Chloride.

Ammonia.

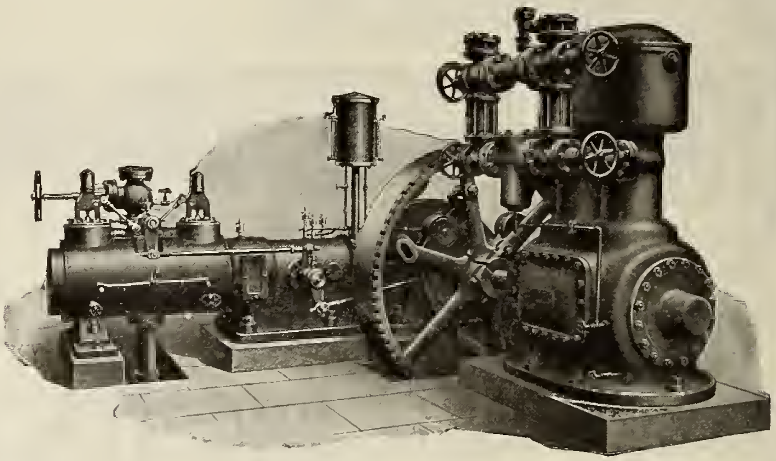
Agents For "TRIUMPH" Ice Machine.

J. L. WILSON & SONS
REFRIGERATING ENGINEERS
3 SILVER AVE. TORONTO

FRICK COMPANY, INC. TRADE FRICK MARK WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical



Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

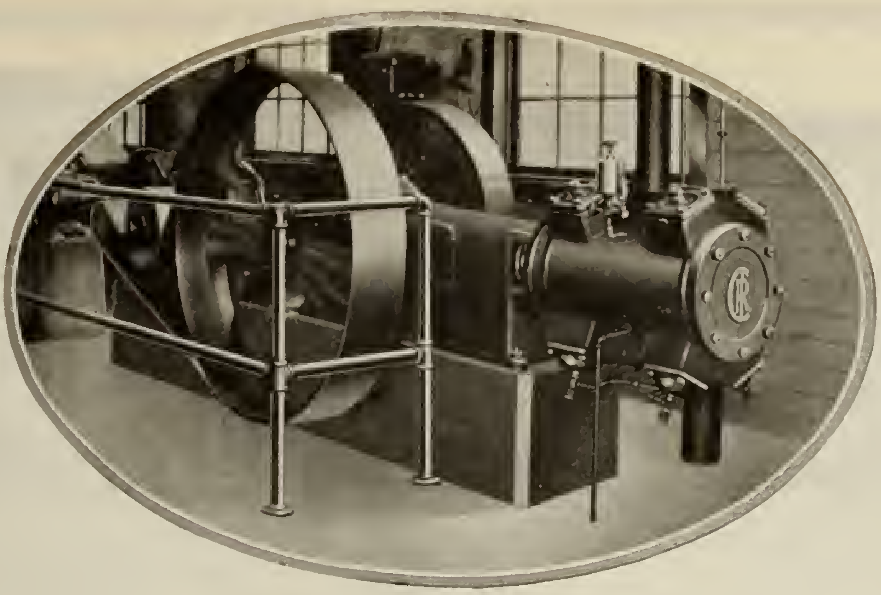
See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers--also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto



Small Compressors for the Modern Industrial Plant

The small compressor for machine shops, foundries, or other industrial plants, should be efficient, reliable and as nearly automatic in action as modern design and skilled workmanship can make it.

Efficient because so many operations require air and the lower the cost of compressing air, the greater the saving in production costs.

Reliable because if the compressor breaks down production will be held up until repairs can be completed.

Automatic because usually but little attention can be given the compressor; labor is generally scarce and costly and an operator's time can often be used to better advantage in other ways.

For this class of work there is no simpler or better machine than an Ingersoll-Rand Class ER or FR Compressor.

You can always satisfy yourself as to the value of these machines before buying, as it is easy to locate nearby installations where their worth is being constantly proven.

Class ER and FR Compressors are straight line, single-stage, double-acting units fitted with Ingersoll-Rand Plate Valves. They are simple, sturdy machines possessing every requisite for efficient and continuous operation with minimum care and attention. Class ER units are furnished for long or short belt drive; Class FR machines are equipped with piston steam valve and automatic cut-off flywheel governor. They are readily converted to belt drive if desired.

When operations demand more air, additional ER or FR units may be installed, resulting in a very flexible plant. If a larger compressor is preferred, they can be used as auxiliaries, or readily sold at a price which will help materially in buying the larger machine.

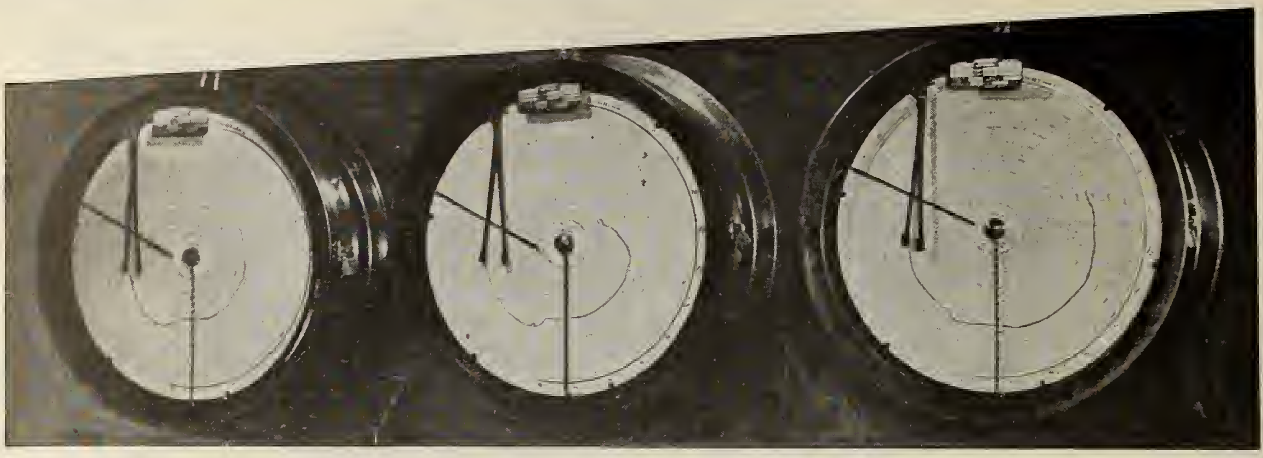
Our nearest branch will be glad to help you select and get the most out of pneumatic equipment for present or contemplated needs. Consult them whenever they can be of service.

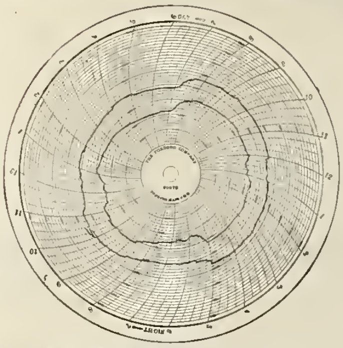
Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

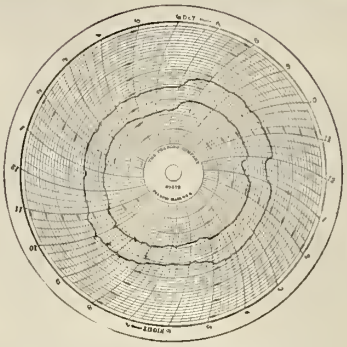
Refer U. S. Inquiries to Ingersoll-Rand Co., 11 Broadway, New York.

Ingersoll-Rand

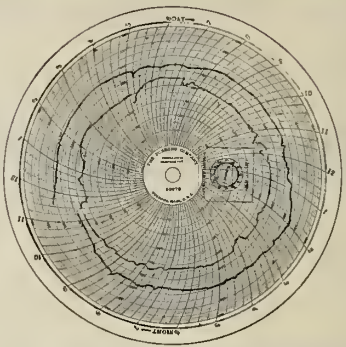




Temperature of Gases Entering and leaving No. 1 Economizer
Range—0-800° Fht.



Temperature of Gases Entering and leaving No. 2 Economizer.
Range—0-800° Fht.



Temperature of Feed Water Entering and leaving Economizers.
Range—0-400° Fht.

For Convenient Comparison

Foxboro Two-Temperature Records

It's easy to check the efficiency of the economizer at the Salem Electric Lighting Co.'s plant.

At a glance you can read temperature of flue gases and of feed water entering and leaving the economizer.

The combination of records gives, at once, vital information as to condition and operation of boilers, stokers, automatic draft control, feed water heater and economizer.

Foxboro Two-Pen Recording Thermometers are so constructed that both pens accurately follow the time arc of the chart. Pens are made to pass each other.

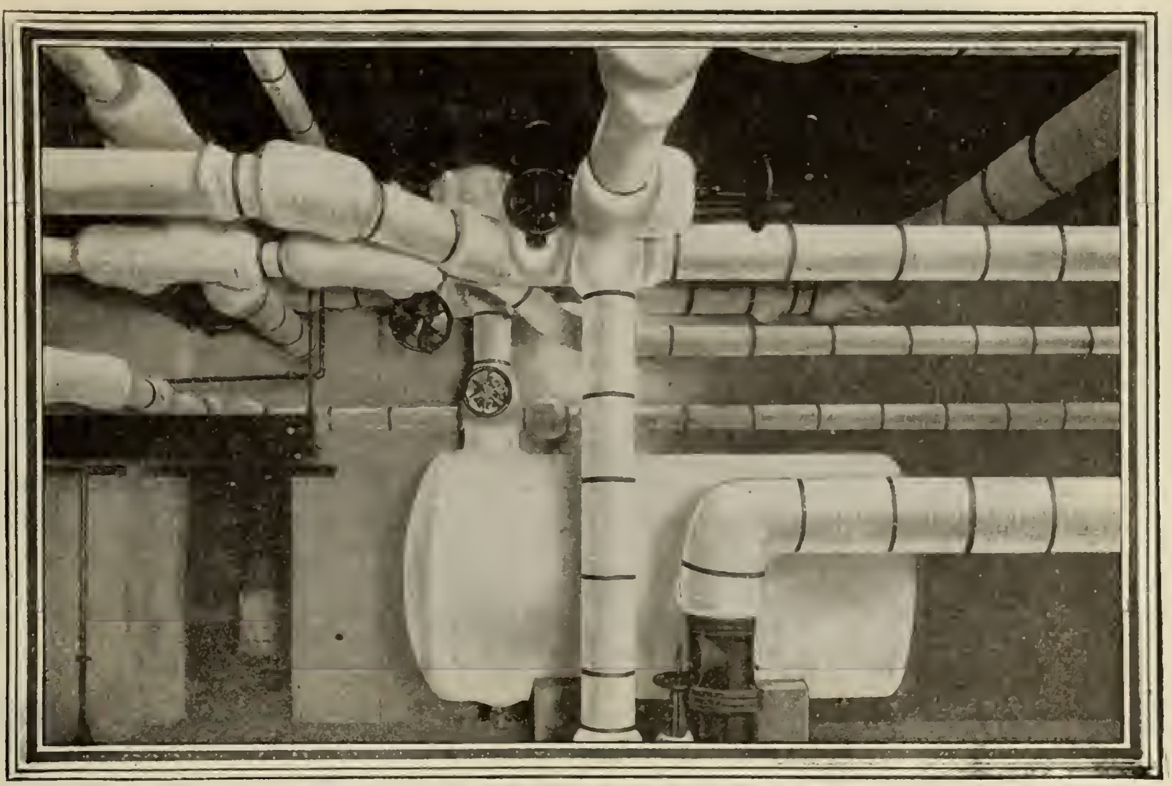
The Improved Foxboro Helical Tube Movements used in these instruments assure the same permanent accuracy and dependability that have made every Foxboro Instrument a "Compass of Industry."

Foxboro dependability protects your plant from waste and loss. Get the facts. Write for Bulletin CF-104-1.

THE FOXBORO CO., INC., FOXBORO, MASS., U.S.A.
New York Chicago Boston Philadelphia Pittsburgh Cleveland Rochester
Birmingham Tulsa Los Angeles San Francisco Portland, Ore.
PEACOCK BROTHERS, LIMITED, 179 Delorimier Avenue, Montreal, Canada

FOXBORO
REG U.S. PAT. OFF.
THE COMPASS OF INDUSTRY

5547



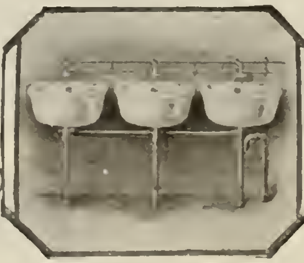
THIS CRANE PIPING CONTRIBUTES TO THE SAFETY AS WELL AS THE WORKING EFFICIENCY OF A LARGE CENTRAL STATION

INSURING SAFE HIGH PRESSURE PLANTS

Meeting the need of the modern power plant for piping equipment to handle high pressure superheated steam, Crane Ltd. has produced a complete line of valves, fittings and steam specialties of cast-steel and monel metal. The use of these materials overcomes the "growth" or permanent expansion encountered with cast iron, malleable iron or semi-steel units which are subjected to wide temperature variations. Crane cast-steel equipment retains its original size and strength under the most severe conditions, insuring permanently tight connections and maximum safety.

CRANE

CRANE LIMITED, GENERAL OFFICES: 386 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., HEAD OFFICE: 45-51 LEMAN STREET, LONDON, ENG.
Branches and Sales Offices in 21 Cities in Canada and British Isles
Works: Montreal, Canada, and Ipswich, England



Crane "Barracks" Lavatories

BOILER CHEMICALS

Made in Canada for You

Do it Now

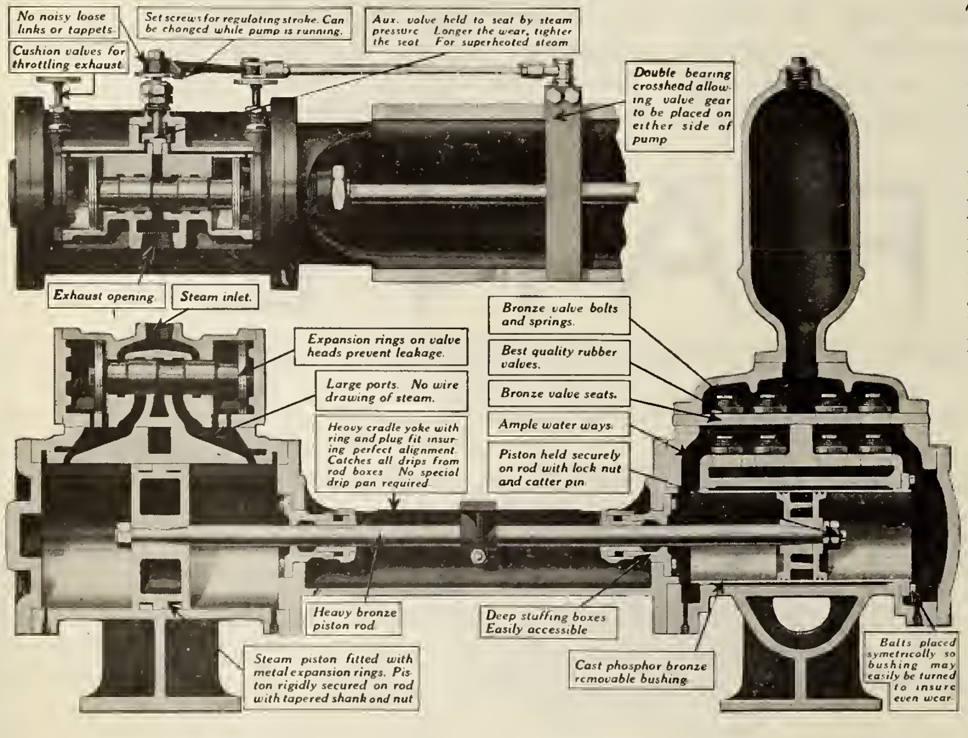
Not a hit-and-miss ready-made compound, but made for you on scientific principles.

Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal **Factory: Cobourg**

AMERICAN--MARSH PUMPS


No noisy loose links or tappets.
Set screws for regulating stroke. Can be changed while pump is running.
Aux. valve held to seat by steam pressure. Longer the wear, tighter the seat. For superheated steam
Cushion valves for throttling exhaust.
Double bearing crosshead allowing valve gear to be placed on either side of pump
Exhaust opening.
Steam inlet.
Bronze valve bolts and springs.
Expansion rings on valve heads prevent leakage.
Best quality rubber valves.
Large ports. No wire drawing of steam.
Bronze valve seats.
Heavy cradle yoke with ring and plug fit insuring perfect alignment. Catches all drips from rod boxes. No special drip pan required.
Ample water ways.
Piston held securely on rod with lock nut and catter pin.
Heavy bronze piston rod
Deep stuffing boxes Easily accessible
Steam piston fitted with metal expansion rings. Piston rigidly secured on rod with tapered shank and nut
Cast phosphor bronze removable bushing
Balts placed symetrically so bushing may easily be turned to insure even wear.

THE illustration tells its own story. Why the American-Marsh are the most reliable, trouble-proof and efficient pumps on the market.

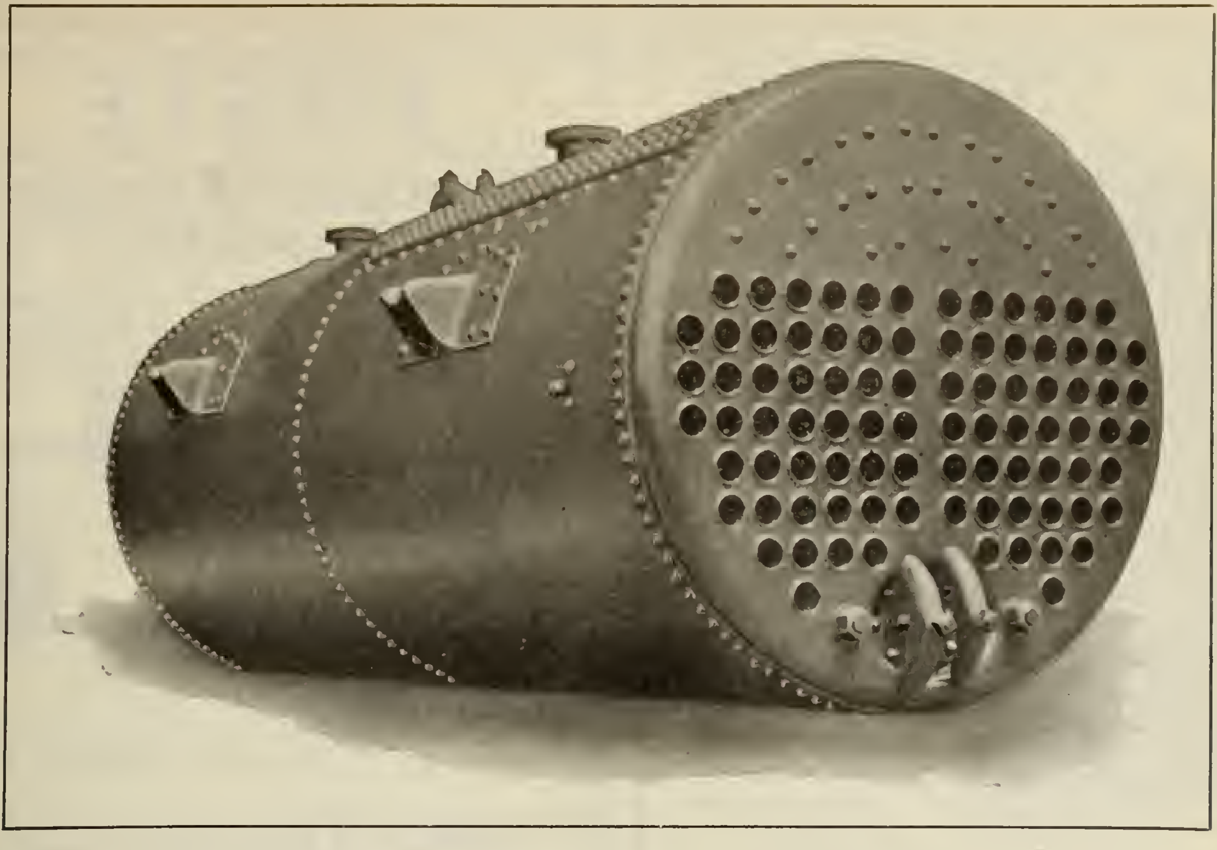
Less than one-half the wearing parts found in the duplex type while a saving of 25% in steam consumption is guaranteed.

Over 160,000 in successful operation.

Ask for catalog.

Canadian Agents: A. R. Williams Machinery Co., Ltd., Toronto and Winnipeg; Williams & Wilson, Ltd., Montreal. Bissett Pinder & Co., Edmonton. Stephens & Boyle, Vancouver. London Engine Supplies Co., London.

American Steam Pump Co., Battle Creek, Mich.



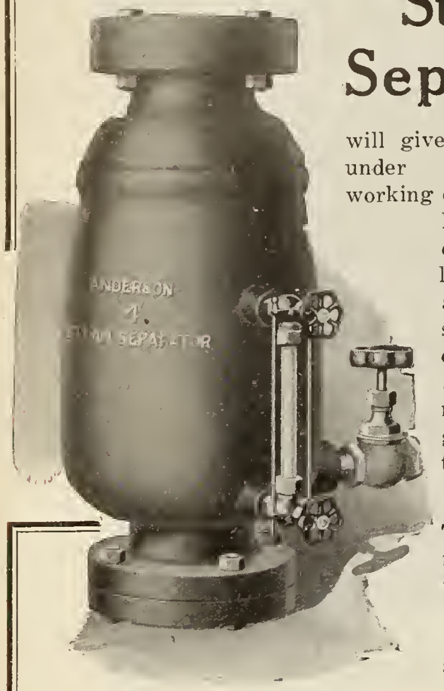
Here it is—the Heart of Your Plant

Buy a modern, high-grade Boiler from us, built according to Interprovincial Boiler Code, and you will have a real dividend maker in your plant. Buy it over-size, both because of economy in firing and to allow room for the increasing power requirements of your business. Our Boiler making experience goes back over 35 years, during which time we have developed machines and methods that provide the highest grade of workmanship at very moderate prices.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Building, Montreal

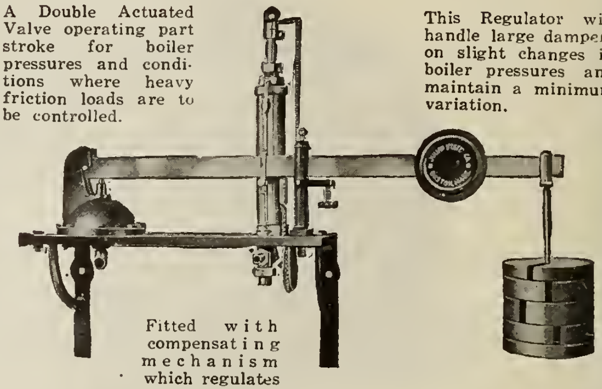


The ANDERSON
Steam
Separator

will give you dry steam, under practically any working condition, at very low cost. It is one of the most reliable safeguards against the possibility of breakdowns caused by accumulation of moisture in engine cylinders or turbine casings.

The Anderson is made in both vertical and horizontal styles. Let us send you a catalogue.

THE V. D. ANDERSON CO.
West 96th St., Cleveland, Ohio



D'ESTE
Hydraulic Damper
Regulator

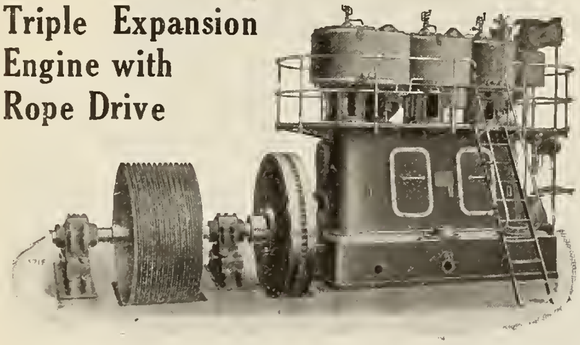
A Double Actuated Valve operating part stroke for boiler pressures and conditions where heavy friction loads are to be controlled.

This Regulator will handle large dampers on slight changes in boiler pressures and maintain a minimum variation.

Fitted with compensating mechanism which regulates opening and closing.

SPECIALTIES sent on application.
Our Catalogue No. 50 of CURTIS ENGINEERING

Julian d'Este Company
Main Office: 26 Canal St., Boston 14, Mass.



Triple Expansion
Engine with
Rope Drive

Belliss & Morcom Ltd.
Birmingham, England

Builders of:

STEAM ENGINES
AIR COMPRESSORS
STEAM TURBINES
CONDENSERS
CRUDE OIL ENGINES

Packing for Centrifugal Pump Spindles will not cut

Maxim Silencers
for Air Compressor Suction,
Gas Engine Exhausts, etc.

Welldeck Steam Traps
do not get out of order

AGENTS:
LAURIE & LAMB, Board of Trade Bldg., MONTREAL

Flue gases can be reduced 50 degrees by careful firing and clean boiler surfaces

Such is the substantial saving that can be effected by recording and measuring your flue gas temperature with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.
Recording Pyrometers

Of course, the temperature of outgoing gases can be decreased by economizers, or by a change in the baffling — but such changes are costly and the economy depends upon the cost of coal.

The information supplied by Bristol's Pyrometers, as to the temperature of uptake gases leaving the boilers, is of prime importance as an aid to super-efficient plant operation.

Hundreds of Bristol's Pyrometers are recording flue gas temperatures in prominent power plants. Let us tell you more about what they could do in your plant. Our new Catalog 0-1401 is waiting for your address.

The Bristol Company, Waterbury, Conn.

Canadian Distributors:
Eastern Territory: Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory: Gorman's, Ltd., Edmonton.

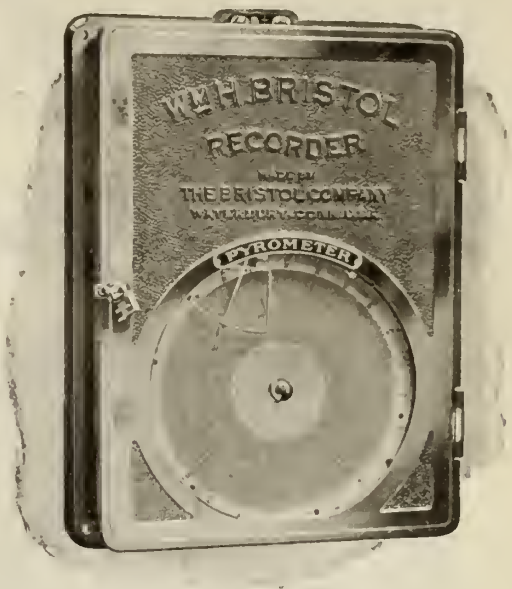


Fig. 1007
A suit has been filed in the United States Federal Court against a Pyrometer manufacturer who is infringing patents owned by the Bristol Co. covering Automatic Cold End Compensation for Thermo-Electric Pyrometers.

Guaranteed Blow-Off Service

Put Yarway Tandem Blow-Off Valves in your plant and for two years, at the very least, you won't have to spend another cent for blow-off service.
The Yarway Tandem—a combination of the Yarway Seatless Blow-Off Valve (formerly the Simplex) and the Yarway Double-Tightening Valve—is **unconditionally guaranteed** for two years. Should any part of either valve fail within that time, we'll make it good.

The chances are about fifty to one that you'll get much more than two years' service from the Yarway Tandem. The Yarway Seatless has established many records of eight and ten years' service, often without repairs; and the Yarway Double-Tightening —the younger member of the tandem—is building up similar records for itself.

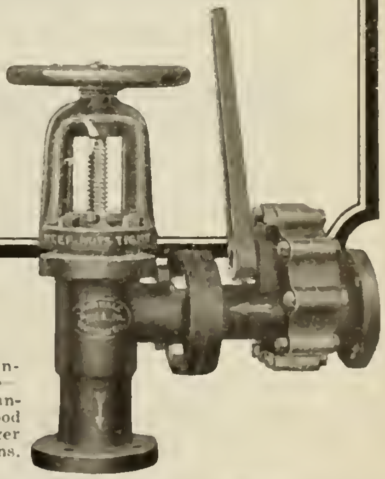
Both valves are described in Booklet B-410. May we send you a copy?

Yarnall-Waring Company

Mermaid Lane and Ardleigh St.
PHILADELPHIA

No. 207 St. James St.,
Montreal

No. 400 Penobscott Bldg.,
Detroit



This is the Yarway Tandem Blow-Off Valve unconditionally guaranteed for two years, good for a great deal longer under normal conditions.

YARWAY

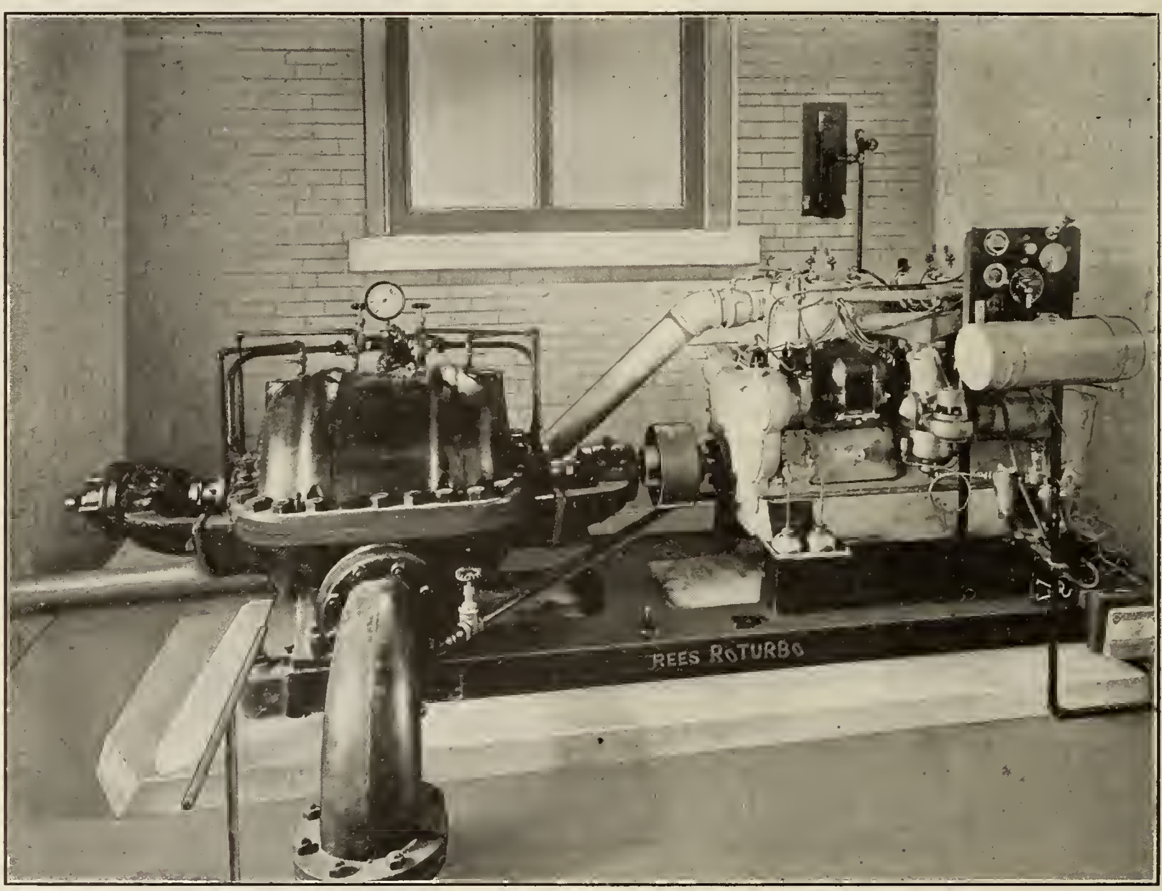
POWER PLANT DEVICES *to save fuel*

YARWAY BLOW-OFF VALVES—YARWAY SPRAY NOZZLES—YARWAY-LEA V-NOTCH METERS

THE REES RoTURBo

THE GOLDIE & McCULLOCH CO LTD
DEPENDABLE
POWER PLANT
& PUMPING
EQUIPMENT
GALT-CANADA

A Centrifugal Pump for Any Service



Showing a REES RoTURBo Pump at the Waterworks Pumping Station, Grimsby, Ont., with Sterling Gasoline Engine Drive.

REES RoTURBo PUMPS ARE SELF REGULATING

They automatically adjust themselves to sudden Drop or Overload without injury to themselves or the prime mover, and they assure a high and constant efficiency over a wide range of duties.

Municipal and Industrial Plants all over Canada are installing REES RoTURBo PUMPS.

Mr. C. H. Bromley, Town Engineer, Grimsby, Ont., in a letter recently sent us makes the following statement:—

"I have nothing but praise for both pump and engine. They both more than fulfil your guarantee for efficiency and are mechanically perfect."

Catalogs and further information on request

The GOLDIE & McCULLOCH CO., Limited

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bldg.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig,
400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B.C.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

N. C. SHATFORD
News Editor

Sharing Real Savings

COMPLAINT was made at the Canadian National Exhibition in the past week, by the owner of a large Quebec plant that engineers do not co-operate wholeheartedly with the management in cutting fuel costs in power plant operation but seem to think that their sole duty is to keep up the required pressure.

This accusation is unfair to the great majority of the engineers of Canada, but if it is true that some engineers fail to realize that they are a part of an organization primarily concerned in earning a return on the capital invested and do not co-operate with the management to that end, is the fault entirely with the engineer?

How many owners show appreciation of the efforts of their engineers to cut down labor costs and prevent waste of coal, oil and other supplies.

Too many accept such savings as a matter of course and it seldom occurs to them to give the engineer even a word of thanks, much less show their appreciation in more tangible form.

Conscientious engineers, with a proper pride in their work, whether it receives recognition or not, will nevertheless continue to give the best possible service they can render, although it may be true that sometimes they cannot help but harbor a feeling of resentment that their efforts on behalf of their employers go unrewarded, when their records clearly show that a saving of thousands of dollars a year often has been effected.

It must not be forgotten that some of the larger and more progressive manufacturers seek to create a personal interest on the part of their engineers by paying a bonus in recognition of economies effected, but although the practice is gaining momentum daily it is not yet by any means general.

Those enlightened managements, which recognize that the engineer is entitled to a small percentage of what he saves, are not the ones who complain of lack of co-operation on the part of their employees.

* * * *

Power, Heat and Light

REAL ability is necessary when the engineer is called upon to determine the proper distribution of power in a plant. Suppose his problems involve the proper capacities of electric, steam or water lines, as related to distances covered, average and peak load conditions, and various applications of such energy to present and prospective production units and their necessary requirements.

He must see that present needs are provided for, and also are sufficient to carry the increase needful to probable development.

What horse power should be provided for a given unit? Is it one of a group of similar units? What percentage of time are all such units operated at once? Are other kinds of machines likely to be idle while these units are operated?

Answers to questions like these are not only of real importance, but their practical application may well mean increased boiler capacity and power made available elsewhere in the plant, where a congestion might otherwise interfere with normal output.

Heating and lighting are closely allied to power as regards distribution; in fact, all the elements which go to make for proper manufacturing conditions are of so great an import that it is vital to-day for the engineer to obtain from reliable sources such as Power House the data and experience that permit him to understand fully their relation to one another and to power in these days of progress.

* * * *

An Anthracite Strike

ONE indictment of present day civilization by the 158,000 men engaged in the anthracite industry, is that facts vitally affecting the coal problem are ignored by the public. To a large extent any decision as to "full recognition," hours or wages is a game of blindman's buff—blindman's buff tempered by force and necessity.

Here is a basic industry—the very flame of life in many of the homes of Canada under existing conditions—and yet have we sought to know it, to master it, in a sensible and fore-thoughtful way to avoid being trapped by our dependence upon it?

Or is it accurate to speak of "chaos" as the truth—that we ignore the fact that storage is to the coal industry what the fly-wheel is to an engine.

Continuous operation must be the fundamental aim of any successful enterprise. Perhaps some day we may consider it the paramount aim. Intermittent operation breaks down the morale of a working force, leads to high overheads, prohibitive price quotations and failure to meet quantity and quality standards in the product. Then, too, intermittent operation is usually accompanied by an unbalanced wage scale and unnecessarily high hourly and piece rates which make but a poor substitute for a high annual return to the workers.

It should be recognized that this irregularity of operations is the primary cause of the unsatisfactory condition of the mining industry, the high prices of coal and the dissatisfaction among the miners and operators alike.

Regularity of operation necessarily involves regularity of demand whether the product be mined in Alberta or Pennsylvania, and it is possible to accomplish much in this direction through stimulation of demand in the seasons which are normally dull, and by discouraging orders at the peak.

* * * *

Send in Your Picture

IN THE next issue of Power House there will be the usual number of articles, practical ideas and newsy notes of what men in the power plant field are doing. Each article and idea is supposed to contain one thought that is of interest or of value in cutting operating costs.

Speaking of things of interest, why don't you send in an odd picture of yourself, or a picture of something you have done? It's so easy to send a photo or a snapshot, with a line or two on the back telling what it's all about.

Your picture will be welcome. The more pictures the better the Power House

Why Labor Decides Use of Coal or Oil As Fuel

Specially written for Power House

Consensus of Opinion Indicates That Oil at Five Cents a Gallon and 14,000 B.t.u. Coal at $8.72 a Ton is Same Price per B.t.u. Turned Into Steam

> *In our heating plant we have two boilers of approximately* **100** *h.p. each. One is fitted with an oil burner and last year we used oil in it to heat our building, the consumption being 48.000 gallons approximately, which ran our costs up pretty high. As a result we are considering the use of coal this year. Which is the cheaper fuel for our plant if it is necessary to employ two extra men to do the coal firing?*
>
> —HERBERT BALL, Toronto.

IN DECIDING whether fuel oil burning equipment is more economical than coal burning equipment in the average plant, the writer has found a large number of what might be called major considerations. The following list is by no means complete but may be suggestive to those faced with this problem:

1. The fuel cost per boiler horsepower hour at the existing contract price for coal and oil.
2. The dependability of the supply of each.
3. First cost of the boiler burning equipment proper, repairs, and replacements, depreciation.
4. The fuel storage problem and fire hazard.
5. Relative labor costs.
6. Ash handling and removal.
7. Cleanliness.
8. Flexibility in meeting sudden changes of load.

In the above tabulation no attempt has been made to place the factors in order since their relative importance depends almost entirely on local conditions.

Average Evaporation

First is the balance of the B.t.u. against dollars' worth of fuel. For example, let us assume that a plant burns 14,000 B.t.u. bitumionus coal in hand-fired boilers. In units where the load curve is not too regular, an equivalent evaporation from and at 221 deg. Fahr. of 8 lbs. of water per lb. of coal, should be averaged.

The corresponding figure for well installed oil burning equipment is an equivalent evaporation of 13 lbs. of water per lb. of oil. The coal, let us say, cost $6.00 per ton of 2,000 lbs., while the oil price has been quiescent around 10 cents per gallon for tank delivery.

Based on these values, the fuel cost per boiler h.p. hour is:

For bituminous coal 1.3 cents
For fuel oil 3.78 cents.

Another way to say this is that oil at 5 cents per gallon and 14,000 B.t.u. coal at $8.72 per ton is the same price per B.t.u. turned into steam. The comparison is often between oil and stoker-fired coal. If the small stoker-fired plant is well managed, an equivalent evaporation of 9½ lbs. might be expected. In this case the fuel cost per boiler h.p. hour is reduced to $1.09 cents.

Coal at $8 a Ton

Assuming that steam coal is delivered to the boiler room of the Toronto plant in question at a cost of $8 a ton in September, and that the heating value of this coal is 13,000 B.t.u. per lb., and that fuel oil can be bought at 10 cents a gallon, with a heating value of 19,000 B.t.u. per lb., and a weight of approximately 9 lb. per gallon, then the cost of the 48,000 gallon of fuel oil used in the season would be $4,800.

The actual heat contained in this oil (48,000 x 9 x 19,000) B.t.u.

The heat contained in one ton of coal (2000 x 13,000) B.t.u.

The tons of coal equivalent to this would be

$$\frac{48\,000 \times 9 \times 19{,}000}{2\,000 \times 13{,}000} = 316$$

Assuming that oil can be burned with an efficiency of 75 per cent., and coal with 60 per cent., then to equal the heating value of the oil actually $\frac{75 \times 316}{60}$ =395 tons of coal would be necessary.

Cost of coal then is 395 x 8 =$3,160.

If coal were used, two firemen would be required, working 12-hour shifts, 7 days a week. If the rate for firemen was 45c. per hour, and they were required thirty weeks a year, the labor bill would be 45 x 24 x 77 x 30 =$2,268.

Cost of coal—$3,160 + 2 268 =$5.428.
Cost of oil — $4 800.

Difference in Cost

The difference in cost assuming oil at 10 cents per gallon, and coal at $8 a ton, and that two more men are necessary utilizing coal, is therefore slight.

Now let us consider this problem from the viewpoint of a plant in pre-war days close to the Pennsylvania coal fields utilizing 7 water tube boilers rated at 1,650 h.p., which considered the alteration of its boiler room to burn liquid fuel.

The figures given apply fairly well to a plant in any section of the country when the proper substitutions are made for present prices of coal and liquid fuel.

In the plant under consideration the seven boilers supplied steam 24 hours a day at 125 pounds pressure. A mixture of 85 per cent. No. 3 Buckwheat and 15 per cent bituminous coal was being hand fired, the cost of the mixture being $5.00 per long ton delivered at siding.

A fuel oil contract was offered at 3 cents per gallon f.o.b. siding. The oil weighing 8 pounds per gallon. Calorimeter tests of the fuels under consideration were as follows: (dry)

	B.t.u. per lb.
No. 3 Buckwheat	10,900
Bituminous	13,900
Mixture (85% and 15%) ..	11,350
Fuel oil	18,500

Increasing Efficiency

An efficiency of 62½ per cent had been regularly obtained with coal. It was assumed that under oil the efficiency of the boilers would increase to 67½ per cent., since uniform fire would be possible, and the doors need seldom be opened for cleaning the fires.

The average daily equivalent evaporation from and at 212 degrees Fahr. for this battery of boilers was 1,141 000 pounds of water.

In this study all the fuels were assumed to be dry when burned. The number of heat units actually transferred into the water was for the two kinds of fuel as follows:

Coal mixture 11,350 x 62½ / 100 = 7,094 B.t.u.
Fuel oil 18,500 x 67½ / 100 = 12,487 B.t.u.

The number of heat units necessary to raise 1 pound of the water (equivalent evaporation) into steam is 974.7.

Therefore, the number of pounds of each kind of fuel necessary per day will be:

Coal

$$\frac{1{,}141\,000 \times 974.7}{7{,}094} = 157{,}000 \text{ pounds}$$

Fuel oil

$$\frac{1{,}141{,}000 \times 974.7}{12\,847} = 86\,6000 \text{ pounds}$$

The daily cost of each kind of fuel will be:

Coal

$$\frac{157{,}000 \times \$5.00}{2{,}240} = \$350.$$

Fuel oil

$$\frac{86{,}600 \times 3c}{8} = \$325.$$

There was then a slight saving at this price of nine years ago in fuel cost for fuel oil over coal. In the comparison of daily boiler room costs for the two types of fuels, however, the cost of labor, water, supplies and repairs had to be considered similarly to the Toronto plant to-day.

1 Ton and 154 Gallons

It is of interest to note, by comparison of the pounds of coal and oil necessary per day, that under conditions outlined one ton of the coal mixture was equivalent to 154 gallons of oil.

Comparative fuel and labor costs were then per day as follows:

Coal		
Fuel cost		$350.00
Labor cost		
Firing and coal passing	$84.14	
Repairs	13.29	
Handling ashes	7.38	
Handling coal in	13.68	
Ash removal	13.68	
Supervision	3.62	
		135.79
Total		$485.79

Fuel Oil		
Fuel cost		$325.00
Labor cost		
Firing	$30.09	
Repairs	9.30	
Supervision	3.62	
		43.01
Total of fuel oil		$368.01

The daily saving of fuel oil over coal was about $120. or 25 per cent of the total fuel and labor cost when using coal.

Changing Over Costs

Having established the possible saving through the use of fuel oil at 3 cents a gallon, the cost of changing over to burn liquid fuel was of immediate interest. This cost was estimated roughly as follows:

Oil circulation systems, pumps, burners, installed ready for operation but without storage tank and small preheating tank: $1.00 per rated b.h.p., total $1,650.

Storage tanks holding 10,000 gallons, or ten day's supply, together with small circulation and preheating tank of 1 000 gallons capacity, $5,000 installed, or about $3.00 per rated b.h.p.

Assuming the price of coal would not drop materially in the near future, and that an oil contract could be signed for several years at the price named. it was decided to change over the boilers to fuel oil. The actual cost of the conversion turned out to be:

1,700 fire-brick @ $70 per 1,000	$539.
1,400 lbs. high temperature cement	30.
Portland cement and fireclay	35.
Mason's labor	336.
Pipefitters' labor	150.
Cost of two pumps and pipe	350.
Strainer	15.
Fourteen burners	210.
Circulation and preheating tank	250.
	$1.915.

In Canada to-day with an oil price of 9 cents a gallon, the best obtainable, and steam coal quoted at $6.38 f.o.b. cars a very different condition prevails in the heating of large units, the use of oil being almost prohibitive, as fuel oil with a gravity of .9 and a heating value of 19,000 B.t.u. per lb. costing 9c per lb. is equivalent in cost solely on a B.t.u. basis, to 13 000 B.t.u. coal costing $13.70 a ton.

Reads Power House—Wins Wage Boost By Reducing Fuel Costs Thirty Per Cent.

By C. RYE*

WHEN our coal bin was filled with a lot of slack coal. which resembled black sandy mud more than it did a pile of latent heat, we tried several ways to induce it to burn and let us have the heat which it possessed, which was not much, to put it mildly.

The coal was like so much black sand, and it caused our firemen to say a few things that would not look good in Power House. The coal was bought through the office, and to many offices anything black that a coal dealer calls coal, is coal.

The engineer tried all possible ways to burn the stuff, but was not making much progress, when he asked the around him if they had ever seen, heard, or read, of any method of burning material such as this so-called coal! Much to his surprise, one of them had a recollection of reading in his engineering newspaper about a fellow who mixed such stuff with sawdust and got good results.

This gave a ray of light to the engineer. Hope dawned, and he speedily obtained a load of dry sawdust which he mixed with the coal until he got a mixture that seemed to make the old boilers groan with heat.

This mixture was tested to see why so much heat was developed, and the following conclusion was reached:

Lacked Air

When the slack coal was fired it checked the fire, as the smoke given off from the new coal could not get enough air through the bed of fine coal. This made a lot of smoke and combustion was not completed, such a condition wasting most of the coal that did burn.

Any attempt to work the fire, so as to get more air through the bed, resulted in allowing slack coal to fall through the grates.

The sawdust brought the following result, when mixed with one part of sawdust to two of coal, by volume. When fired first, the usual gas and smoke was given off by the coal, but as sawdust gives off a gas that ignites at a temperature much lower than coal gas does, this gas consumed the coal gas and smoke, causing the firebox to be full of flame as long as the sawdust lasted.

Then the fire was hot enough to drive off and completely burn the coal gas, which continued the flame and heat, and as the sawdust that was in the bed of burning coal was heated so that it was gasified, as about all that takes place in a furnace is to gasify the fuel, and then ignite it and see that combustion is completed—and as this gas comes in contact with the flame and air, combustion was completed.

This left the place that once held the particles of sawdust practically empty, and as the coal bed then resembled a sponge, it was easy to get air through it.

Holes Grew Larger

As the coal burned, these small holes grew larger, admitting more air. but the bed of fuel held its form much better than was expected. This allowed fresh fuel to be applied with less trouble in keeping the fire bed free from hills, hollows or holes.

This bed of coals or coke needed little or no working. As everything was naturally taking care of itself, the fire burned clear, the smoke was consumed, steam was up, and, best of all, the engineer was back where he generally is when everything is O. K.

If you want to see what happens when sawdust and coal are fired, take a handful of slack coal, slightly dampen it and shut your hand tight on it. It will stay in a lump as you compress it. Now mix sawdust with it and try squeezing it again, and when you release it it will fall apart.

This indicates an opportunity for air to work its way through the fire bed and help support combustion, which is impossible in the first case where the coal is "tight."

When such good results were obtained more sawdust was ordered at once at a cost averaging three cents a cubic foot, and weight for weight it was as cheap as coal on a B.t.u. basis. But the mechanical mixture of the two solids and the chemical mixture of the two gases sure did make the engineer and all hands smile.

Still Better Results

After the coal was all burned, we got a different kind of slack coal at a much lower price and mixed it with the sawdust, and even better results were had for still less money.

The extra work for the fireman did not amount to the time needed for firing with the coal alone, but as there was a thirty per cent. saving in fuel expenses, each operator involved received an increase of twelve dollars and fifty cents per month.

This was recognition from our employer of his willingness to share with us the profit of our improvements, and he was as well if not more pleased than the engineer.

I have more to write along similar lines, but would rather wait to see if this is printed in Power House, the paper that has been such a helping hand to engineers in time of need.

I often sit and wonder, would we be in the same old rut instead of enjoying better conditions in life if our sawdust suggester had been a fellow who did not read papers such as Power House to see how the other fellows overcame their difficulties?

---

*Wesley College, Winnipeg, Man.

London No. 30, Canadian Association of Stationary Engineers, on frolic at Springbank Park, London, Ont., on Aug. 18.

Rain Fails to Mar Fun of London No. 30, C.A.S.E.

G. F. Galloway, Immediate Past President of Association, Given Jewel by Geo. J. Soucy, Dominion Secretary—Mrs. William Ward Crowned Queen of Beauty

"I SURELY did have a good time!" This seemed to be the way members and friends of London No. 30, Canadian Association of Stationary Engineers had of expressing themselves on August 18, after the annual picnic of the association at Springbank Park.

The spot chosen for the picnic was certainly one of the prettiest possible, about four and a half miles west of London on the banks of the Thames river. The weather did not fulfil its early morning promise, for about 3.30 p.m. the exact hour the sports were scheduled to commence, rain began to fall, and for a while thoughts of a flood were paramount. Nothing daunted, however, George Moll, president of No. 30 and chairman of the sports committee decided to reverse the programme, and gave the ladies orders about the preparation of supper. In due time the signal to "fall to" came, and Mr. Moll urged members and others to make themselves at home, though even as he as speaking, he admitted that all present eemed to be doing that very thing.

About 5.30 p.m. the rain held up ufficiently long to enable a group photograph to be taken, and after everyone had "smiled" at the camera the presentation of a past president's jewel was made by the grand secretary of the Association, George J. Soucy, Toronto, to G. F. Galloway, immediate past president of the association.

The sports programme was varied, and certainly tested the prowess of all ages and sizes. Among other amusements, a beauty contest was held, and after long deliberation—for it was no easy matter for the judges—Mrs. William Ward was declared the victor. Miss Shirley Ward, daughter of Mrs. William Ward, was voted the prettiest child present. The youngest aspirant for membership in the C. A. S. E. was William Potter, six months old son of Mr. and Mrs. Albert E. Potter.

About the most popular pastime was the watermelon eating contest, during which George Moll proved himself to be an able entertainer. He sang many southern melodies and other popular airs, among favorites being "Shufflin'," "How Wet I Am," and "Pack up your Pleasures in your old Dinner Pail."

After supper an attempt was made to carry out the original programme insofar as the ball game was concerned, but only one inning was played, which showed a score of 13 to 2. Woodstock, represented by a large delegation, made up one team, and picked men from London played on the other. R. A. Lyons, of the Garlock Packing Company, acted as umpire on all disputed points, and the players realized after one or two attempts, that it was quite useless to gainsay his decision.

The line-up was as follows:

Woodstock team—R. Arnup, captain; Fr. Ferguson; Art Gepp, sr.; Art Gepp,jr.; H. Argent; William McCalley; Ed. Wilcon; K. McCalley; W. McFadden.

London team—J. Smith, captain; V. Whittaker; D. F. Campbell; G. F. Galloway; J. Waters; G. E. Moll; D. Freedy; J. Reynolds; W. Baker.

Grand Finale Staged

At 8.15 p.m. the grand finale was staged, consisting of a "penny scramble" for the kiddies. Needless to say, all entered, though all were pretty tired by this time. Amy Stevens proved the smartest and was rewarded by becoming the owner of the wherewithal to keep her in lollipops for quite a few days.

The following is a list of the races and their winners. The winners are residents of London except where otherwise stated:

1. Boys under six years—first, E. E. Stevens.
2. Girls under six years—first, Shirley Ward.
3. Boys ten years and under—first, Chas. Darman; second, Sidney Nash; third, Bert Potter.
4. Girls ten years and under—first, Evelyn Gepp (Woodstock); second, Marion Ash; third, A. C. Steven.
5. Boys fourteen years and under—first, Chas. Darman; second, Sidney Nash.
6. Girls fourteen years and under—first, Grace Clark; second, Evelyn Gepp (Woodstock).
7. Single Men's Race—first, Ed. Wilcox; second, Ken Smith.
8. Single Ladies' Race—first, Florence Galloway; second, Emily Tripp (Woodstock).

Expressions of regret were heard on all sides on account of the departure of Mr. and Mrs. G. F. Galloway from London to Galt, Ont., and hearty wishes were extended for Mr. Galloway's success in his new venture. He has purchased a controlling interest in a motor sales business in Galt, and will still maintain his interest in the C. A. S. E., and will attend the convention to be held next year in Montreal.

Thus ended a wet, but very enjoyable day. The children were tired, as children should be after a picnic, but it is unlikely that the day will be forgotten for some time to come. When the C. A. S. E. does anything it does it with the utmost success.

Combustion Losses and How to Minimize Them

By ROBERT JUNE, A.S.M.E.*

The Place to Begin to Save Dollars in Power Plant Operation is the Boiler Furnace—Here There is Opportunity to Effect Larger Savings Than Anywhere Else

COMBUSTION is supported solely by oxygen and a combustible therefore is an element or compound which will combine with oxygen. Table 1 comprises the principal elements and compounds encountered in the combustion of coal, and shows the chemical reactions which take place. The ignition temperatures of the combustible constituents of the coals commonly used in boiler practice are also given in Table 1.

Air, a chemical mixture of oxygen, nitrogen, and slight traces of carbon dioxide, water vapor, argon, etc., is for the purpose of combustion considered to be proportioned as follows:

	By Volume Per Cent.	By Weight Per Cent.
O_2	20.91	23.14
N_2	79.09	76.85

The nitrogen in the air is a source of direct loss in combustion since it absorbs heat in its passage through the furnace. It is a further source of loss since space must be provided in the furnace, boiler passages, and chimney for its accommodation, which would not be required if pure oxygen could be supplied to the fuel.

B.t.u. Value of Elements

The B.t.u. value of the various elements and compounds listed in Table 1 is given in Table 2. This table shows vividly the difference in heat produced between burning one pound of carbon to carbon monoxide, (CO), and burning the same carbon to CO_2. Nearly three times as much heat is produced in the latter case. High production of CO_2 then is essential to high combustion efficiency.

In studying Tables 1 and 2 it is well to remember that the heat value in the boiler furnace is dependent upon the final products of combustion, and that intermediate combinations which may have occurred, have no bearing upon the ultimate result.

Air for Combustion

The terms "perfect combustion" and "complete combustion" are frequently confused. Perfect combustion would result if all of the elements and compounds in the fuel were to be combined with oxygen which would be supplied in such proportions that all of the oxygen would be utilized.

In distinction from this, complete combustion results from the oxidation of all of the elements and compounds, but it does not imply that all oxygen supplied is utilized. With "perfect combustion" there would be no boiler losses. With "complete combustion" boiler losses occur because of the presence of excess oxygen.

TABLE I

ELEMENTS AND COMPOUNDS ENCOUNTERED IN COMBUSTION

Substance		Atomic Weight	Molecular Weight	Reaction	Ignition Temperature Degrees F.
Carbon	C	12	—	(to CO) $2C+O_2=2CO$ (to CO_2) $2C+2O_2=2CO_2$	(Fixed Carbon Bituminous) 766 (Fixed Carbon Super Bituminous) 870 (Fixed Carbon Anthracite) 925
Carbon Monoxide	CO	—	28	$2CO+O_2=2CO_2$	1210
Carbon Dioxide	CO_2	—	44	—	—
Sulphur	S_2	32	64	(to SO_2) $S+O_2=SO_2$ (to SO_3) $2S+3O_2=2SO_3$	470
Sulphur Dioxide	SO_2	—	64	—	—
Hydrogen	H_2	1	2	$2H_2+O_2=2H_2O$	1130
Hydrogen Sulphide	H_2S	—	34	$2H_2S+3O_2=2H_2O+2SO_2$	—
Oxygen	O_2	16	32	—	—
Nitrogen	N_2	14	28	—	—
Methane	CH_4	—	16	$CH_4+2O_2=CO_2+2H_2O$	1202
Acetylene	C_2H_2	—	26	$2\ C_2H+5O_2=4CO_2+2H_2O$	900
Ethylene	C_2H_4	—	28	$C_2H_4+3O_2=2CO_2+2H_2O$	1022
Ethane	C_2H_6	—	30	$2C_2H_6+7O_2=4CO_2+6H_2O$	1000
Water Vapor	H_2O	—	18	—	—
Air	—	—	29	—	—

A real measure of the efficiency of combustion is found in the relations existing between the amount of air theoretically required for the burning of fuel and the amount of air actually supplied for such combustion. Table 3 shows the theoretical requirements for various fuels and the resulting maximum per cent. of CO_2 in flue gas for complete combustion.

Combustion Losses

In order to utilize all the heat of combustion a boiler would have to be free from radiation and leakage losses, the coal completely oxidized, and the products of combustion discharged at atmospheric temperature. Commercially such conditions are unobtainable.

A boiler which is operated constantly at eighty per cent. overall efficiency is very exceptional; seventy-five to seventy-eight per cent. efficiency is extremely good practice. The various losses which occur in combustion, including the heat utilized by the boiler, constitute the "Heat Balance." The losses considered are:

1. Loss due to moisture in the fuel.
2. Loss due to hydrogen in the fuel
3. Loss due to moisture in the air.
4. Loss of fuel through the grate.
5. Loss due to incomplete combustion.
6. Loss through the dry chimney gases.
7. Loss due to unburned fuel carried beyond combustion chamber.
8. Radiation and unaccounted for losses.

These will be considered separately.

Moisture in the Fuel

Moisture in the fuel represents a very definite loss. It must be brought from atmospheric temperature to boiling point of 212 degrees, and again raised from 212 degrees to the temperature of the exit gases. At times firemen turn the hose on the coal pile. This is of value only to assist coking or reduce dust. The theoretical furnace temperature is decreased.

Wet coal will only give a higher evaporation by preventing loss through the grate, or reducing the percentage of excess air in thin fires, as a result of packing the coal better. Don't let your firemen run wild with the hose. Watch your step in purchasing coal to see that the moisture content is specified and that deliveries conform to the contract, or else that proper adjustment is secured for excessive percentages of moisture.

Loss Due to Hydrogen

The combustion of a pound of hydrogen results in the production of nine pounds of water vapor. This moisture must be heated and discharged at stack temperature.

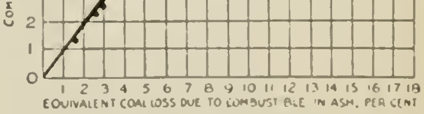


Figure 1.

---

*Specially written for Power House. Copyrighted 1923, by Robert June.

Further, since water is the direct product of combustion, the latent heat must be taken into consideration. Therefore, despite the fact that the combustion of a pound of hydrogen, liberates 62,000 B.t.u., we find that the presence of hydrogen in anthracite coal causes an approximate loss of 2.5 per cent. total heat value and with bituminous an average loss of 4.5 per cent. of the total heat value of the fuel. This loss then can be minimized only where it is practical to substitute a low hydrogen fuel for a high hydrogen fuel, without additional cost or without affecting other factors.

Loss Due to Moisture

This is usually a minor loss, but on hot, humid days, or in regions where the air is constantly sur-charged with water vapor it becomes appreciable. Since the moisture content of the air must be accepted as found the only manner in which this loss may be kept in a minimum is by the reduction of the exit gas temperature to the lowest practicable figure.

From 15 to 50 or 60 per cent. of the total weight of refuse in the ash pit is combustible matter. The quantity of this unconsumed carbon in the ash in any given plant depends upon the size and quality of the coal, the type of grate, the rating at which the boiler is operated, and to some extent upon the skill of the fireman.

TABLE II

HEAT OF COMBUSTION

By Calorimetric Determination.

Combustible	B.t.u. per lb.	B.t.u. per Cubic Foot
Hydrogen	62000	348
Carbon (to CO)	4380	——
Carbon (to CO_2)	14540	——
Carbon Monoxide	4380	342
Carbon in CO	10160	——
Methane	23850	1073
Acetylene	21460	1590
Ethylene	21450	1675
Ethane	22230	1883
Sulphur (to SO_2)	4050	——
Sulphur (to SO_3)	5940	——

In hand fired plants the total loss resulting from this waste of fuel has been found to range from 3 to 12 per cent. or more of the total heat value of the fuel. Good stoker practice should show losses ranging from one per cent. to a maximum of five per cent. of the heat value of the fuel.

The only way to find out where your plant stands on this important point, is to have a series of analyses made of representative samples of ash. If you are not equipped to make such a test yourself you can send your samples to testing laboratories in any of the large cities, which will do this work for a nominal fee.

If you find that your losses are high, study the proportioning of the grate openings to the size of coal burned; note further how your firemen handle the fire. You may find that your trouble is due to the use of coking coals, and that if it is practical to do so you will greatly reduce your losses by the substitution of free burning coals.

Incomplete Combustion

The difference between the burning of a pound of carbon to CO and burning it to CO_2 is 10,160 B.t.u. A very small percentage of CO in the flue gas is therefore fatal to high boiler efficiency. The extent of losses resulting from the presence of CO in the flue gas is shown graphically in Figure 2.

Carbon monoxide being a colorless gas, its presence in the chimney gases cannot be detected by the absence of smoke. A clear stack does not indicate perfect combustion. If you find that you are running high percentages of CO look first to the method of handling the fire on the part of the firemen. Then check up your furnace design. Remember that if ample combustion space is not provided the volatile gases will be brought in contact with the boiler surface before combustion is complete, and the CO being thus reduced in temperature, may fail to unite with the oxygen to form CO_2.

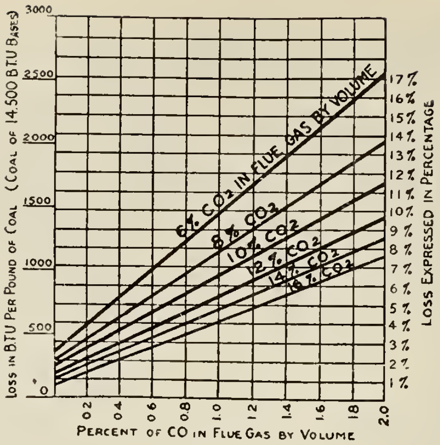


Figure 2.

Dry Chimney Gases

This is usually the greatest of all the losses. In even the best practice this loss is usually not far from 12 per cent. with a general average of from 20 to 25 per cent. The size of the loss arises in the fact that stack temperatures less than 450 degrees are seldom found except in connection with economizers, and that temperatures of 600 to 700 degrees are by far more common. Figure 3 shows the amount of heat carried away under varying conditions.

The quickest way to reduce this loss is by the installation and regular use of soot blowers. Put in soot blowers and you will find your stack temperatures greatly reduced with a consequent direct saving in fuel of from 3 to 5 per cent.

Next cut down the amount of excess air admitted to the furnace to a minimum. Eliminate air infiltration by providing absolutely tight boiler settings. And finally, keep the boilers free from scale so that they will readily absorb heat.

Unburned Fuel

When large quantities of unconsumed particles of carbon are deposited beyond the bridgewall, the fault is usually due to improper furnace design or to improper draft conditions. The fuel should be burned before it leaves the combustion chamber. If it is not, the situation demands a special study of plant conditions.

Unaccounted for Losses

These losses which it is practically impossible to measure, include; 1. Radiation loss, which varies with the size of the furnace and boiler condition of the setting. Careful tests on properly designed boiler furnaces show that the radiation loss in the very best practice does not exceed 2 per cent. 2. Losses due to unburned volatile hydro-carbons. 3. Loss due to the combination of carbon and moisture, with the consequent formation of hydrogen ($C+H_2O$ equals $CO+H_2$), which may or may not be burned. This action may occur when wet fuel is thrown on an incandescent fuel bed.

The test figures of 2 per cent. radiation and unaccounted for losses can be approximated in the average boiler plant. Unfortunately these losses are usually sadly neglected. They are frequently found to amount to as much as 10 or 15 per cent. due primarily to leaky boiler settings, as well as cinders blown out of the stack under a high draft pressure. With improperly insulated boiler settings there is just one thing to do —build the walls thicker and insulate them properly.

Smoke

Smoke consists of the gaseous and solid products of combustion both visible and invisible, including substances carried in the atmosphere with the products of combustion.

The direct loss due to visible smoke is very small. Compilation of the results of a large number of tests show that this loss as represented by unconsumed carbon seldom exceeds one per cent. It is the invisible and practically colorless gases issuing from the stack which may represent combustion losses many times greater than that due to the actual carbon in the gases. A small amount of carbon will color an immense volume of gases.

TABLE III

THEORETICAL AIR REQUIREMENTS FOR VARIOUS FUELS AND THE RESULTING MAXIMUM PER CENT CO_2 IN THE FLUE GAS FOR COMPLETE COMBUSTION.

Fuel, Moisture and Ash Free	Ultimate Analysis C.	H.	N.	O.	S.	Air, Pounds Per lb. of Fuel	Per 10,000 B.T.U.	CO_2 % By Volume
Anthracite	94.39	1.77	0.71	2.13	1.00	11.39	7.4	20.06
Semi-anthracite	89.64	3.97	0.63	3.23	2.53	11.59	7.5	20.00
Super-bituminous	86.39	4.84	1.46	5.50	1.81	11.41	7.6	18.65
Bituminous	79.71	5.52	1.52	9.87	3.38	10.70	7.4	18.46
Sub-bituminous	78.06	5.70	1.35	13.10	1.79	10.24	7.3	81.56
Lignite	70.64	4.61	1.22	22.67	0.86	8.75	7.3	19.68

TABLE IV

Heat absorbed and losses itemized	Highest attainable Efficiency	Excell'nt practice	Good practice	Average practice	Poor practice
Heat absorbed by boiler	89.86	80.0	75.0	65.0	60.0
Loss due to free moisture in coal	0.50	0.5	0.6	0.6	0.7
Loss due to hydrogen in coal evaporation of H_2O	4.20	4.20	4.30	4.3	4.4
Loss due to heat in dry flue gases	5.33	10.0	13.0	17.5	20.0
Loss due to carbon monoxide	0.00	0.2	0.3	0.5	1.0
Loss due to combustible in ash and refuse	0.00	1.5	2.4	4.5	5.5
Loss due to heating moisture in air	0.11	0.2	0.2	0.3	0.4
Loss due to unconsumed hydrogen, hydrocarbon, radiation, and unaccounted for	0.00	3.4	4.2	7.3	8.0
Calorific value of coal	100%	100%	100%	100%	100%

As a matter of fact a smoky chimney may indicate a much more efficient furnace than one which is smokeless, due to the fact that a furnace operating with a minimum air supply may cause dense clouds of smoke, and still give a higher evaporation than one made smokeless by a large percentage of excess air.

The loss due to unconsumed or partially consumed volatile hydro-carbons though not evident from the color of the gases issuing from the stack, may represent a very appreciable percentage of the total fuel fired. The way to determine this loss and to minimize it is by constant analysis of flue gas and by the application of remedies suggested by the results of such analysis.

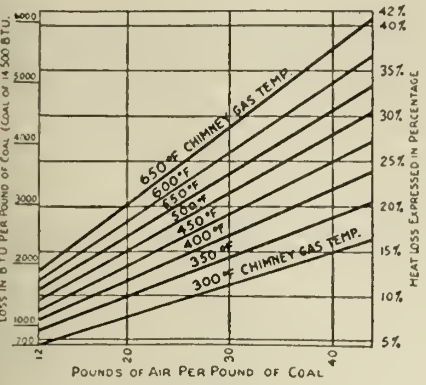


Figure 3.

Stand-by Losses

Stand-by losses include: (a) heat lost in shutting down boiler; (b) coal required to start up cold boilers; (c) fuel required in banking fires; (d) heat lost in "blowing off" and cleaning boilers. Depending upon the size and character of the boiler equipment and the conditions of operation stand-by losses will range on the average from 5 to 15 per cent. or more of the total heat generated over the period of a year. This means that if your boiler normally operates at an efficiency of 70 per cent. for example, that its actual efficiency over a period of a year will probably not exceed 60 per cent.

Bearing this fact in mind, efficient power plant managment demands that the closest watch be kept on the detail of taking off or putting boilers on the line. It is better to work three boilers continuously at a high rating if this can be done, than to work four intermittently.

Heat Balance

The heat balance consists of a chart on which a summary is made of the various losses together with the amount of heat absorbed by the boiler. It is a bookkeeper's device, very valuable to the power plant operator, for it shows him at a glance where his losses are and thus in itself suggests means for minimizing them.

A representative heat balance is shown in Table 4. To the operating man this table is of value for purposes of relative comparison only. The actual heat balance for any given plant must be worked out on the ground, with reference to the grade of fuel, type of furnace and grate, rating at which the boiler is driven, and similar factors.

Improving the efficiency of a boiler plant is a man size job. It requires enthusiasm, patience and persistence, but given these the reward is certain.

Acid in oil will cause corrosion when in contact with moisture. The presence of sulphuric acid may be determined by a solution of barium chloride in distilled water, a few drops of which put into the oil after it has been thinned with an equal amount of gasoline or benzine will cause a whitish precipitate if acid is present. In the absence of moisture the acid is not so active and may escape notice.

C.A.S.E. Notes

The regular meeting of the Canadian Association of Stationary Engineers, London of No. 30, was held in Foresters Hall on August 17, 1923, and was well attended. Past grand president George E. Moll presided. George J. Soucy, grand secretary of the Association was present, and spoke on the "good of the order," touching on the subject of what the C. A. S. E. held out to prospective candidates for membership. He also outlined the enthusiastic membership campaign being launched by the grand president, James J. Sullivan, of Ottawa.

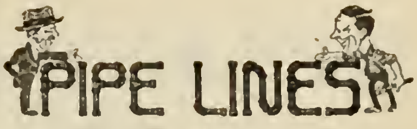
R. E. Lyons, representing the Garlock Packing Co., made a short address outlining ways and means that the C. A. S. E. could be of service to the engineers of the community. D. F. Campbell who has been conducting technical classes in steam engineering was present and consented to act on the general educational committee of the C. A. S. E.

The Grand Lodge is quite convinced that with a Minister of Labor such as Dr. Forbes Godfrey, a satisfactory advance will be made in the way of better enforcement of the act and its impartial application. A resolution of the Grand Lodge requesting the appointment of Inspectors, not members of the examining board, has been presented to the Minister of Labor, and he has promised that it will have his careful consideration.

Final plans for the annual picnic held August 18, were made. London expects to see a big increase in membership under the leadership of George E. Moll—Joseph H. Ward, Secy-Treas.

G. F. Galloway, past president of the C. A. S. E. has purchased a controlling interest in a motor business in Galt, Ont., and with Mrs. Galloway and family has moved to Galt from London.

George J. Soucy, grand secretary of the C. A. S. E., was in London, Ont., on August 18, for the purpose of presenting G. F. Galloway, with a past president's jewel. While in London, Mr. Soucy attended the annual picnic of the London No. 30, C. A. S. E. at Spring Bank Park.



UNCOVERED IN ANY OLD SPOT

The straight repulsion-type of single-phase motors may be reversed by shifting the position of the brushes from one side of the axis of the field poles to the other. The correct running position of the brushes is generally about 12 to 15 electrical deg. to the right or left of the field-pole axis.

* * *

Technical School Director: (*to engineering class*) "*What is a drydock?*"

Oshawa Student: "*A doctor who won't issue any prescriptions.*"

* * *

Singing or Hissing of Brushes: Apply a small quantity of good machine oil or vaseline with a piece of canvas and then wipe off. Just a faint trace of oil should be all that is required.

* * *

As the great steel magnate was raking Johnny, the office boy, over the coals, the lad sobbed:—"Gee, I just wish you'd put as much trust in me as mother does in a safety pin."

* * *

Bearings Out of Line: Loosen bearings by partly unscrewing bolts that hold them in place; usually they will align themselves after machine has been started and then the bolts can be gradually tightened up. This must be done with the belt off.

* * *

There is nothing suicidal about a girl hanging on a man's neck at the Canadian National Exhibition.

* * *

Overhead-sheave bearing boxes should always be packed with compression-cup grease. The grease must be pushed against the shaft once or twice a week, as sufficient heat is not generated in the bearings to cause the grease to run as in the case of continuously operated machinery.

* * *

No, Nita, it does not always indicate a cold, just because one is continually coughing up.

* * *

A synchronous motor is an alternating-current generator operating as a motor. If two alternators are connected in parallel and the prime mover of one shut down, this alternator will continue to rotate in the same direction and will pull its engine; the alternator then becomes a synchronous motor.

* * *

Teacher: "*Johnny, use the word Egypt in a sentence.*"

Johnny: "*I asked him for my change but E gypt me.*"

* * *

Coefficient of friction means the proportion of the pounds pull (or push) to the pounds (weight) being moved over a given horizontal surface; that is, wood on wood without lubricant may have a coefficient of 0.5, or require ½-lb. pull to move one pound along slowly. Or, coefficient of friction is the ratio of the force required to slide a body along a horizontal plane surface to the weight of the body.

The Value of the Slide Rule in a Power House

By **ARTHUR MURPHY**

The Solution of Simple and Everyday Problems of the Engineer With a List of Ratios Found Handy Around Power Plants

IN THE July 5 issue of Power House an outline was given of the use of the slide rule and its application to some simple calculations. This article is intended to show its applicability to some simple and everyday problems of the power plant engineer.

The placing of the decimal point, when using the rule, should present no serious difficulty, if the engineer, instead of trying to keep track of the point, will ignore it until the calculation is completed, then place it by simple arithmetic.

Example:—Multiply 2 × 30.

If on the slide rule we set the left index of C over 2 on the D scale, then under 3 on the C scale, we find 6—not 60.

Placing Decimal Points

Place the decimal point by inspection. From arithmetic we remember that when multiplying decimals we first multiply as if there were no decimal points, then count off as many decimal places as there are in the numbers being multiplied.

Problems:—

1 20 × 3
2 2 × 300
3 .2 × 3
4 .2 × .03
5 .02 × .003

In problem 4 there are three decimal places. The answer must be .006. In problem 5 there are 5 decimal places, giving the answer .00006.

The multiplication of three or more numbers presents no more difficulties than the multiplication of two, it is simply continuation.

To find the value of 4.1 × 56 ×.26 × 49.

Using scales C and D, set the right index on C to 41 on D and then move the indicator to 56 on C. We have now multiplied 41 × 56. The result so far is 2,296 opposite the indicator on scale D, neglecting the decimal point.

Now set the left index of C to the indicator and move the indicator to 26 on C. On D under the indicator is 597.

Set the right index to the indicator and move the indicator to 49 on C, on D. Opposite the indicator find 2,925, the answer. The position of the decimal point is fixed by inspection. 4.1 × 56 × .26 ×.49 is roughly 4 × 60 × ¼ × ½ or 30. The answer then is 29.25.

It is not necessary to read the result of each step in the calculation as has been done above, read nothing but the final result. In this way, provided care is taken in the setting of the indicator and the slide, the only place for inaccuracy in reading the graduations is in the answer. The slide rule can be relied upon to give fairly close figures, even in a problem involving several settings of the slide and the indicator.

Cube Roots

Occasionally the engineer will have to find the cube root or the cube of a number. The K scale is used for this operation in conjunction with the D scale. To find the cube of a number, set the indicator to the number on the D scale and read the cube on the K scale.

Finding the cube root requires more caution, the scale is divided into three parts. Suppose we wish to find the cube root of 270. As a rough guess it is a little more than 6, thus we would set it to somewhere between 6 and 7 on the D scale and then look on the K scale and find the division in which the 27 occurs and set the indicator to the correct place. Read the answer 6.46 on the D scale.

Area of Circle

To find the circumference of a circle having a diameter of 16 inches.

The circumference of a circle is 3.1416 × the diameter, usually written π × D.

Set the left index of the C scale over π on the D scale. Under 16 on the C scale read the answer 502 on the D scale, and since 3 × 16 is about 48, the answer must be 50.2.

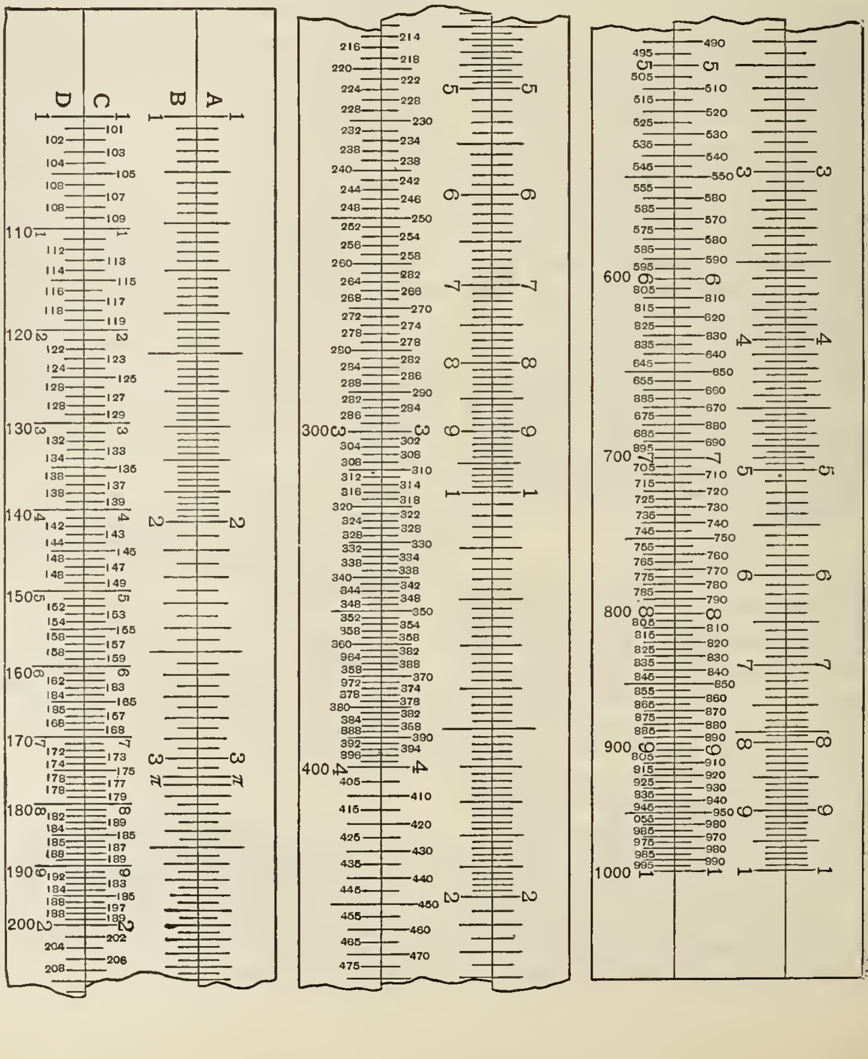
To find the area of a circle whose diameter is 8 inches.

The general formula for the area of a circle is πr^2 where π is a constant = 3.1416 and "r" is the radius of the circle.

On the slide rule π will be found on the D scale. Multiply 4 × 4, using scales C and D, then multiply by π.

Set the right index on scale C over 4, the radius, on scale D. Set the indicator to 4 on scale C, then move the slide till the left index of scale C is under the line of the indicator. Under π on scale C read 5.02 on scale D.

Another handy formula for the area of a circle is .7854 × D^2. This is convenient for the slide rule as it is then



ot necessary to divide the diameter by to get the radius.

To find the area of the 8-inch circle y this rule.

Set the right index of the C scale over 7854 on the D Scale. Under 8 on the scale set the indicator, then move the ide till the right index is in line with he line on the indicator. Under 8 on the scale read the answer 5.02 on the D cale.

Find Horse Power

Find the horse power of an engine unning 250 r.p.m., with a weight of 100 ounds on the scales, the length of the rake arm being 4 feet.

The formula for H. P. is $\frac{2 \pi r n w}{33.000}$.

where

r = length of brake arm, in the case of a rope brake, "r" is the radius of the pulley.

n = revolutions per minute.

w = net weight or effective weight on the scale.

The H. P. of the engine is

$$\frac{2 \times \pi \times 4 \times 250 \times 110}{33,000}$$

Using scales C and D multiply 11 by 25, divide by 33, then multiply by 8, then by π, and by inspection the 190 we found by the slide rule must be 19.0.

Useful Ratios

The slide rule will be found to be of value to the engineer in problems involving proportion as when finding the lb. per sq. in., equivalent to head in feet, United States gallons to Imperial gallons, etc.

As an example, suppose we wish to find the number of Imperial gallons corresponding to 1,200 U. S. gallons.

$$\frac{6 = \text{U. S. gallons}}{5 = \text{Imperial gallons}}$$

Thus the number of Imperial gallons

$$\frac{5 \times 1800}{6} = 1500$$

On the slide rule this is an easy calculation, and its use will shorten the time required to change a table given in U. S. gallons to the Imperial gallons. so that it can be used in Canada.

Place the 6 on the C scale over the 5 on the D scale, then under 18 on the C scale, read the answer 15 on the D scale.

As another example find the number of pounds per sq. in. equivalent to a head of 34 feet of water.

In the manuals published by the slide rule makers the usual method of indicating a problem of this nature is

C	Set 60	Under 34
D	To 26	Find 14.75 pounds = answer

Or, in other words, on scale C set 6 over 26 on the D Scale, then under 34 on the C scale find 14.75 on the D scale.

The following list of ratios will be found handy around the power house for quick calculations, the departure in no case from the exact ratio exceeding one in a thousand.

$$\frac{\text{Set } 226 = \text{Diameters of circles}}{\text{To } 710 = \text{Circumferences of circles}}$$

$$\frac{70 = \text{Side of square}}{99 = \text{Diagonal of square}}$$

$$\frac{6 = \text{U. S. gallons}}{5 = \text{Imperial gallons}}$$

$$\frac{430 = \text{Imperial gallons}}{69 = \text{Cubic feet}}$$

$$\frac{26 = \text{Inches}}{66 = \text{Centimeters}}$$

$$\frac{82 = \text{Feet}}{25 = \text{Meters}}$$

$$\frac{46 = \text{Imperial gallons}}{209 = \text{Liters}}$$

$$\frac{57 = \text{Inches of mercury}}{28 = \text{Pounds per square inch}}$$

$$\frac{60 = \text{Feet of water}}{26 = \text{Pounds per square inch}}$$

On Trip West for Power House

Walter J. Hudson to Give Unique Service to All Engineers "Stumped" by Problems

WALTER J. HUDSON.

THERE are perhaps few men in engineering circles in Canada who would hold the same interest among stationary engineers and power plant operators as Walter John Hudson, who now lives in Toronto. Mr. Hudson has had an enviable experience in all work in connection with the operation of steam power plants. Born at Burton-on-Trent, Staffordshire, England, on June 17, 1860, attended the public schools until he was 13 years old, and became an apprentice in the machine shop of the Cannock-Rugley Coal Co., transferring himself three years later to the engine room.

By diligent application, Mr. Hudson qualified as a stationary engineer in 1881, coming to America to fill a position in this capacity with the Oliver Iron & Steel Co., Pittsburg, Pa., which he held for three years. Seeking further advancement, he became employed with Chess Cooke & Co., and the Republic Iron Works, finally being appointed chief engineer of the Pittsburg Incline Co., and superintendent of the Monongahela Incline Planes Co.

For nearly seven years he was master mechanic of the Western Penitentiary, Pittsburg, Pa.

Coming to Canada in 1913, he was appointed engineer at the plant of the Moffatt Stove Co., at Weston, Ont., later becoming chief engineer at the C. P. R. and Dominion Express Company's building at Simcoe and King street, Toronto, a position he held for four years before being appointed chief engineer at the Standard Sanitary Manufacturing Company's plant, Royce Avenue, Toronto, and later superintendent of production of the Coca-Cola Co., Toronto.

Mr. Hudson is a prominent member of the F. & A. M., being past master of his lodge, and a member of the I. O. O. F., and past district deputy master of No. 3 district, Pittsburgh. He is a past chief of the Universal Craftsmen Council of Engineers, and resigned his position as secretary of Toronto No. 27, on August 27, 1923.

He is now making a service trip to Winnipeg, and on his return will call at Kenora, Port Arthur, Fort William Sudbury, Sault Ste. Marie, and other cities, in the interests of Power House. He is at the service of all engineers and operators, and his varied experience in all work pertaining to steam efficiency should be of great value in solving perplexing problems in the power plant.

The town of Unity, Sask., has purchased one 90 h.p. Vickers-Petter, semi-Diesel, heavy oil engine.

Two 550 h.p. Vickers Diesel engines, direct connected to Westinghouse generators, were recently installed in the Hollinger Gold Mines.

Tenders have been called for by the City Clerk, City Hall, Vancouver, B. C., for a hot-water heating system in the Relief Building, 530 Cambie Street, Vancouver.

Modern Practice in the Transmission of Power

The Transmission Gear Must be Taken Into Consideration in Order to Eliminate the Absorption of More Power Than is Actually Required by the Machines

THE importance of ascertaining accurately the loss of power in power transmission gear is now becoming recognized. It is impossible to estimate the efficiency of any power system unless the transmission gear is taken into consideration, for this may be absorbing more power than is actually required by the machines in the plant.

For a number of years the question of the individual electric drive has been coming more and more into prominence, for instances are constantly occurring where appreciable sums have been saved by the elimination of mechanical transmission gear.

It is a mistake to imagine, however, that the individual drive is always the most economical, for this is not the case. Its efficiency depends largely on two factors: (a) The h.p. required by the machine; (b) the percentage of working hours that the machine actually requires power from the motor.

If Horse Power is Large

Should the h.p. of the machine be fairly large, and the number of working hours per week small, the individual electric drive should always save power, provided the machine was previously driven from a line of shafting that was constantly in use.

In some cases the individual electric drive may even effect economies when the line shafting was not constantly in use, owing to the power loss in the shafting when the machine in question was receiving power.

In the majority of workshops the machines individually require little power, so that the savings that may be made by the individual drive may be so small as not to warrant the additional expenditure. The whole question depends on the efficiency of the mechanical transmission gear.

Before considering this question any further it would perhaps be as well to deal with the efficiency and layout of mechanical transmission gear. Although the value of chain driving is becoming more generally recognized, belt driving is still the most favored system of transmitting power.

Lower Expenditure

This is largely due to the lower expenditure involved and the simplicity of this method.

Every engineer knows the troubles attendant on the use of tight belting, and the difficulty often experienced in avoiding this. Tight belting is a constant source of trouble and expense, and may cause damage to the journals and shafting.

Although belt slip is usually considered to exist only to a small extent, it is a fact that a belt slip of from 5 to 10 per cent. is the rule rather than the exception. Belt slip is the cause of a great deal of trouble, and besides damaging the belting often ruins both wood and metal pulleys, owing to the heat that is generated by the slipping. Wood pulleys have been known to catch fire and metal pulleys to expand and crack under these conditions. The decreased production must also be taken into consideration, as time, output and labor are wasted owing to the slower working speed of the machinery.

Primary Points

The primary points to be considered when designing a belt drive are as follows:

(1) Ratio of the diameter of the driving to the driven pulley.

(2) Distance between shaft centres.

(3) Speed of the shafting in revolutions per minute.

(4) Belt speed in feet per minute.

(5) Arc of contact on the smaller pulley.

(6) Co-efficient of friction between belt and pulleys.

(7) Belt slip and creep.

(8) Jointing of the belting.

(9) Size and type of belting.

There are also a number of smaller considerations dependent on the above conditions. For practical purposes, unless a drive is to be mathematically worked out in every respect, the co-efficient of friction is not always taken into account, although if really reliable figures are required this should be done. Variation of any one of the above conditions affects one or more of the other conditions, so that considerable care must be taken when planning an efficient drive, particularly if expense is an important condition, as is usually the case.

The greatest difficulty when planning a drive is usually to reconcile the ratio of the diameters of the driving and driven pulleys with the available distance between the shaft centres. There are many rules in use for this problem, one of the most practical giving a distance between the shaft centres of 18 times the diameter of the smaller pulley.

A Minimum Distance

For example, with a 6-in. pulley driving on to a 30-in. pulley this would mean a minimum distance between shaft centres of 9 ft.

Some authorities go much further than this and specify a fixed minimum distance between shaft centres under any conditions. The following table shows the minimum distances between shaft centres adopted by one of the best authorities:—

Ratio of Driver to Follower	Minimum distance between Shaft C'ntres	Ratio of Driver to Follower	Minimum distance between Shaft C'ntres
1 to 2	8 feet	1 to 4	12 feet
1 to 2.5	9 feet	1 to 4.5	13 ft. 6 in.
1 to 3	10 feet	1 to 5	15 feet
1 to 3.5	11 feet	1 to 6	18 feet

Drives planned in accordance with this table will give very high efficiencies, and it is wise whenever possible to keep to these figures. Certainly a shorter distance than 18 times the diameter of the smaller pulley should never be employed if at all possible.

Electric motors are now used in every kind of workshop, and owing to the comparatively high speed at which most of them work, drives with high-speed ratios are largely in use. Electric motors of a given h.p. are much cheaper when made for a high speed and the temptation is therefore to invest in a high-speed motor and arrange the transmission gear accordingly.

Choice of Motor

Unfortunately the choice of the motor is not always left to the engineer who is

LINE SHAFTING

Diameter of Shaft in inches ...	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	½	5
R P M	Maximum Distance between bearing centres in feet											
100	7½	7¾	8¼	8¾	9¼	9¾	10¼	10¾	11¼	11¾	12¼	13¼
150	7	7½	8	8½	9	9½	10	10½	11	11½	12	13
200	6¾	7¼	7¾	8¼	8¾	9¼	9¾	10¼	10¾	11¼	11¾	12½
250	6¼	7	7½	8	8½	9	9½	10	10¼	10¾	11¼	12
300	6	6¾	7¼	7¾	8¼	8¾	9	9½	9¾	10¼	10¾	11½
350	5½	6¼	7	7½	8	8¼	8¾	9	9¼	9¾	10	11¼
400	5¼	6	6¾	7¼	7¾	8	8¼	8½	8¾	9	9¼	9¾
500	4¾	5¾	6½	6¾	7¼	7¾	8	8¼	8½	8¾	9	9½
600	4½	5½	6¼	6½	6¾	7¼	7½	7¼	8¼	8½	8¾	0¼
700	4¼	5	5¾	6	6¼	6¾	7¼	7½	8	8¼	8½	8¾
800	4	4½	5¼	5½	5¾	6¼	6¾	7¼	7¾	8	8¼	8½
1000	3¾	4¼	4¾	5	5¼	5¾	6¼	6¾	7¼	—	—	—

usually called in to fix the motor and fit up suitable transmission gear.

This is a pity, for it is often necessary to use two or three countershafts in order to get the required speed ratio, and this means waste of power and additional expenditure. On the other hand, if the motor is some distance from the machines, a high speed may be advantageous, as smaller shafting and belting may be used for the countershaft drives.

The h.p. that shafting of any given size will carry varies directly with its speed. On the other hand, the maximum distances between the journals decrease as the speed of the shafting increases, although not in direct proportion. The following formulae are for the h.p. which mild steel shafts of good quality will transmit at various speeds:—

No. 1. Head Shafts: $\dfrac{(\text{dia. of shaft})^3 \times \text{r.p.m.}}{100}$

No. 2. Line Shafts: $\dfrac{(\text{dia. of shaft})^3 \times \text{r.p.m.}}{66\ 2/3}$

No. 3. Transmission Shafts: $\dfrac{(\text{dia. of shaft})^3 \times \text{r.p.m.}}{50}$

If these formulae are adopted the maximum distance between adjacent bearings supporting the shafting will be found in the tables accompanying this article.

Subject to Explosions

Where the shafting, however, receives its power from gas or oil engines, and is therefore subject to shocks from the explosions of the engine, stronger shafting should be used, a given shafting being capable of carrying safely approximately 30 per cent. less power under these conditions.

One of the most important features of power transmission gear is the bearings. Upon their suitability for the work depends to a certain extent the success of an installation. It is commonly believed that the metal of the bearing rubs against the shafting, and that the friction of a bearing depends upon the materials of which it is composed. This is not the case should the bearing be properly lubricated. The lubricating oil or grease imposes a thin film between the two metals and prevents actual contact, so that it is immaterial what metal is used, if properly lubricated, as far as friction is concerned.

Excessive pressures may squeeze the oil out of the bearings, and the metals then come into contact, in which event the heat generated will cause them to expand and grip each other, causing a "seize."

Tight Belting Dangers

Tight belting is particularly responsible for this evil, the continual heavy drag on the bearing tending to break the oil film far more easily than heavier intermittent loads.

Both belt slip and tight belting are caused through the belt getting insufficient grip of the circumference of the smaller pulley, this in turn being due to too high a speed ratio for the distance between shaft centres.

Where conditions permit of no improvement, the difficulty to a certain extent may be overcome by the use of a wider belt.

It has been conclusively proved that the friction between belt and pulley varies considerably with the speed, so that for correct calculations the co-efficient of friction must be taken into consideration. In ordinary practice this varies between .3 and .5 for leather belting running on cast-iron pulleys. The following table gives the co-efficient of friction at various belt speeds:—

Speed in ft. per minute	Co-effic'nt of friction	Speed in ft. per minute	Co-effic'nt of friction
600	.298	3,500	.437
1,000	.327	4,000	.453
1,500	.355	4,500	.468
2,000	.379	5,000	.483
2,500	.400	5,500	.497
3,000	.419	6,000	.510

Greater belt slip is liable to take place at high-belt speeds, owing to the action of centrifugal force.

Belts should not work at a speed exceeding 5,250 ft. per minute, owing to centrifugal force, and also because this is the safe limit of periphery speed for cast iron pulleys of ordinary construction.

Generally speaking, from 1,000 to 2,000 ft. per minute for machine drives, and from 3,000 to 3,600 ft. per minute for main belts conforms to good practice.

HEAD SHAFTING

Diameter of Shafts in inches	Distance between centres of Bearings in feet				
	4	5	6	8	10
	Diameters of Swells in inches				
3	3½	4	4½	—	—
3½	4	4½	5	—	—
4	4½	5	5½	6	—
4½	5	5½	6	6½	—
5	5½	6	6½	7	7½
5½	6	6½	7	7½	8
6	—	7	7½	8	8½
6½	—	7½	8	8½	9
7	—	8	8½	9	9½
7½	—	—	9	9½	10
8	—	—	9½	10	10½

TRANSMISSION SHAFTING

Diameter of Shaft in inches	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	4½	5
R P M.	Maximum Distance between bearing centres in feet											
100	9¼	10¼	11¼	11¾	12¼	12¾	13¼	13¾	14¼	14¾	15¼	16
150	8¾	9¾	11	11½	12	12¼	12¾	13¼	13¾	14¼	14¾	15½
200	8¼	9¼	10¾	11	11½	11¾	12¼	12¾	13¼	13¾	14	14¾
250	7¾	8¾	10¼	10½	11	11¼	11¾	12¼	12½	13	13½	14
300	7¼	8¼	9¾	10	10¼	10½	11	11¼	11¾	12¼	12¾	13¼
350	7	8	9	9¾	9½	9¾	10¼	10¾	11	11¼	11½	12¼
400	6½	7½	8¼	8½	8¾	9¼	9½	9¾	10¼	10½	10¾	11¼
500	6	7	7¾	8	8¼	8¾	9¼	9½	9¼	10	10¼	10½
600	5½	6½	7¼	7½	7¾	8¼	8¾	9¼	9½	9¾	10	10
700	5	6	6¾	7	7¼	7¾	8¼	8¾	9	9¼	9¾	9¾
800	4¾	5½	6¼	6½	6¾	7¼	7¾	8¼	8¾	9	9¼	9¼
1000	4½	5	5¾	6	6¼	6¾	7¼	7¾	8¼	—	—	—

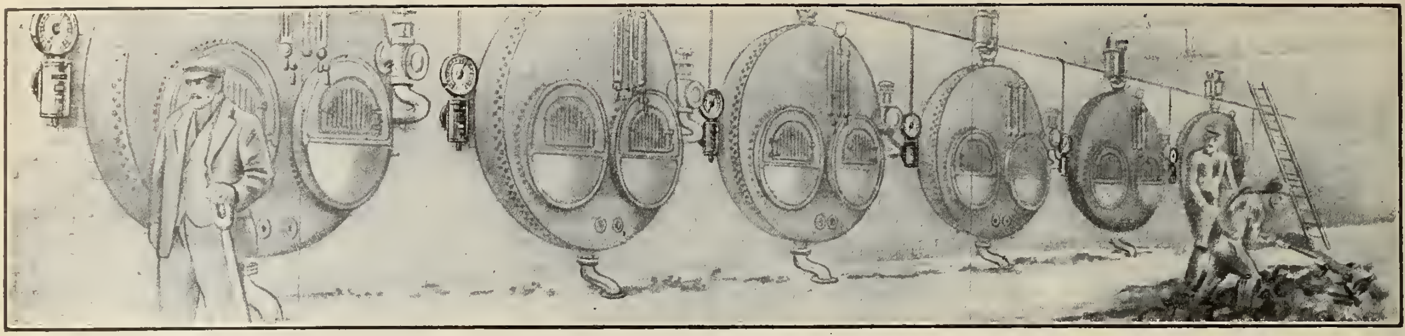
C. A. S. E. Notes

James J. Sullivan, grand president of the Canadian Association of Stationary Engineers, attended the convention of the association for the first time in 1921 as delegate from Ottawa No. 6. For two years he was president of Ottawa No. 6, being elected grand treasurer in 1922, and grand president in 1923.

JAMES J. SULLIVAN.

For the past twenty-six years, Mr. Sullivan has been plant superintendent of the Continental Paper Products, 147 Booth street, Ottawa, and is considered an expert on paper bag machinery and construction and maintenance work in paper bag factories.

Mr. Sullivan spent a year in Krappitz, Germany, supervising the reconstruction of the factory of the Continental Paper Products there. His present address is 20 Jeanne D'Arc St., Hull, Quebec.



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.
Director of Engineering, Central Technical School, Toronto.

ACCURACY, when dealing with measurements, is a purely relative term in that we are physically unable to measure absolutely accurately, and therefore any calculations we may make, using such measurements as a basis, cannot give results more nearly accurate than the original measurements.

Absolute accuracy can only be obtained in calculations based on exact data, such as a case of a man working 44 hours a week at 75c. per hour, we know his weekly pay to be exactly 44 × .75 = $33.

Accurate measurements cannot be obtained because we have not instruments which will measure absolutely accurately. In grinding a piston rod to size, a machinist will use a micrometer to measure the diameter, which is graduated in 1/1,000-inch divisions, or, perhaps, in 1/10,000 inch.

No matter how hard he may try, he cannot get the diameter closer to the required diameter than 1/20,000 of an inch with this instrument. However, when he gets the size correct within, say, 2/1,000 of an inch he will call it close enough, because he knows the packing will expand and contract sufficiently to prevent leakage with that much or more variation in size.

In this case it is seen that even the accuracy which the machinist might have obtained is quite unnecessary. Gauges have been made which are correct within one millionth of an inch, but we cannot be sure that they are absolutely accurate, for they may be several ten-millionths of an inch out, and we have no way to tell. In any case it makes no difference.

The majority of measurements taken by an engineer are seldom more accurate than 1/32 of an inch, or perhaps 1/64. Suppose an engineer ground down an old piston rod, originally 1¼ in. diameter; by means of calipers and scale he might get a measurement of 1-9/64 in. This would be plenty close enough, but it is not accurate, because if it is 1/128 in. either larger or smaller than this size he cannot measure it. In this case the possible variation from the measured size is 1/128 in. either way or a total of 1/64 in., which is 1/64 ÷ 19/16 × 100 = 1.37 per cent.

In measuring a three-foot square pump foundation, the measurements would be sufficiently accurate if correct within say ½ in. either way. This allows one inch variation in 72, or about 1/72 × 100 = 1.39 per cent. Thus a variation of one sixty-fourth of an inch in a piston rod diameter is relatively no more accurate than a variation of an inch in such a foundation, although the accuracy of measurement was much greater.

Measuring a Coal Bin

In measuring a coal bin, forty-nine feet long, the average engineer would be satisfied to call it fifty feet, which would would be within one part in fifty, or two per cent. of the correct measurement. On the other hand, in measuring the diameter of a three-foot engine cylinder, most engineers would try to measure within at least 1/32 inch, which is one part in 1,152 parts, or closer than 1/10 of 1 per cent.

Thus it is seen that different measurements require different degrees of accuracy, and the good engineer is the one who can tell which measurements should be made to any particular degree of accuracy.

Suppose we desire to know how many tons of coal a bin 48 ft. 6 in. × 10 ft. 3 in. × 9 ft. 1½ in. will hold. Assuming these dimensions as accurate, we would get for the volume of the bin 48.5 × 10.25 × 9.125 = 4536.265625 cu. ft. We must now assume the weight of a cubic foot of coal. Let us say that coal weighs 40 cubic feet to the ton, then the weight of coal in the bin would work out as

$$\frac{4536.265625}{40} = 113.406640625 \text{ tons of coal.}$$

It is easily seen that we might as well neglect all but the first two decimal places, because .0066 tons is only 13.2 lbs., and it would be easy to either add this much coal to the bin or take that much out without appreciably affecting its height; but we have done a lot of work in multiplying and dividing to get these figures which turns out to be wasted work. The coal might have weighed one ton to each or to each 41 cubic feet.

Weight May Vary

In the former case the weight of coal in the bin would be only about 110.7 and in the latter case about 116.2 tons. Thus, although we took our measurements of the bin with considerable accuracy, our result may be a long way out, because our estimate of the weight of the coal was not relatively as accurate. We shall now see that we did not need to take such accurate measurements of the bin and could have saved a lot of work.

The accuracy with which we took the relation between weight and volume of coal was one part either way, or two parts in 40, which is 5 per cent. This means that our result was only within 5 per cent. of the correct weight. Thus, if we take our measurements of the bin within 5 per cent, our final accuracy will probably be just as close. For example, let us call the bin 50 ft. × 10 ft. × 9 ft. = 4,500 cubic feet.

Our length is taken 1½ parts in 50, or 3 per cent. too great, our width is taken ⅛ part in 9 parts, or about 1.6 per cent. too small.

It will be noticed that when using approximate sizes in this way it is better to average them up by taking some too small and some too large. 4,500 cubic feet at 40 cubic feet to the ton of coal would hold 112½ tons. This is well within the limits which we found our error in the weight of coal showed us to be possible, and it is just as likely to be correct as any of the other results we got, and we have saved an enormous amount of arithmetic in working this out.

Errors in Measurement

From the above it is seen that we need not strive for absolute accuracy in every measurement, and that, in fact, we can sometimes introduce errors in measurements by using approximate values instead of measured values and still get a result which is likely to be just as accurate.

Let us take an example of finding indicated horse power of an engine, using the formula $\text{H. P.} = \frac{P \times L \times A \times N}{33,000}$. The Mean Effective Pressure, represented by P, will likely be measured by means of indicator cards, and the measurements taken off cards by different people are found to vary within several per cent., showing that the accuracy of this measurement may be considerably out. The length of the stroke is likely to be correct within a very small percentage; but the speed, if counted by means of an ordinary speed counter, is likely to be inaccurate. Therefore, if we calculate the area of our piston within one or two per cent., our result will be as nearly accurate as we can get it anyway.

Now, if we use a micrometer to measure the diameter of the piston rod, in order to subtract its area from that of the piston on the crank end, we may find it to be 1-5/16 in., which gives an area of about 1.353 sq. in.; is it worth while calculating this area any closer, or even as close as above? Let us suppose that the diameter of the cylinder is 10 inches. The area of the piston on which the steam acts will be about 78.54 sq. ins. on the head end, and 78.54 — 1.353 sq. ins. on the crank end. It is obvious that we might as well have called the area of the piston rod 1.35 sq. in. because we have not in this case calculated the area of the piston farther than the second decimal place.

Let us see what effect it would have if we use 78.5 — 1.5 instead of the above. We will get as a result 77.2 instead of 77.19, which is an error of 1 part in 7,720 parts, or $\frac{100}{7,720} = 0.013$ per cent. Obviously this is still far more accurate than the other measurements we have taken, and might have simplified it further still.

Let us call the area of the piston 1 sq. in. and see what error we get. This will leave a net area of 77.5 sq. ins. which is an error of 31 parts in 7,750 parts which gives a percentage error of $\frac{31 \times 100}{7,750} = 0.4$ per cent., or less than ½ of 1 per cent.

Even if we neglect the area of the piston rod altogether on the crank end it only makes an error of 1.35 parts in 78.54 parts which is about $\frac{1.35 \times 100}{78.54} = 1.72$ per cent. Therefore, if our measurements of speed, pressure, etc., are only correct within, say, 2 per cent., we will be just as nearly accurate in the final result if we neglect the piston rod altogether. However, if the pressures are measured by means of a large number of cards measured by several people, and the speed taken over a long period of time, the results will, of course, be much closer than the above accuracy, and it will be necessary to take the piston rod into consideration.

Judgment of Engineer

In the above problems we worked out some of the results which farther than necessary, and it is in determining how far calculations of this kind should be worked, to give sufficiently accurate results, that the good or bad judgment of an engineer is shown. In this respect, the question is asked quite frequently: "To how many decimal places should a problem be worked?"

There can be no answer given to this question, because it is similar to asking: "How closely should anything be weighed?"

You could not give a general answer, such as: "Exact within an ounce," or "correct within ten pounds," because it all depends upon what you are weighing.

If you are buying a sheet of packing by weight you would weigh it within the nearest ounce, but in weighing a truck load of coal you would consider it quite satisfactory if weighed to the nearest ten pounds.

Some people teach a rule which says: "Work a problem correct to four decimal places." We shall see that such a general rule is absurd.

Let us suppose we measure a tank with a two-foot rule, and calculate the volume to be 1376.4268 cubic feet. Here we have an apparent accuracy in figures of one part in over thirteen million parts. An accuracy of this degree is absolutely unobtainable with a two-foot rule, in fact it is probable that the rule itself is much more inaccurate than that. We have, however, worked the above to four decimal places. The above tank might be said to be a 1376½ cubic feet tank, but more likely it would be said to contain 1,375 cubic feet, and the latter is just as likely to be correct as the former, considering the way in which the measurements were taken.

Thus, in this case, four decimal places are seen to be at least four too many. On the other hand, suppose we calculate the cost of pumping water to be $0.0008487 per gallon. If we only work this correct to four decimal places we would get $0.0008 per gallon.

Now, if we want to find the cost of pumping a million gallons of water, its actual cost would be $848.70, while, if we had used only the four decimal places, as above, its cost would work out to be $800.00, an error of $48.70, which, as we all know, is too big an error to be neglected. In this case four decimal places were far too few. Thus it depends entirely on conditions as to how many decimal places should be used.

Significant Figures

Instead of "How many decimal places?" the question should be: "How many significant figures?" By significant figures we mean those which signify something, and, therefore, these include all the digits except 0, which by itself signifies nothing.

In most engineering calculations, four significant figures will be found to be sufficient. In the foregoing examples we see that 1,376, or even 1,375, is quite accurate enough for all practical purposes for the volume of the tank, while for the cost of pumping water, using four significant figures, $0.0008487 still may give us an error of several cents on the cost of a million gallons, therefore it is not too accurate.

Very often three, or sometimes two, significant figures are sufficient in engineering work, and much time and work can be saved in using as few as required without sacrificing accuracy. For example, if a coal bin is 122 ft. 6 in. by 23 ft. 9 in., we might as well call it 120 ft. by 24 ft., thus using only two significant figures, but saving a great deal of calculation. The area by the measured sizes would be 122.5 × 23.75 = 2909.375 square feet. By the assumed sizes the area would work out at 120 × 24 = 2880 square feet. The error here is about 29 sq. ft. in about 2,900 sq. ft., or one part in 100, or 1 per cent., which is as close as we can measure the weight of a cubic foot of coal, therefore sufficiently accurate.

When simplifying figures for calculation in this way, it is worth while to try to keep the error as small as possible. Thus in the above case of multiplication we reduced the 122½ to 120, while we increased the 23¾ to 24, which gave us a smaller error in the product than if we had either increased or decreased both the factors. In the case of division, the error in the result is minimized by either increasing or reducing both numbers at the same time in simplifying them.

Increase in Divisor

For example, if we desire to divide 1378.3 by 19.8, we see at once that it will be much easier to divide by 20 than 19.8, which is an increase in the divisor, in order to reduce the error as far as possible we should increase the dividend also, let us make it 1380. The quotient will be 1380/20 = 69. Whereas, if we use the original numbers, the quotient will be 1378.3/19.8 = 69.61. The error in this case is 61 parts in 6900 parts or less than 1 per cent. If we had reduced the size of the dividend, say to 1378, we would have got for a quotient 1378/20 = 68.9, which is an error of 0.71 or 71 parts in 6900, which is a greater error than 1 per cent.

In making calculations in our work we must have a clear understanding of the difference between errors and mistakes. An error is an unavoidable difference, due to inaccuracies in measurement, or a difference due to unimportant facts or figures which have purposely been neglected in the calculations. While mistakes are unintentional slips in the calculations, they must be avoided by all possible means while errors may be introduced provided they make no important difference in the result.

Electricity in the Power House

By J. A. BURNETT, M.E.I.C., Consulting Engineer, 205 St. James St., Montreal.

THE induction motor may be either of the squirrel cage or the slip-ring type. The squirrel cage is for performance with easy starting conditions, the slip-ring for heavy starting conditions. The squirrel cage type costs less than the slip-ring, which requires a drum-type controller and external resistance usually of the grid type.

In addition there is the high torque type of induction motor suitable for freight elevators. The efficiency in this type is low, and it is made only in sizes up to ten h.p. This type may be thrown directly on the line, requiring no auto starter, but necessitating extra heavy wiring and fuses.

In the induction motor practically the only parts requiring attention are the bearings. These are subject to wear and in time the rotor will drop sufficiently to rub on the stator causing the motor to smoke. This requires immediate attention; if neglected, the bottom coils will be destroyed due to the heat generated by the friction of the rotor against the stator.

This condition can readily be detected by using a wooden lever and a block to raise the pulley end of the motor, a slight movement indicating a worn bearing.

Babbitt Bearings

The great majority of motors use babbitt bearings. The white metal alloys are solid materials, composed of two or more items, such as aluminum, zinc, nickel, tin, lead, copper, antimony and bismuth, in varying quantities, and fluxed and alloyed in various ways.

Originally babbitt metal had a fixed composition, being made up of 90 per cent. of tin and 10 per cent. of copper and antimony, the last to make it expand when it cools and fill the mould, but at the present time the term babbitt metal signifies no definite composition for there are babbitts made up according to fifty different formulas, on the market.

Except in a few cases, but two babbitts, one a lead-base alloy and the other a tin-base alloy, each being the best that can be made, are required for a complete line of bearings, ranging in weight from a few ounces to several tons.

Lead-Base Softer

Lead-base babbitt is softer than tin-base babbitt, as a general rule, and is cheaper because lead costs from one-quarter to one-fifth as much per pound as tin. It is readily appreciated that babbitt can cost anywhere from the price of lead to the price of tin, depending on the proportions used. However, the cheapest kind of bearing metal which when properly lubricated will give efficient service, is equally desirable compared with the expensive metal which gives no better service.

A successful bearing is attained only when the metals are melted slowly, thoroughly, without overheating, kept at a constant temperature while working, and poured properly at the correct temperature.

Lubrication Needs

Mineral oils are all petroleum products, and form the whole, or the greater part of most of the lubricants employed. The generally accepted qualifications of a good lubricant are: first, body (i.e. viscosity), enough to prevent the surfaces to which it is applied from coming in contact with each other; second, freedom from corrosive acid, of either mineral or animal origin; third, as fluid as possible, consistent with sufficient body; fourth, low coefficient of friction; fifth, high "flash" and burning point; and sixth, freedom from all materials liable to produce oxidation or gumming.

Ring lubrication is the preferred form for most horizontal motors. The oil reservoirs, dimensions of rings and oil grooves in the bearings must be carefully designed, as a defect in any one will materially affect the heating. A recent improvement is the substitution of a number of laminations instead of a single oil ring. This decreases the possibility of the oil ring sticking, because with a number of laminations it is not probable that all of them would stick at the same time.

Ball and roller bearings have been used in electric motors to a limited extent, and it is generally admitted that at a low speed the friction of ball and roller bearings is less than the babbitt bearing. Both ball and roller bearings must be carefully mounted, otherwise they are liable to make considerable noise.

Care at Starting

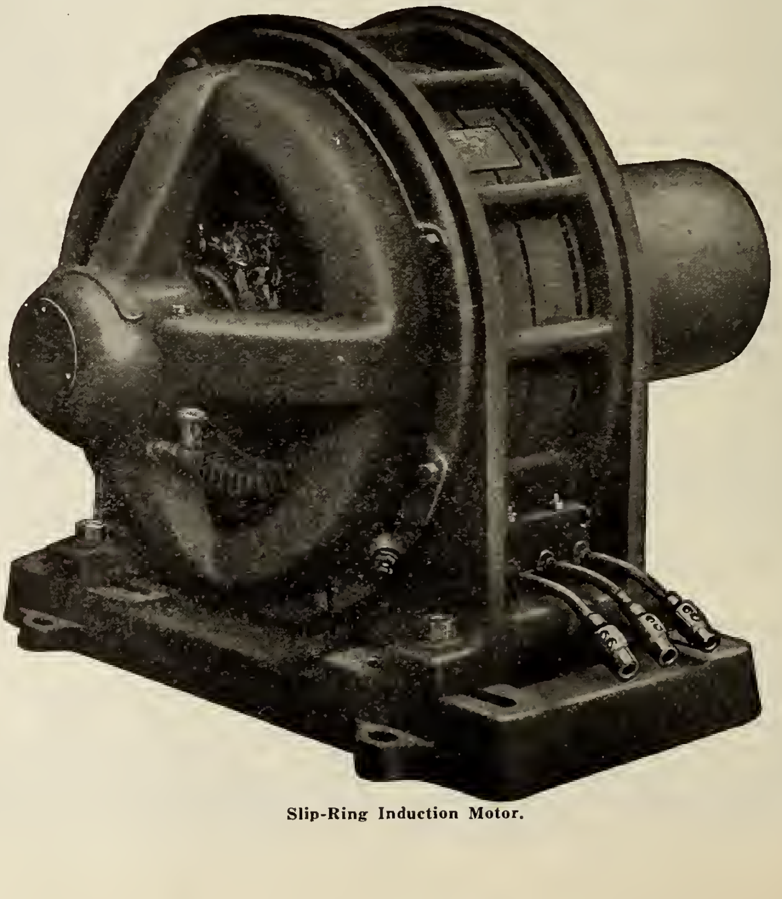
Where a motor is installed in an out-of-the-way place, and where zero weather may prevail the motor should receive some attention at the time of starting. The engineer should squirt some warm oil on the bearings or the oil rings, otherwise the motor bearings may seize due to the bearing oil not circulating properly.

A no-voltage release device is essential in all installations in which when the power has failed the resumption of the supply causing the machine to start unexpectedly, would be liable to injure anyone who might be at work around the machine.

When the power goes off it should be possible only for the operator to start the motor.

A large user of electric power should ascertain whether or not it is possible to be served with at least two or more primary circuits from the substation. Double throw switches should be installed to make a quick change in case of failure of supply.

(Continued on page 44)



Slip-Ring Induction Motor.

Practical Ideas From Practical Men

CARE OF PUMP VALVES

MUCH economy may be effected by paying attention to the valves of pumps. A certain plant had a number of pumps of different types and makes working on high pressure. The seats of all these pumps had been neglected for some time, and were in bad condition. In addition to these pump valves there were six angle blow-off valves on the boilers fitted with brass seats and a babbitted disc which was renewed at intervals to reduce the leakage to a minimum.

The seats eventually became badly cut, and there was no means of reseating them. After looking round for a suitable machine it was decided to make one which would answer the purpose of reseating the pump and blow-off valves and also any large globe valves about the plant.

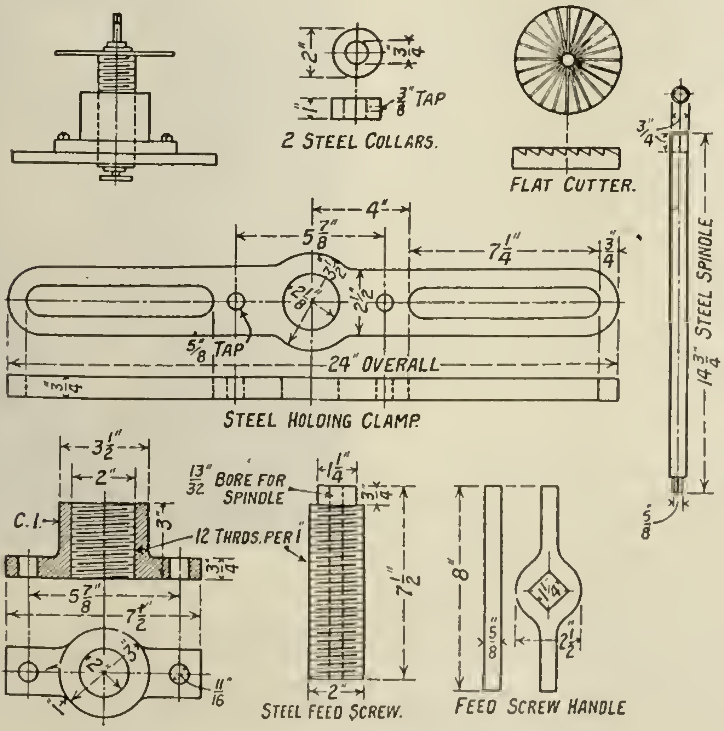
The accompanying drawing shows the arrangements, details and dimensions of the several parts with the cutter used for flat seats. Some of these pumps had seats on an angle of 45 deg., in which case a cutter of the proper shape was used. The body of the machine was made to fit the studs on the pot-valve type pumps, the bolt holes taking the valve cap studs and also the hinged studs on the blow-off valves.

The studs on the extension bar also fit these holes, and it is bolted to this when used on flat valves in the ordinary type of boiler feed pump. When reseating the discharge valves in this type of pump, which are usually level with the top of the discharge valve chamber, a block is placed under each end of the bar, and it is bolted down tight with the studs that hold the discharge chamber cap on.

In making this machine the only difficulty was to get a good cutter. If means are not at hand for making the cutter it would be best to purchase it from a company making milling machine parts. Where hard rubber valves are used they may be scraped to fit after the seats have been refaced. With brass valves, and especially those having a seat at 45 deg. angle, they should be ground in to fit with a grinding compound made up of cup grease, into which has been worked as much powdered glass as it will take without becoming too stiff. This compound will stick to the surface to be ground, and will not run off like oil.

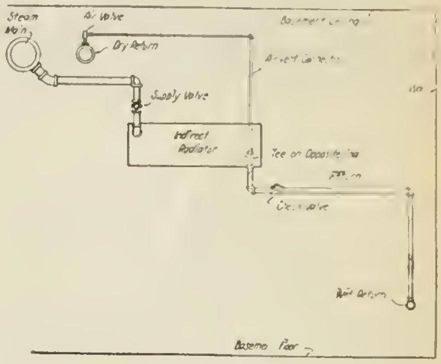
When this machine was used on the blow-off valves occasionally the steam and water issuing from the open end of the blow-off pipe were kept down to a minimum. Each valve could be reseated several times, and when the seats were worn out they were knocked out and new ones were made and put in.

In most power plants there are but few globe valves above 4 in., as gate valves are more frequently used except for certain conditions. This machine, with some modifications, can be used for reseating these valves.—FRANK STROH.



PIPING CONNECTIONS

Indirect radiators, hung on basement ceilings, often complicate the pipe-work, especially that part of the piping which drains the radiator and vents the air. Unless the basement is a high one, the return is usually very close to the water line of the boiler, and the radiator is apt to become somewhat "water-logged" occasionally. For this reason, air vents which discharge directly to the atmosphere, should be avoided where possible.



Piping Connections.

The indirect radiator shown in Fig 1 is placed under a landing in a main hall entrance, and hence was below the steam supply and dry return of the vapor system. As shown on the drawing, an independent wet return was run just above the basement floor, having a check valve below the indirect radiator, and a separate air venting connection taken from the top of a tee at the return opening and carried over and connected to a thermostat type air line vent valve place at the dry return main.

—GEORGE DIXON.

A CONDENSER REPAIR

This repair was intended as a temporary job only, pending the arrival of a new condenser door, but it stood so well that, after a lengthy trial period, a new door was considered unnecessary. Fig. 1 shows the crack which developed, and its position. The length, as far as the writer remembers, was 8 in. to 12 in. A sketch was made, and a pattern roughed out, curvature and section, as Fig. 2. While this was being done, the holding-down studs in the vicinity of the crack were removed. The pattern was then "fitted" with red marking.

It should be mentioned that the pattern was of ample length, about 28 in. to 30 in. possibly. Having been fitted—or, rather, "bedded"—to the satisfaction of all concerned, it was taken to the foundry and a gunmetal casting made. This was again carefully fitted in place, marked off and drilled for the door studs proper, and also for an additional series of holes as shown.

The studs extracted were replaced by longer ones as necessary, and the adjacent side holes in door marked off from casting, and drilled and tapped. A liberal supply of red-lead was then applied and th

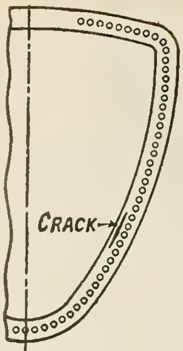


FIG. I.

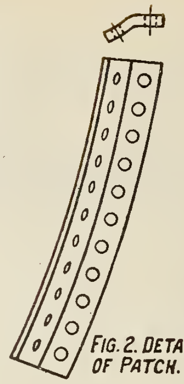


FIG. 2. DETAIL OF PATCH.

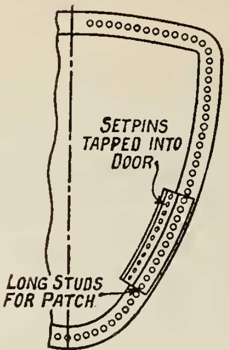


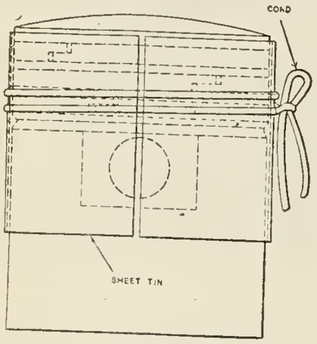
FIG. 3.

casting finally placed in position. The original nuts were used on the studs, and set-pins then securely pulled up into the adjacent side. This effected a very substantial repair.—FRANK GALLOWAY.

ASSEMBLING PISTONS

The writer read with great interest a description of a device for assembling pistons in cylinders which appeared in a recent issue of Power House.

The method described appeared to be a very good one, the only criticism being that different sizes of pistons would require separate sleeves. This fact, however, would hardly need to be considered except where a great variety of engines are assembled, as in repair shops handling general repair work.



A method that the writer has found very satisfactory is as follows: Cut a piece of stiff tin such as used for canned goods to a length that will nearly but not quite encircle the piston. The width of this piece should be about two-thirds the height of the piston. The tin is wrapped carefully around the piston and rings after they have been cleaned and oiled ready to be assembled in the cylinder. A heavy cord is passed around the tin a couple of times and pulled tight in order to compress the rings. The string is tied in place with a single bow-knot as shown in the accompanying illustration.

As the piston is slid into the cylinder, the tin and string slide off at the lower end of the piston and are easily removed from the connecting-rod. This method keeps the piston clean and simplifies the work of assembling. The cost of the device is practically nil, and one piece of tin can be used for several sizes of pistons.—M.D.S.

CRANK CASE OIL

In crank cases or tanks from which oil s pumped through engines or other machinery, the oil sometimes becomes thick and gummy in the bottom of the tank and will not run out through the drain cock. Since it is not advisable to use waste or wipers to remove this thick oil, on account of lint stopping up the strainer, which is usually of fine mesh, one method of draining is as follows:

Drain off the oil that will readily run out and then pour considerable hot water into the case or tank and loosen the oil from the bottom with a stick, and the thick oil will float on top of the water. Then take paper of any kind and s the oil off the top. The water can then be drained off in the usual way.—G. UHL, Galt, Ont.

AMMONIA COMPRESSORS

The ammonia compressor should never be started until the engineer has made sure that the discharge-valve line is open. He should not forget to turn the water on the condenser coils before or immediately after starting the compressor.

The head or condenser pressure should be watched upon starting the compressor, as it will warn the engineer if things are wrong.

The suction valve should not be opened hurriedly upon starting, especially if the machine has been shut down for a long time without having the expansion coils and suction lines pumped out. The operator should keep his hand on the discharge valve if possible. If it gets cold suddenly and if the discharge valve and compressor work noisily, liquid is likely coming back with the gas, and the suction valve should be closed off until the machine begins to warm up. If there is a slamming in the cylinder, the suction valve should be closed until the noise stops. This slam is in most cases due to the presence of some liquid ammonia coming in from the suction line. —H. STEVENS.

KEEPING BEARINGS COOL

We had started up a new large refrigerating unit and it had not been in operation long before we spotted one of the bearings running hot. We tried several adjustments but it did not seem to relieve matters, and we, therefore, sent for the erecting man to return and give the matter attention.

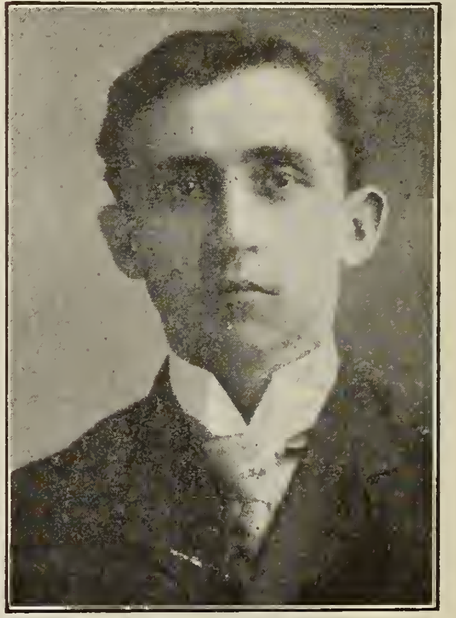
In the meantime our load forced us to keep the unit going, and as a means of affording temporary relief we tried a scheme recommended by a friend.

We took a piece of old pliable belting about four feet long, placed it over the shaft and laced the two ends together. A tub of water was then set below so that the lower end of the belt was submerged in it for about six inches. The rotation of the shaft and the adhesion of the belt to it resulted in the turning around of the belt, and, naturally, as it turned it carried a certain amount of water up with it, just enough, it turned out, to keep the bearing from heating up too much.

This very simple scheme can probably be used to advantage in other ways where it is desired to feed water or some other liquid continuously to a heated bearing, without constant attention and without making a lot of mess and slop in the engine room—WALTER HUDSON.

C. A. Maguire, chairman of the Board of Control, Toronto, is receiving tenders until September 3 for a three-motor travelling crane, hoist and appurtenances.

The Clark Gold Mines Corporation, with office at Halifax, N. S., have taken over the whole of the interests of the Montague Goldfields, Limited, and the Metals Recovery Company of Canada, Limited. At the present time the entire property and mines are in the process of electrification. A new power plant is being installed, and will consist of a fifty stamp mill with 1,500 pound batteries, and 20 concentrating tables. The present plant is costing approximately $100,000. E. S. Romilly Smith is the general manager of the company.



Joseph Grier.

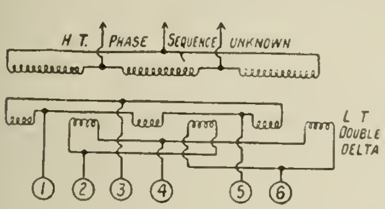
Joseph Grier, the engineer in charge of the plant of the Northern Rubber Co., Guelph, Ont., has been a subscriber to Power House for many years, and would not miss a single issue.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

PHASE ROTATION

Will you analyze the accompanying diagram and state if the low-tension leads of the transformers when connected to a six-phase rotary converter in the manner indicated by the numbers of the leads would be correct, and uphold a six-phase sequence? The high-tension phase sequence is unknown. The numbers are considered by the querist to be incorrect, and he would be glad if you would say how the low-tension leads should be connected to rotary slip-rings.—HYDRO ENGINEER.



Answer: The diagram accompanying the query is not correct if the numbers on the L. T. leads of the transformer refer to the slip-rings, assuming the rings are numbered from left to right, or vice versa. Apart from this, however, the internal connections of the transformer are right. Phase sequence has little bearing on the matter.

There seems to be haziness in the minds of some engineers regarding the production of a six-phase supply from a three-phase, and perhaps a little explanation on this point will enable "Hydro Engineer" to see the reason why the internal connections of the transformer being correct, H.-T. phase sequence does not affect the production of a six-phase supply to the converter, except as regards the direction of rotation of the rotary armature.

Fig. 1 shows the arrangement of connections for delta-double-delta in perhaps a rather clearer manner, though the arrangement and numbering of leads is exactly the same as in the diagram given in the query. The arrows indicate instantaneous directions of voltages in the windings. The vector diagram for the H.T. winding is the triangle A B C.

Consider the first upper delta secondary system 1-3, 3-5, 5-1. The vector diagram for this system is the triangle 1, 3, 5. The currents flowing to the rotary slip-rings through the tapping points 1, 3 and 5 are the resultants of the currents in the two windings terminating at each of these points and are denoted by the dotted vectors pointing outwards from them. These vectors are 120 electrical degrees apart and constitute a three-phase system. To obtain a six-phase system a further three vectors angularly displaced midway between these are required. Such vectors are produced by the second delta system, by virtue of the reversal of the internal connections of this delta with regard to the upper system. The reversal results in the dotted vector triangle 6, 4, 2. It should be noted that the sense of direction round this triangle having regard to the arrows, is opposite to that of triangle 1, 3, 5, but the phase sequence is the same in both triangles, *i.e.*, clockwise when the primary sequence is A B C.

Inscribed in Circle

If the two triangles 1, 3, 5 and 6, 4, 2, be inscribed in a circle, the currents in the rotary slip-rings are denoted by the six radial vectors, those of one delta system directed radially outwards and those of the other system directed radially inwards, and it is these vectors which constitute the six-phase supply. The vector diagram in Fig. 1 is the key diagram for delta-double-delta supply, but obviously any arrangement of transformer secondary windings resulting in the production of the six radial vectors will give a six-phase supply. The diameter star connection, shown in Fig. 2, is widely used on rotaries where a neutral point for a three-wire system is required. Only three secondary windings are used in this connection.

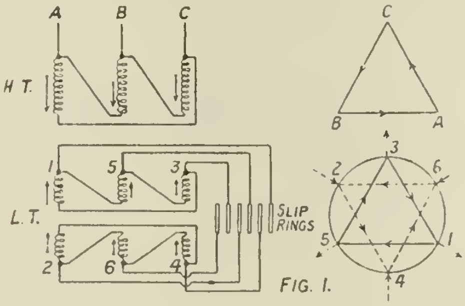


FIG. 1.

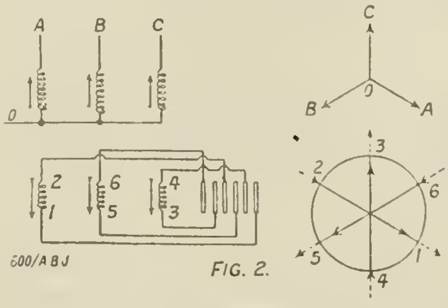


FIG. 2.

Phase Rotation.

In the case in point it would be best to obtain from the rotary makers a diagram of connections. Failing this, the connections can be checked by careful inspection, though it may be a tedious job owing to the multiplicity of tapping and equalizer rings on the rotary armature. The following tests should be carried out:

(*a*) Before connecting transformers to rotary.—First check each secondary delta system, by opening one corner of the delta and testing for voltage across the gap. Correct connection gives zero reading; a reversed coil gives a reading across the gap which is double the normal voltage of one coil. Next test for polarity. Temporarily join terminals 1 and 6, and test voltages across.

Where E represents the normal voltage of one secondary winding—

5-2. Reading should be zero.
3-4. Reading should be √3E.
4-5. Reading should be E.
3-2. Reading should be E.

If these check out correctly, the transformer is ready for connection to the rotary slip-rings. The leads from the transformer, numbered in accordance with Fig. 1, should be connected to the slip-rings in the order 1, 6, 3, 2, 5, 4, commencing with No. 1 lead on the left-hand ring and finishing up with No. 4 lead on the right-hand ring assuming that the armature tappings are taken to the slip-rings in cyclic order, which, so far as the writer is aware, is standard practice. As an additional safeguard, however, the rotary might be inspected to determine whether this is so. There will be six tappings per winding pitch, and the order of connection of these tappings to the slip-rings should be noted.

It is practically certain that the order of connection is as indicated, so that under normal conditions the same voltage exists between any two adjacent slip-rings.

STEAM-BOUND PUMP

How can the water end of a boiler feed pump be prevented from becoming steam bound?—R. WILSON.

Answer:—A feed pump may become steam bound from hot water of the boiler being forced back through the pump to the suction from leaky boiler-feed check or stop valves and leaky pump piston and valves.

The trouble from that cause is not likely to be serious if the boiler-feed line stop valve is shut down hard when the pump is not in use, and if the pump when in operation is run fast to overcome the leakage. When pumping hot water, the pump may become steam bound, because the suction head is not great enough for filling the pump chamber without reduction of pressure below the boiling point of the water corresponding to its temperature.

The reduction of pressure that results from friction of flow to the pump will be reduced by running the pump slower. If that is not practicable, the suction water must be supplied to the pump under a greater head, i.e., by lowering the pump or raising the level of the suction water.

The loss of suction head will be greater, the smaller the size and greater the length of the suction line. Unless the suction water is supplied under head and the suction line is short and of full size of the inlet provided on the pump, trouble is likely to be experienced in pumping water warmer than about 150 deg. F. and about one foot additional. head will be required for each 5 degrees higher temperature of the suction water.

WATER IN 10-INCH PIPE

What is the velocity of water flowing through a 10-in. iron pipe where the pressure at points in the line 75 ft. apart are 20 and 17 lb. per sq. in.? —O. W. E.

Answer:—The rate of flow corresponding with the drop of pressure would depend on the roughness of the pipe and on the number of bends, fittings or obstructions; but assuming that the pipe is fairly clear and straight, based on experiments, this loss of pressure, namely, 3 lb., or loss of head of 3 × 2.3 = 6.9 ft., would be due to discharge at the rate of about 3,600 gal. per min., which would correspond to a velocity of 882 ft. per min.

This estimate is based on the assumption that the drop of pressure is correctly taken at 20 — 17 = 3 lb., and it should be borne in mind that estimates of pipe flow cannot be regarded as closer than 5 per cent. because of the difficulty of knowing whether the pipe surfaces are in the same condition as pipes on which the formulas have been constructed.

QUALITY OF STEAM

Where a non-condensing engine under a stated load is guaranteed to have a steam consumption of 24 lb. of dry steam per indicated horsepower-hour supplied at stated pressure, and the actual quality of the steam used is only 96 per cent. dry, what consumption of steam of quality actually supplied would fulfill the guarantee?—A. M.

Answer:—Each pound of the wet steam as supplied would consist of 0.96 lb. of dry steam and 0.04 lb. of water; and the guarantee would be fulfilled for consumption of 24 ÷ 0.96 = 25 lb. of wet steam per indicated horsepower-hour. The consumption of actual dry steam will be the same for any reasonable variation of the proportion of moisture present. Experiments have shown that introduction of water in proportions from 1 to 42 per cent. is practically without influence and that the water remains inert, neither helping nor hindering the dry steam consumption.

APPARENT CUTOFF

In operation of a steam engine what is meant by "apparent" cutoff and "real" cutoff?—LONDON.

Answer:—Cutoff is the event during the stroke when the steam-admission valve has just closed, preventing further admission of steam, and the fraction of stroke that is completed at the time cutoff occurs is called the "apparent" cutoff.

During the remainder of the stroke the piston receives the expansive force of the volume of steam in the clearance space plus the volume contained in the space swept by the piston from the beginning of the stroke to the point of cutoff, and the "real" cutoff is the ratio of the sum of these volumes to the volume swept by a complete stroke of the piston plus the volume of the clearance.

Hence, to find the real cutoff, add the clearance, expressed as a percentage of the volume swept by a complete stroke of the piston to the apparent cutoff expressed as a percentage, multiply the sum by 100, and divide the product by 100 plus the clearance percentage.

FAN CAPACITY

What would be the relative size or capacity of a fan required for mechanical draft or induced draft?—A. M.

Answer:—The relative capacities depend on the conditions. For a given boiler the volume of gas passing through an induced-draft fan is much greater than would be handled by a forced-draft fan, depending on the draft pressure the temperature of the gases, and to some extent on their analyses. Under conditions of average plants the fan capacities required for induced draft are about 50 per cent. greater than for forced draft.

HUNTING GOVERNOR ACTION

What causes the irregularity of speed following a change of load of an engine? —A. STEVEN.

Answer:—When there is a change of load, there is an alteration of speed of the engine and the governor cannot act immediately, because it only can operate after a change of speed has occurred. Then a change in position of the governor does not affect the change of speed of the engine immediately, both on account of the inertia of the moving parts of the engine, which has the effect of resisting a change of speed, and also because of the energy contained in the steam that has passed the control of the governor.

In case of a throttling governor the steam chest is filled with steam at the time the change of speed begins, and if the governor acts upon the cutoff its opportunity for controlling the speed has passed it cutoff has occurred.

Hence there is a time lag between the governor and the engine speed. If the governor is too sensitive, then by the time the change in engine speed has had full effect on the governor, it is forced into a position of over-control; that is, a position beyond that which is necessary to bring the engine speed back to normal. The engine speed then begins to change in the opposite direction and for the same reasons the governor forced into a position of over-control in the reverse direction.

A state of oscillation is thus set up, which causes the speed to be first too high and then too low—a condition known as "hunting," which can be reduced to a minimum by not having the governor too sensitive and also by dashpots attached to the governor in such a manner as to dampen its motion.

WATER HEATING SURFACE

I am unable to find a good formula for determining the steam coil surface required in water heating tanks. The known conditions are: pounds of water to be heated per hour; initial and final temperature of water; steam pressure. Coils to be submerged in tank, consequently the velocity of the water will be about nil.—J. SMITH.

Answer:—We have before us a pocket size catalog called "The Ideal Fitter," and in it there appears a diagram showing the square feet of steam pipe coil while heating water in tanks.

On this diagram three hyperbolical curves are drawn, the first for galvanized or blank pipe, the second for brass pipe and the third for copper pipe. The vertical column or ordinate at left shows temperature differences ranging from 0 to 200 deg. F., while the horizontal column or abscissa shows 0 to 140 lbs. steam condensed per hour per square foot of coil surface. It is stated that "these curves are plotted from a large number of tests made with these pipes placed vertically in a tank of water." It is also added that the curves show only about 80 per cent. of the real condensing capacity, 20 per cent. being reserved due to so much lower efficiency to be expected in actual practice.

Thus in a vertical pipe the entrapped air may be at top, while in a regular horizontal coil the air will retard the exchange of heat.

Curves Start at Zero

At no difference between steam and average water temperature 0 lb. steam will be condensed per hour per square foot of coil surface. Hence all three curves start from zero. Then they spread out as indicated by the following:

Deg. temp. diff.	50	100	150	200
Lb. steam condensed				
Galv. or black pipe ..	7.5	18.3	32.5	48.8
Brass pipe	12.5	38.	76.5	128.
Copper pipe	14.2	43.8	88.	148.
B.t.u. per sq. lb. hour through black pipe ..	7270	17760	31500	47300
Same, deg. diff.	145.5	177.6	210.	236.8

At higher temperature differences the water is in stronger circulation than at low temperatures and this results in an increased rate of heat transfer, as is apparent from the last line in table.

Ratio More Favorable

While in the above table the steam condensing capacity of the galvanized iron and black pipe is rated at but 42 per cent. of that of copper pipe, the actual ratio must be more favorable than this. In E. Hausbrand's book "Evaporating. Condensing and Cooling Apparatus," it is stated that in good practice the heating capacity of iron pipe is taken at 0.75 that of copper tubing, cast iron at 0.50, and lead at 0.45. He also points out that the air within the steam may greatly hinder the transfer of heat, hence if the duty of the coil surface is to be increased this can be done by providing a small vent and let a little steam escape with the air into the water, if permissible. Efforts should be made to obtain a high steam velocity, small pipes being much more efficient per square foot than large pipes; in large pipes the steam in the coil not coming in contact with the wall of pipe. The shorter the pipes the better, because in a long pipe the pressure and steam temperature drop considerably toward the end.

Drain Condensed Steam

The pipes ought to be inclined to help drain the condensed steam. If the group of coils could be arranged on one side of a vertical partition, the circulation of the water to be heated could be admitted, the warm water rising above the coils and descending by gravity on the other side of the partition. In some cases vertical sheets of metal are placed in a tank, the water entering at one corner of the flat tank and being compelled to flow zigzag through the tank to the opposite outlet. In this way the water flows through the tank with some velocity which greatly favors the rate of heat transfer.

Of course, where all the steam may be injected (through small holes in pipes) directly into the water only enough piping is necessary to accommodate the required number of holes. The smaller and more scattered the holes, the less the crackling noise caused by rapidly condensing steam.

The following example is worked out in the catalog already mentioned:

Surface required to condense 500 lb. steam per hour in galvanized or black pipe coil immersed in the water of a storage tank:

Temperature of steam in pipe, 220 deg. F.

Initial temperature of water, 40 deg. F.

Final temperature of water, 160 deg. F.

Hence mean temperature of water, 100 deg. F.

Temperature difference between steam and water, 120 deg. F.

The curve on chart shows that with 120 deg. difference each sq. ft. of galvanized coil surface condenses 24 lb. steam per hour. Incidentally the brass pipe curve shows 51.5 lb., and the copper 59.5 lb. condensed. For 500 lb. steam it requires 500/24 or 20.84 sq. ft. galvanized or black surface.

If we assume now that the heat given up per lb. of steam is only 970 B.t.u., then 24 lb. steam gives up 970 × 24 or 23,280 B.t.u. per sq. ft. black surface, per hour, with 120 deg. difference, which is equivalent to 23,280/120 or 194 B.t.u. per deg. difference.

This factor or coefficient is usually designated by the letter k.

OIL BURNERS

I am operating a 100 h.p. horizontal return boiler equipped with an oil burner. The results so far have been very poor. The building is new and the equipment the same as furnished by the contractor.

The only part of the boiler that was receiving any benefit of the heat was that section directly above the fire. The brick arch was built to within 9 inches of the boiler leaving 11 feet of combustion chamber 5 feet 6 inches high under the boiler, which in my opinion is too large.

Recently I pulled down the brick arch and built the combustion chamber up to within 20 inches of the shell, and put baffles in at intervals as far as the back walls to hold the gases to the boiler shell. In addition the original burners furnished have been replaced with one of my own design, a straight oil and air burner.

Oil is fed to the burner at 24 lb. pressure and the air between 5 and 6 ounces, supplied by an electrically driven fan.

Would it be advisable to heat the air and if so what would be the cheapest method of doing so? Would it be of any advantage to heat the oil and increase the pressure? The steam pressure carried is never more than one pound.

A. WRIGHT, Toronto.

Ans.—You do not give sufficient information for an engineer to give a definite opinion as to whether the change would be of any real benefit. In the first place cutting down the size of the combustion chamber will cut down radiation losses and if the brick work around the boiler is in bad condition the chance for air filtration will be less. Oil burners do not require as large a combustion space as coal, but care must be taken to keep it large enough to prevent the oil flame inpinging directly against the shell or there will be danger of blistering.

With the original burner installed, if insufficient air is provided with the oil, and an excess admitted at a point some distance from the burner it is impossible to secure proper combustion. The new burner installed by you will give good results if you are securing proper atomization and adjust the supply of air. The advantage of oil over coal is that the amount of excess air with the oil can be cut down to a minimum; some engineers do not take the full advantage of this fact.

CLEANING BOILERS

We have a 60 h.p. locomotive type boiler which is used for stationary purposes. The boiler has so much sand and muck in it that it is impossible to make a good job of cleaning it. At present there is a coating of scale about 1-16 inch thick on the tubes and the shell. It is not possible to get at the scale to remove it, the only way that we can attempt to clean the boiler is by washing monthly.

No compound is used, would it be advisable to use the formula given on page 39 in the August issue of Power House?

GEO. KARAMADUK,
Montreal.

Ans.—The compound referred to has given a fair degree of satisfaction in the boiler in which it is used in Toronto according to the engineer in charge, E. Golightly, but it does not follow that it would do the same for your boiler. The proper procedure is to find out what is causing the scale, then use a suitable compound to counteract the scale forming compounds in the water. Sodium carbonate (washing soda) and sodium hydroxide (caustic soda) are the main ingredients in many of the boiler compounds used by prominent engineers.

CHARCOAL DEODORIZERS

Can you advise me where I may obtain information in regard to the removal or absorption of odors from ice chests, etc., by the use of charcoal or any other means.

Have any articles been written on this subject that you know of?—ENGINEER.

Answer:—It is a well-known fact that charcoal has the property of absorbing odors. Wherever ice is being made from distilled water, which is usually derived from steam exhausted by engines, pumps, etc., charcoal-filled filters are used for absorbing the gases contained in the steam, as well as the odor imparted by the oil necessarily used for lubricating the steam cylinders. Reference to this practice may be found in all books treating of artificial ice making.

If it is desired to remove odors from ice chests, simply spread out a one-inch thick layer of flake charcoal on wire netting and replace with a fresh charge as often as required, perhaps once a week, depending upon the state of the chest and the size of filtering area.

By an "ice chest" is understood a refrigerator built like a trunk, the ice being as low down as the provisions or perishable goods. This makes a cheap ice box in every sense of the word. This type should be avoided where possible because it has no proper circulation.

Since cold air is heavy it should be given a chance to drop a perceptible height, crowding out and upwards the warm air which can then deposit its moisture as well as odors upon the melting ice. Unless the air can circulate thus up and down there will be large differences in temperature between points near and remote from the ice. The uncooled perishables decay and emanate objectionable odors. The lower the air temperature the less is the tendency to cause odor. In a properly built sanitary refrigerator the ice or source of refrigeration is always placed at the top, with amply large down-ducts and up-ducts to promote and guide the circulation of air. In that case no deodorizing agents are necessary.

Power Plant Supplies a Feature of Exhibition

Lack of Suitable Foundations Prevents Actual Operation of Heavy Equipment—Power Plant Supplies Include Traps, Valves, Transmission Machinery, Belting, Oil Engines, Fire Brick and Grates

MACHINERY HALL at the Canadian National Exhibition is full of exhibits of interest to the power plant engineer this year.

At one end is a large Diesel engine operating full blast, fascinating every visitor with the thrust of its mighty piston and the swift revolution of the mammoth fly wheel, while in another section there is a miniature Niagara flowing from a pump that operates continuously.

Several firms exhibiting heavy engines and equipment were unable to show the equipment in actual operation.

Among exhibitors noticed on a tour of the exhibition grounds were:

The W. R. Sexton Boiler Setting Co., with W. Russell Sexton explaining to engineers the importance of proper brick work and Nonpareil shaking and dumping grate bars.

Cole automatic return traps of various sizes being explained by Bruce H. Mowat.

The Beardmore Belting Co., with a complete line of leather belting, Frank Inrig in charge.

The Farrfhern Steam Service Co., represented by J. E. Farrell, agents for the Morehead steam trap and steam specialties.

Jones & Moore Electric Co., with W. Dalton in charge, Century motors.

The D. K. McLaren Co., with a full line of mill supplies, leather and canvas beltings; W. S. Hamilton in charge of booth.

Dodge Manufacturing Co., exhibiting general transmission machinery, including pulleys, shafting, bearings and hangers; W. B. Burrows in charge.

The John T. Hepburn Co., of Toronto, displaying power plant auxiliaries, compressed air furnishing the energy for driving the following: a duplex steam pump, a simplex boiler feed pump, a high pressure vertical ram type pump, and a small vertical steam engine. One 3-inch double suction centrifugal pump direct connected to a 5 h.p. motor, delivers three hundred gallons per minute against 40 foot head, the other a one-inch single stage delivering 35 gallons per minute against the same head. H. Skitch, chief engineer of the company, is in charge.

The Fairbanks-Morse Co., in addition to transmission equipment, belting, both leather and balata, displaying a semi-Diesel heavy oil engine. According to F. W. Evans, with fuel oil at 9c a gallon the cost for fuel with the semi-Diesel engine is about ½c per h.p. hour. This engine has solid injection, variable stroke fuel pump and air starting.

The Link-Belt Co., represented by N. A. Weston, show a machine called a "paradox" for showing the action of the silent chain in passing over the gears. In addition they demonstrate chains for the transmission of power and the handling of materials.

C. R. Peckover, of the Peckover Steel Co., shows boiler tubes, stair treads and checkered floor plates.

Westco Pumps display in charge of C. Templeton. This type of pump is of special interest to engineers interested in oil burning equipment. A fire fighting pump direct connected to a 4-cylinder gasoline engine is also on view.

Mid-West Canada, Limited, of Montreal, show air filters. The Dominion Engineering Agency, 24 Adelaide St. E., are the Canadian representatives. D. M. Fraser in charge. In addition they handle electric equipment, R. & M. motors, circuit breakers, high tension equipment, Sundh industrial control, and Rawlplugs.

Imperial Oil, Limited, with E. A. Olver in charge exhibit a complete list of oils and greases.

Albany Pump Co., 120 Adelaide St. W., showing the Albany water seal rotary pump. A. W. Bennet representative.

Keighley Gas & Oil Engine Co., of Keighley, England, with W. S. Haggas, 131 Front St., Toronto, general manager for Canada, demonstrating oil and gasoline engines. A 50 h.p. Imperial Keighley semi-Diesel heavy oil engine driving an air compressor which furnishes air to all parts of Machinery Hall. This engine is of heavy duty horizontal type with solid injection. The gasoline engine field is represented by the following: A four cylinder four cycle 35 h.p. engine direct connected to a 21 K. W. generator; an Imperial 8.5 kerosene-gasoline engine direct connected to a 750 gallon per minute pump running at 750 r.p.m. In addition there are several smaller engines.

Ingersoll-Rand have a compressor connected to the Keighley heavy oil engine.

The Dominion Belting Co., with E. Kinrade in charge show canvas belting.

Waukeska Motor Co. have several engines on display in their stand in the Arena, including a 50 h.p. power unit on skids suitable for fire protection or industrial uses. J. J. Swain is the Canadian representative.

The James Morrison Brass Co. are in the Industrial Building, with Arthur Betton in charge and have a very complete exhibit of brass goods, including steam traps, gauges, both indicating and recording, injectors, iron and brass body valves, whistles, gong bells, oil cups, water gauges, gauge cocks, and a general line of engineers' supplies.

Vickers-Petter have two exhibits this year, one in the Pure Food Building showing some of the lines made by them, including forgings for engine crankshafts and small gasoline and oil engines; the other at the eastern entrance showing a semi-Diesel heavy oil engine in operation. This engine is rated at 60 h.p. at r.p.m., compression pressure 150 lb. per sq. in., using solid fuel injection. The Petter Oil engine made in sizes to 25 h.p. has an interesting device for cold starting without the use of compressed air; a cartridge is screwed into the head and ignited, the engine then starts from a few turns of the crank handle. Canadian Vickers of Montreal are the agents for Canada. R. S. Griffith is the sales manager.

Refrigerating Engineers, Limited, of Toronto, Canadian distributors of Frick refrigerating machine have in operation a two-ton ammonia compression machine of the combined unit type. J. V. Turner is assisting in explaining the good points of the unit.

Ruston and Hornsby, Limited, of Lincoln, England, showing a 60 h.p. airless injection cold starting oil engine. The engine is of the horizontal type fitted with air starting equipment. Fuel consumption under ordinary conditions is claimed to be about .42 lb. per B.h.p. hour. Laurie and Lamb, of Montreal, are the Canadian distributors. Albert Laurie is in charge, assisted by C. C. Cottrell.

Power Notes

Chas. Warnock, Montreal, has been elected president of the Robt. W. Hunt Co., Ltd., inspecting and testing engineers, Montreal.

Clarence McNaughton Steeves, B.Sc., Sussex, N. B., a member of the Engineering Institute of Canada, has been appointed construction engineer of the New Brunswick Hydro Commission.

E. Ibbotson Leonard, president of E. Leonard & Sons, boiler manufacturers of London, Ont., has been elected a director or the Canada Trust Company.

POWER
PLANT
EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA
TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK & WILCOX, LIMITED

Toronto Office
Bank of Hamilton Building

ST. HENRY—MONTREAL

Choosing Boilers for a Huge Municipal Plant

Advisory Committee Sustains Recommendation of Detroit Public Lighting Commission That Contract for Cross Drum Water Tube Boilers be Given Babcock & Wilcox Co.

THE report of W. B. Mayo, chief engineer of the Ford Motor Co., T. H. Hinchman, of Smith Hinchman and Grylls, and J. C. McCabe, head of the City Research Bureau, the members of the special committee appointed by the Public Lighting Commission of Detroit to decide the merits of the different boilers on which tenders were made for the new municipal station in the Motor City, an installation consisting of four 20,000-kw. turbo generators, each served by two boilers designed for 350 but to be run at about 300 lb. and 200 deg. F. superheat, using powdered coal, will interest Canadian engineers.

The report, which was made public last week, sustains the recommendation of the commission that the contract be awarded to the Babcock & Wilcox Co., the second highest bidders on the eight cross drum water tube boilers specified.

The bids follow, but a reduction in the size of the boilers to 13,700 sq. ft. reduced the successful bid by $40,128, making the price $331,456 for the eight boilers, and $66,960 for the superheaters.

SCHEDULE OF BOILER BIDS FOR DETROIT MUNICIPAL PLANT

Bidder		Babcock & Wilcox Company		D. Connelly Boiler Company		D. Connelly Boiler Company		Heine Boiler Company		Geo. T. Ladd Company		Wickes Boiler Company		Springfield Boiler
Price—eight boilers		$372,584.00		$273,200.00		$261,200.00		$377,800.00		$215,100.00		$270,382.00		$273,000.00	
			p.c. Tolerance		p.c. Tolerance		p.c. Tolerance		p.c. Tolerance		p.c. Tolerance		p.c Tolerance		p.c. Tolerance
Net weight per boiler, lb.		297,000	..	280,000	10	......	..	380,000	..	210,000	5	230,000	10	270,000	5
Water-holding capacity, cu.ft.		1,761	..	2,260	5	......	..	925	..	1,700	1	1,720	5	1,314	5
Maximum moisture in steam at nozzle evaporation 110,000 lbs. per hour...		1p.c.	..	1p.c.	15	1p.c.	15	0.75p.c.	..	1pc	None	1.5p.c.	30	None	None
	Lb. per Hr.														
Draft loss (inches of water) through boiler when weight of flue gas is	85,000	0.17 in.	10	0.10p.c.	15	0.10p.c.	15	0.14p.c.	5	0.25p.c.	2.5	0.20p.c.	15	0.20p.c.	25
	173,000	0.84 in.	10	0.43p.c.	10	0.43p.c.	10	0.60p.c.	5	0.55p.c.	2.5	0.40p.c.	15	0.55p.c.	36.4
	260,000	1.75 in.	10	1.43p.c.	5	1.43p.c.	5	1.60p.c.	5	1.20p.c.	2.5	0.65p.c.	15	1.25p.c.	28
Flue-gas temperature at outlet when furnace temperature is 2,400 deg. and weight flue gas is	85,000	480°F.	10	460°	5	460°	5	509°	5	490°	2.5	485°	10	475°	2.1
	173,000	570°F.	10	535°	5	535°	5	569°	5	550°	2.5	520°	10	530°	4.7
	260,000	675 F.	15	640°	5	640°	5	632°	5	680°	2.5	575°	10	600°	6.6
Efficiency boiler and superheater when furnace temperature is 2,400 deg. and weight of flue-gas is	85,000	76.7p.c.	0.5	77°	2	77p.c.	2	77p.c.	3	78.8p.c.	2.5	92.2p.c	2.5	79.5p.c.	1
	173,000	74.5p.c.	0.5	74.5°	2	74.5p.c.	2	74.3p.c.	3	75.2p.c.	2.5	90.3p.c.	2.5	76.5p.c.	1
	260,000	70.5p.c.	0.5	67.5°	3	67.5p.c.	3	71.8p.c.	3	71.5p.c	2.5	87.3p.c.	2.5	73.5p.c.	1
Type boiler		Horizontal Water Tube One Cross Drum		Hortizonal Water Tube Two Cross Drums		Hortizonal Water Tube one Cross Drum		Horizontal Water Tube One Cross Drum		Vertical Water Tube Three Cross Drums		Horizontal Water Tube One Cross Drum		Horizontal Water Tube, One Cross Drum	
Type header and material		Sectional Forged Steel		Sectional, Cast Steel		Sectional, Cast Steel		Sectional Cast Steel		....		Box, Steel Plate		Sectional Cast Steel	
Heating surface, sq. ft.		15,920		15,956		......		15,740		15,300		15,630		15,800	
Size drum, in		54		44		54		54		Two 42 in. One 48 in.		54		54	

ELECTRICAL POWER

(Continued from page 34)

Single-phase operation of a polyphase motor will cause the motor to fail to start and produce a dangerous temperature in the current-carrying phase; if the single-phase operation occurs during running conditions the motor may burn out due to the excessive load, or break down. The effect of unbalancing either phase, voltages or angles is to increase the heating and decrease the maximum output or torque. This effect is very important, as a 15 per cent. unbalancing on a standard motor may nearly double the heating.

Surging on Lines

Small motors may be thrown directly on the line, but where large motors are treated in this manner there may be serious surges on the line and unless the motor windings are extremely well braced, there is apt to be injury to the insulation due to the crushing forces of the magnetic reactions.

It is recommended that an oil switch be used for all motors of 100 h.p. capacity or over; below this size it is recommended that fuses be checked daily with pilot lamps. In this connection it is to be noted that a line of push button, magnetic switch starters have been brought out and can be purchased at moderate cost. These are applicable for three-phase motors rated from one to ten horse power and provide phase failure protection as they open all three legs of the circuit by means of the three pole Magnetic Switches.

Power Notes

The Foundation Company of Canada, Limited, Montreal, have been awarded the contract for the construction work in connection with the Southern Canada Power Company's new power development at Hemming's Falls, near Drummondville, Quebec. The preliminary work is to be started at once.

A. T. Croft, secretary Nova Scotia Power Commission, Halifax, N.S., will receive tenders until September 10, 1923, for the construction of a 66,000 volt single circuit transmission line from Hopewell, N.S., to Stellarton, Pictou Co., N.S., and a 13,200 volts transmission line from Stellarton to Pictou, Pictou Co., N.S.

The Broadfoot Electric Company, Ltd., capitalized at $200,000, has been incorporated for the manufacture of a new type of battery recharging machine, and has secured temporary quarters on Thames Street, Chatham, Ont., for manufacturing and assembling purposes.

Tenders have been called for by the secretary-treasurer of the Gladstone School Board, Gladstone, Ont., for the provision and installation of a two-pipe Dunham system steam heating plant.

Obituary

Hertha Ayrton, of Lansing, Sussex, the only woman member of the Institution of Electrical Engineers, died on August 26, 1923. She was the wife of Professor W. E. Ayrton, and invented and constructed a line divider, and ably assisted in the completion of a series of experiments on the electrical arc invented by Professor Ayrton. In 1915 she invented an anti-gas fan, of which more than 100,000 were used on the allied front during the duration of the war.

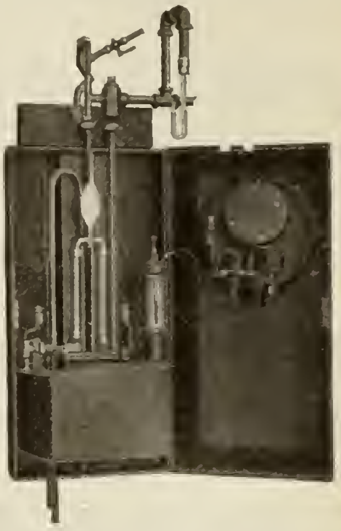
Eliminating "I guess" "I believe" "I suppose" from the Boiler Room!

Put your firemen in a position to know *what* to do and *how* and *when* to do it. It will mean far greater efficiency in the boiler room and save you money. Don't force the firemen to go by "guesswork." A daily chart from the Hays Automatic CO_2 and Draft Recorder will supply the information at the time it is needed.

The Hays Automatic CO_2 and Draft Recorder (Model B) is the last word in being the most practical and simple in construction and operation. Any ordinary unskilled laborer can operate it. The Standard Recorder will chart the percentage of CO_2 contained in the waste gases from the boiler furnaces, stills, kilns and also the draft over the fire. The standard range is 0-20% CO_2 and 0-1 inch water draft. Extra attachments can be provided for:

1. Double Draft Record. By having a record of draft over the fire and another of draft in the last pass, the draft loss or "air flow," as it is sometimes called, is indicated by the "spread" between the two draft records.
2. Record of CO or Unburned Gases can be furnished as an additional attachment when required.
3. Record of Stack Temperature to show whether the heat is being absorbed or wasted up the stack.

All the above records can be placed on one and the same chart. Special recorders are furnished for SO_2 or other acid gases and CO_2 recorders of any range other than 0-20%, on short notice.



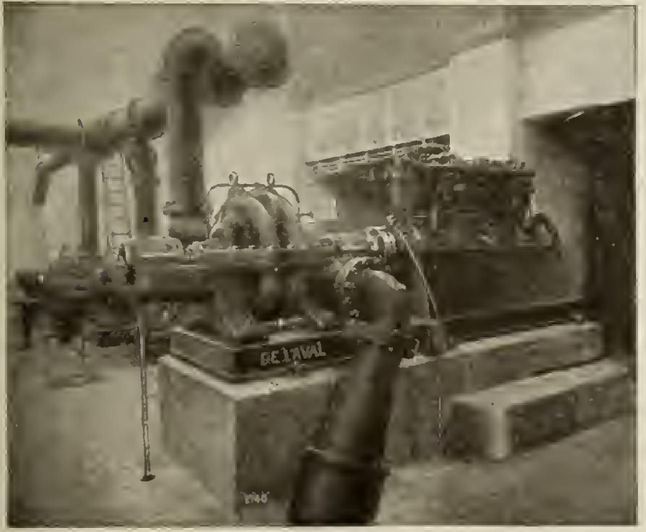
THE ARTHUR S. LEITCH CO.

LIMITED

Kent Building *Toronto*

HIGH GRADE POWER PLANT AND PUMPING EQUIPMENT

Orillia, Ont., Selects De Laval Pumps for Safety and Economy



THREE DE LAVAL centrifugal pumps installed in the water works pumping station of the City of Orillia, Ont., are shown herewith. The two-stage 8-in. pump in the foreground is driven by a gasoline engine, and has a capacity of 1,440 gal. per min. against 325 ft. head. The two De Laval pumps in the background are driven by electric motors. Where cheap electric power is available, this type of plant combines low cost, simplicity, and insurance against shut-down. The amount of attention required is very small, and practically no supplies are used.

The De Laval centrifugal pump is ideally adapted for both electric motor and gasoline engine drive. The starting torque is low and the power characteristic permits the size of motor to be selected to suit the normal capacity, resulting in lower power factor and higher efficiency in the driving motor. In many instances De Laval pumps are driven by self-starting synchronous motors, which can be used to correct the power factor.

State pumping requirements and ask for special publication B-100.

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

241

Miscellaneous

The McClave Brooks Company, Scranton, Pa., makers of McClave grates, stokers and combustion appliances, have appointed the Carbondale-Buffalo Co., Buffalo, N. Y., as their sales representative in New York state and Canada. Their territory will include that part of the state west of Rochester, and also the provinces of Ontario and Quebec in Canada. Henry J. Botchford is Manager of the Carbondale-Buffalo Company.

———

Installations of a No. 1 and two No. 5 Sims converters are being made through Arthur S. Leitch Co., Toronto, in the central heating plant in the county building at Walkerton, Ont.

———

The Spruce Falls Paper Co., are installing a No. 4 Nash hyter vacuum pump in their sulphide plant at Kapuskasing Ont.

———

Through the Arthur S. Leitch Co., Toronto, the town of Stratford, Ont., has purchased two Nash hyter air compressors for activating sludge work in sewage disposal.

———

The Hydro Electric Power Commission, North Bay, Ontario, have purchased through the Arthur S. Leitch Co., Toronto, a Norwalk air compressor of 1,000 lbs. pressure capacity.

———

The Goldie Construction Co., of Toronto, are the contractors for the new stack and tunnel in connection with the central heating system of the University of Toronto.

———

A 25 h.p. Allen heavy oil engine has recently been installed in the thermodynamic laboratory at the University of Toronto. The engine is specially fitted for test and experimental work.

———

John Laxton, 75 years old, 1457 Queen Street West, Toronto, died at his home on August 15. For the past fifty years Mr. Laxton was associated with the Consumers' Gas Company, Toronto, in the capacity of superintendent of street mains—in charge of all construction work. He was also government representative on the Toronto board of harbour commissioners.

———

The Doherty Natural Gas Company, Hagersville, Ont., held their third annual picnic on Wednesday, August 15, at Woodlawn on Lake Erie, three miles west of Selkirk. About 600 employees and friends were present, and the picnic was a big success in every way.

———

Tenders have been called by the Chairman of the Public Utilities, Winnipeg, Man., for the supply of all labor and material required in the erection of a building for a steam stand-by plant of the Hydro Electric System on Amy street, Winnipeg.

An agreement has been reached between the Toronto Harbour Commission and the Hydro Electric Commission concerning the removal of all Hydro towers along Sunnyside from the Exhibition grounds to the Humber River, Toronto, to a location further north, and preparations will be included to take care of the extra 110,000 h.p. soon to come from the Chippewa development. The estimated cost of the work is $75,000.

———

The Warwick Woolen Mills Co., Warwick, Quebec, are asking for prices on steam heating for the $60,000 factory being erected at Warwick.

———

Barr & Anderson, Vancouver, B.C., have been awarded the contract for installing heating equipment in the new city garage on Union Street, Vancouver.

———

Tenders have been called for the supply, delivery, and erection, of an electric travelling crane, capacity of main hoist 25 tons, in the power house of the Corporation of Winnipeg.

———

The Devoe Electric Switch Company, of Montreal and Toronto, have issued catalog No. 10 describing switches and other electrical appliances. The type of equipment illustrated is in the main for use in power plants and electrical stations. Knife switches of various types, motor control, electric time, enclosed safety type, indoor and outdoor disconnecting switches; sphere gap lightning arresters; choke coils; cartridge and high potential fuses; economy renewable fuses; switchboard accessories; panels; both dead and open front panel cabinets; and switchboards are some of the appliances dealt with at length.

———

Albert Forten, general contractor, Bagotville, Quebec, has been awarded the contract by the Bagotville Town Council for hydro power plant equipment, at $125,000.

Trade Catalogs

Tully's Gasification System manufactured by the Tully Gas Plants, Limited, of Millgate, Newark-on-Trent, England, is being installed at Belleville, Ont. The engineer in charge of the plant is William Cooke, an able "chief" and a past president of the C. A. S. E.

The Tully system consists of a generator, a wash box, a blower with primary and secondary air blast, a boiler for the injection of steam—fitted in such a manner that all the operations can be performed by one man.

The upper part of the generator consists of a vertical retort of a special design, surrounded with chequer work through which the exhaust gases pass during the period of the blow. At the base of this chequer work is the secondary air inlet.

The lower part of the generator is made like the usual water gas generators, but with special fittings.

The blue water gas produced in the lower part traverses again at a high temperature, the coal in the superimposed retort carrying away the volatile matter. Oil can be injected to further carburet the gas.

To mix Tully gas with ordinary coal gas: This may be done by allowing the hot gas to enter the foul main or it may be done in the relief holder, but before entering the relief holder, the Tully gas should pass through the scrubber.

Plants can be fitted with automatic clinkering and with waste heat boilers, using up the heat from the blow which would otherwise be lost. The steam generated is used for the steaming operations in the plant.

The B.t.u. quality of Tully gas made from coal relies upon the chemical composition of the coal used. The carbon as coke—going to produce water gas—and the hydrocarbons, producing methane and hydrocarbons present in the gas—so that when working at the maximum efficiency it is best to make a gas of a B.t.u. composition in a ratio of the carbon—hydrocarbon content of the coal used—carbon as coke will only produce a water gas of 300 B.t.u.'s and any B.t.u.'s over that may come from the gasification of the hydrocarbons of the coal.

The most economical method of working is to gasify the coal at its normal rate, and increase the B.t.u.'s as required by the use of gas oil.

In This Issue

Editorial Point of View............ 21
By Campbell Bradshaw

Oil or Coal as the Fuel............ 22
By Campbell Bradshaw

London No. 30 on Frolic........... 24
Illustrated

Cutting Combustion Losses......... 25
By Robert June, A.S.M.E.

Pipe Lines 27

The Slide Rule; Its Value.......... 28
By Arthur Murphy

West for Power House............ 29
Illustration W. J. Hudson

Modern Power Transmission 30

C.A.S.E. Notes 31
Illustration Jas. J. Sullivan

Easy Lessons in Engineering....... 32
By M. Barry Watson, B.A. Sc., M.E.

Induction Motors 34
By J. A. Burnett, M.E.I.C.

Practical Ideas 35
Care of Pump Valves
Piping Connections
Condenser Repairs
Assembling Pistons
Crank Case Oil
Ammonia Compressors
Keeping Bearings Cool

Illustration Jos. Grier............... 36

Problems with Answers............ 37

Phase Rotation
Steam Bound Pump
Water in 10 inch Pipe
Quality of Steam
Apparent Cut-Off
Fan Capacity
Hunting Governor Action
Water Heating Surface
Oil Burners
Cleaning Boilers
Absorption of Odors

Supplies at Canadian National Exhibition 40

Buying Boilers for Detroit......... 42

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

New and Second Hand Equipment For Sale

1—37½-75 H. P. D. C. Shunt Wound Motor, variable speed, 115-230 volts, complete with push button control. (Westinghouse).
2—50-100 H. P. D. C. Shunt Wound Motors, variable speed, 115-230 volts, complete with push button control. (Westinghouse).
2—Type "B" Galt Sprinkler Stokers and Boiler Front for 250 H.P. boiler.
2—Sectional Vulcanizers.
1—Knight Tire Building Machine.
1—Steam D. C. Generator Set, 35 K.W., 125 Volts, 280 amp. This machine is direct connected to one Robb Armstrong engine; to operate at 100 lbs. pressure. (Westinghouse Generator).
1—2 H. P. Motor, 60 cycle, 440 volts, 3 phase, 1135 R.P.M. (Allis-Chalmers).
1—72 in. x 18 ft. 0 in. H.R.T. Boiler 90-4 in. Tubes, 100 lbs. working pressure.
Chain Drive—
Driver—480 R.P.M., 9,050 dia. 19 teeth.
Driven—85 R.P.M., 33.46 dia., 70 teeth.
Driver—Bore 4⅜ in.
Driven—Bore 6¾ in.
Chain—1½" P. x 15 in. width, 21 ft. 3 in. long, 175 H.P.
1—Westinghouse Induction Motor, type H.F., 150 H.P., 2200 volts, 25-cycle, 3-phase, 35 amp. per terminal, 485 R.P.M. Rotor circuit: 308 volts between rings; 220 amps. per ring. Serial No. 48167.
This motor is complete with controller and resistance.
1—500 H.P. Westinghouse Motor 480 R.P.M., 2200 Volts, 3-phase, 25-cycles. Complete with resistance and starting panel.
1—500 H.P. Reduction and Magnetic Clutch for above. Line shaft speed 85 R.P.M.

VULCANIZERS, IN PERFECT ORDER.

Diameter	Stroke	Rampot Dia.
1—4 ft. 10 in.	8 ft. 2 in.	13½ in.
5—3 ft. 10¾ in.	6 ft. 2 in.	12 in.
6—3 ft. 10¾ in.	6 ft. 0 in.	12 in.
7—3 ft. 10¾ in.	5 ft. 11 in.	12 in.
8—3 ft. 10¾ in	5 ft. 11 in.	12 in.

Dunlop Tire & Rubber Goods Co.
Limited
Purchasing Department
TORONTO, ONTARIO

J. A. BURNETT,
M.E.I.C., P.E.Q.
CONSULTING
& APPRAISAL
ENGINEER
Room 301—205 St. James St.
Telephone Main 6737. Montreal.

The reason the champion is always the favorite is because he's better advertised.

POSITIONS WANTED

FACTORY SUPERINTENDENT—OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

ENGINEER, SECOND CLASS CERTIFICATE for Ontario, wants permanent position. Has had good all-round experience. Apply Box 111, Power House.

SELF-OILING HIGH SPEED ENGINE, SINGLE cylinder, 17 in. bore x 16 in stroke. Engine develops 200 H.P. when running at 235 R.P.M. with 100 lbs. steam pressure. There are two heavy leather belts 18 in. wide. The engine has two fly-wheels, each 78 in. diameter x 18 in. face. Apply Box 112, Power House.

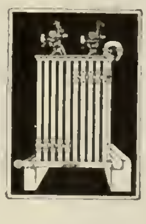
POSITIONS VACANT

STATIONARY STEAM ENGINEER WANTED—familiar with water tube boilers and Turbo Blowers and Generators. Must be an all round competent man, capable of taking charge of plant of about 2,400 B.H.P. Must have first class certificate. State in first letter salary wanted, age, experience, and when you can report. Apply P. O. Box 720, Port Colborne, Ont.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—with house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

·LIQUID·FUEL·
FOR · HEAT · AND · POWER
·HOW·TO·USE·IT·
SEND FOR IT ··· NO CHARGE
LAUGHLIN'S PRODUCTS LIMITED.
WELLAND · CANADA



Not Just One
But Six Advantages

The Sturtevant Fuel Economizer provides six distinct advantages: (1) Increases boiler capacity; (2) Reduces boiler repairs; (3) Purifies feed water; (4) Reduces soot and smoke; (5) Acts as separate water heat without extra fuel cost; (6) Saves fuel.
Details in folder 609

B. F. Sturtevant Co.
of Canada, Ltd.
Montreal Galt Winnipeg Toronto

TAYLOR SAFE FOR SALE
Inside dimensions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110, Power House.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES
4750 PAGES ● $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—
Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines--the Indicator--Lubrication--PRACTICAL MANAGEMENT. GAS, GAS ENGINES--Aeroplanes and Aviation--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulas. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis--C02 Recorders-Construction of all types of Boilers,--Mechanical Stokers--Oil Burners--Setting--Chimneys--Mechanical Draft--HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers--Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--Practical Electrical Engineering as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS, this at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________
Occupation ____________
Employed by ____________
Residence ____________
Reference ____________

Boiler Setting
Service

THE Gates Engineering Co., Limited, are in a position to contract for and specify on all boiler brick work with the least possible delay. Our Engineering Department is qualified to look after your interests, having made a close study of Combustion Problems.

Our Motto—Service and satisfied clients. The confidence of those who use Gates' Patented Air-Cooled Arch, etc., is unqualified, and is retained, because of the low maintenance cost and the guaranteed results.

Ask for our Descriptive Catalog.

Gates Engineering Co., Limited
314 Notre Dame Street W., Montreal

PRATT & CADY
VALVES

P. & C. Swing Checks are made in the regrinding type and with renewable asbestos, rubber or leather discs. They have a full port opening and may be used in either the vertical or horizontal position.

The Swing Type of check valve was first patented by Pratt & Cady in 1878.

Reading Steel Casting Co., Inc.
Pratt & Cady Division
An Associate Company of the American Chain Co., Inc.
General Sales Office: Bridgeport, Conn.
929 Connecticut Avenue
CANADIAN REPRESENTATIVES—CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.

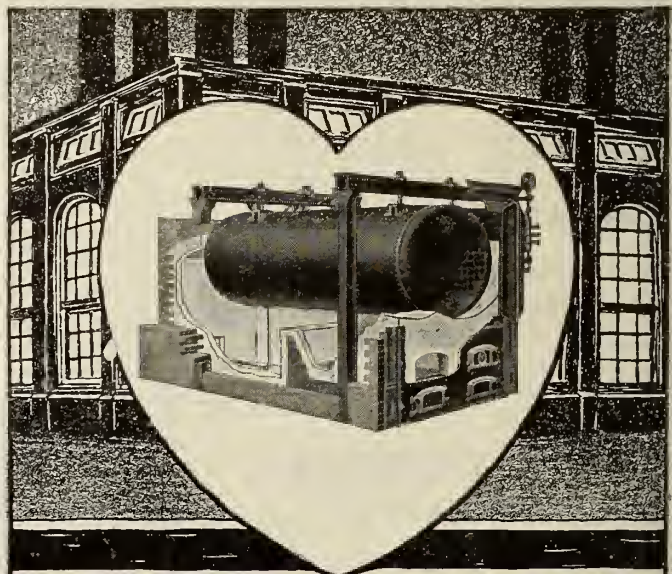
Condenser Packing

Metallic Packing stops electrolytic disintegration of condenser tubes. Crushing and deforming of the tube ends prevented with latest installation tools.

INVESTIGATE! Complete literature just revised. Sent upon request with our compliments.

"MADE IN CANADA"

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS Packing and General Manufacturing Co., Ltd., Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B.C.



The Heart of Your Plant is the Boiler Fire Box

Insure long, efficient service of this vital organ by using only monolithic walls, arches, and baffles made in one seamless piece with Betson's Plastic Fire Brick. Eliminate separate brick, blocks, tile and mortar joints. Learn how to cut repair bills 50%.

Write for booklet.

Betson Plastic Fire Brick Co., Inc.
P. O. Box 386-6 - - Rome, N.Y.
CANADIAN DISTRIBUTORS:
International Chemical Co.
26-8 Adelaide St. E., Toronto, Ont.

The LOGIC of INSULATION

¶ The idea of insulating heat is a relatively new one. It was only a few short years ago that the practice of insulating heated surfaces began to be recognized as a thing worth while.

¶ And yet the theory of insulation is based on a simple fact which has been recognized by man as far back as his cave dwelling days; namely, that to conserve heat it pays to cover heated surfaces with a "blanket" or protection of some kind. This realization prompted the first wearing of clothing.

¶ That is the reason why today we put on heavy clothing and storm overcoats in winter weather—to conserve our body heat and energy.

¶ The heat generated in a boiler or furnace or kiln is as susceptible to atmospheric conditions as our own human bodies. A protecting "blanket" of insulation over the surface (or installed within the walls) of such equipment as boilers, furnaces, kilns, ovens, etc., serves directly as a guard against heat loss through the walls and tops.

¶ SIL-O-CEL Heat Insulation is furnished as Brick, Block, Powder and Cement, and is readily adapted for the insulation of any type or shape of equipment.

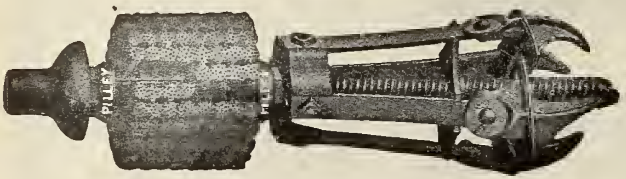
¶ The cost of insulation with SIL-O-CEL is generally paid for in fuel saving alone within six to twelve months of operation, and these savings continue each year through the life of the equipment.

Bulletins containing complete information gladly sent upon request.

CELITE PRODUCTS LIMITED

New Birks Bldg., Montreal, Que.

HINTS TO BUYERS



The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

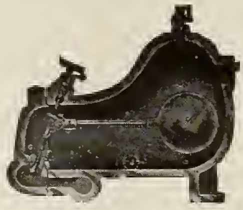
For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto



McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street.-MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE MEANS ECONOMY

Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T.J. CUNERTY** *Company*
9 Richmond St E. *Toronto*

CARHARTT

FROM MILL TO MILLIONS
CARHARTTS
TRADE MARK

HONEST VALUE IN MATERIAL AND WORKMANSHIP

OVERALLS

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you.

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE OF

OF POWER HOUSE

Jardine's Self-feeding Tube Expanders

All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

REGISTERED J TRADE MARK

Made In Canada

A. B. Jardine & Co., Ltd.
Heapeler, Ont.

EDWARD For Exacting Duty

Fitted with EDWARD Protected Seat and Disc.

THE EDWARD VALVE & MFG. CO.

General Office and Works: East Chicago, Indiana.

CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal; Valve Engineering Co., Toronto.

VALVES

NORTHERN CRANES

NORTHERN CRANE WORKS, LTD
Walkerville, Ont.

HIGH GRADE FIRE BRICK

STOKER BRICK - ARCH BRICK
SLABS
SPECIAL SHAPES - BOILER TILE

BELL FIREBRICK COMPANY
1347-51 DUFFERIN STREET TORONTO, ONT.

BOILER SETTINGS
SPECIALISTS IN
FIREBRICK AND ARCHWORK
FOR EVERY TYPE OF STEAM BOILER

A. E. RULE CO.
122 Garden Av. TORONTO Lakeside 1274

BOICO BOILER COMPOUND

routs the most stubborn cases of boiler formations, quickly, thoroughly and economically. Hurts nothing but scale.

ANTI-CLINKER SHELL BAR GRATE

Ample air space gives perfect combustion ensuring maximum heat, without waste, from the last bit of fuel.

ONE-PIECE JOINTLESS FURNACE LINING

"Plibrico" gives your furnace greater resistance. Lasts longer and installed quicker than brick.

TIP-IT PATENT WELDING PROCESS

Tools with shanks of carbon and high-speed steel tips save time and money.

SHELL-BAR BOICO
Supply, Limited
1-15 Saunders Ave., Toronto

Sales Agents: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

Hays Improved Gas Analyzer

Hays Improved Gas Analyzer

compact — rugged--accurate, employs the Hays patented steel wool method of breaking up the gas and presenting a large absorption surface—the most accurate and rapid known. CO2 analysis can be made in 30 seconds, complete analysis for CO2 O2 and CO in 4 minutes.

No troublesome pinch clamps and rubber connections, no glass cocks to stick. We use a special needle valve with renewable seat.

Neat leather carrying cases for Consulting and service engineers.

Better send for Literature.

AGENTS: P. A. Goepel, Vancouver, B.C.; Wm. A. Goold, Winnipeg, Man.; H. N. Brown, New Glasgow, N.S.; General Engineering Co., Reg'd., Montreal, Que.; The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos-W-Hays Corporation
Combustion Efficiency Appliances
1034 E. Eighth Street
MICHIGAN CITY, INDIANA

LADD
WATERTUBE BOILER

LADD WATER TUBE BOILER
COMBINES PERMANENT ECONOMY OF OPERATION WITH UNUSUAL ADAPTABILITY TO ANY INSTALLATION REQUIREMENTS.
DESCRIPTIVE CATALOGUE ON REQUEST.

GEORGE T. LADD COMPANY
First National Bank Bldg. PITTSBURGH, PA

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia. Ont.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR FILTERS
Midwest Canada, Ltd., Montreal, P. Q.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronte

ASBESTOS SPECIALTIES
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Kirby & Co., Toronto, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto. Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal. Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELT DRESSING
D. K. McLaren Limited. Montreal. Que.
Dominion Belting Co., Hamilton. Ont.
Shell Bar Boico Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren. Limited, Montreal, Que

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton. Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Roma, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto
Shel-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
W R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto. Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Gates Egineering Co., Ltd., Montreal, Que.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
A. E. Rule Co'y., Toronto, Ont.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Macbine Works of Can. Ltd., St. Catharines. Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
Refrigerating Engineers, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Scbaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto. Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H, Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa
Waterous Engine Works Co., Brsntford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H, Sarnia. Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co. Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Jeffrey Mfg Co., Montreal, Que.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford. Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.
Combustion Engineering Corp., Toronto,
Jeffrey Mfg. Co., Montreal, Que.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto
Refrigerating Engineers, Ltd., Toronto, Ont.
York Manufacturing Co York, Pa
Wilson & Sons, J. L., Toronto. Ont.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagertown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

COMPRESSORS, AIR FILTERS
Midwest Canada, Ltd., Montreal, P. Q.

CONDENSERS
American Steam Pump Co., Battle Creek. Mich.
Canadisn Ingersoll-Rsnd Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Gait.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COOLING AIR FILTERS
Midwest Canada, Ltd., Montreal, P.Q.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach, Co., Ltd., Hamilton

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Nortbern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto. Ont.

Boiler Brand

The Simplest and Most Effective

FEED WATER TREATMENT

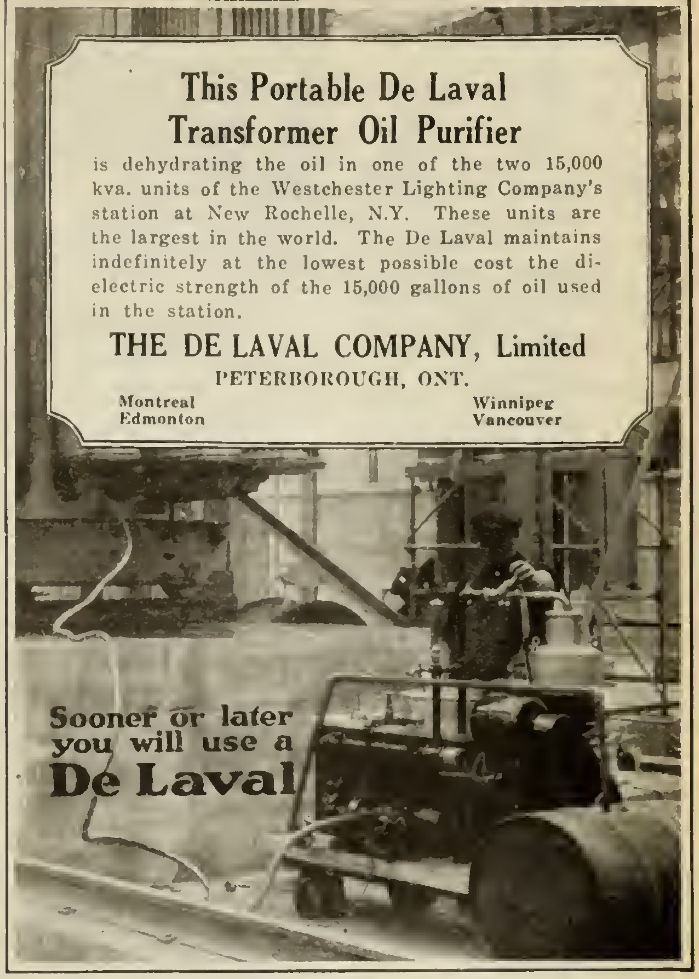
Silicate of Soda is the base of the majority of Boiler Compounds on the market—often made up under special names.

Boiler Brand is but one of our many grades of Silicate of Soda. It does the work of the most expensive compounds but as the engineer knows just what it is he can adapt it to varying conditions. Why bother with complicated treatments for the removal of boiler scale when the solution is so simple?

"Let a Technical Firm do a Technical Job."

G. F. Sterne & Sons, Limited
Chemical Manufacturers, Consulting Chemical Engineers.
Brantford - - Ontario

Toronto Dealer: W. M. Ismond, 48 Wells St., Phone Hill. 6868



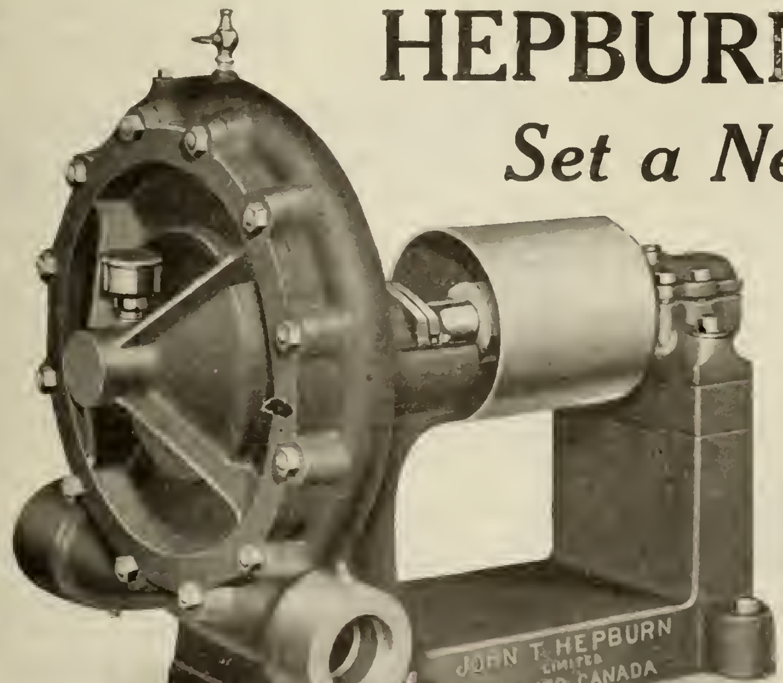
This Portable De Laval Transformer Oil Purifier

is dehydrating the oil in one of the two 15,000 kva. units of the Westchester Lighting Company's station at New Rochelle, N.Y. These units are the largest in the world. The De Laval maintains indefinitely at the lowest possible cost the dielectric strength of the 15,000 gallons of oil used in the station.

THE DE LAVAL COMPANY, Limited
PETERBOROUGH, ONT.
Montreal Winnipeg
Edmonton Vancouver

HEPBURN CANADIAN MADE PUMPS

Set a New Standard



The Hepburn Centrifugal Pump is not one of those "Old Stagers" which was designed 20 years ago and is still the same. It is, on the contrary, A Pump of modern design and up-to-date in every respect.

We also make Simplex and Duplex Pumps, Hand and Electric Overhead Cranes, Vertical Engines, Castings and Forgings.

JOHN T. HEPBURN, LTD. *ENGINEERS AND IRON FOUNDERS* **18-40 Van Horne St., TORONTO**

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DUST FILTERS
Midwest Canada, Ltd., Montreal, P.Q.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas., Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Jeffrey Mfg. Co., Montreal, Que.
Sturtevant Co., B. F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

FEED WATER PURIFIERS
Stephens Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamb, Montreal.
Northern Equipment Co., "Copes" Erie, Pa

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa.

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.
A. E. Rule Co'y., Toronto, Ont.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati. Ohio
Reading Steel Casting Co., Hartford, Conn.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Reading Steel Casting Co., Hartford, Conn.

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS, STEAM, WATER)
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Boico Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FREEZER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada. Ltd., Torento.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto
Can. Steam Boiler Equip. Co., Toronto.
Durabla Mfg. Co., New York, N. Y
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

GAUGES. DRAFT
Bristol Co., The, Waterbury, Conn.
Sanford Riley Stoker Co., Worcester, Mass
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.
John Moncreif, Perth, Scotland.
Kirby & Co., Toronto, Ont.
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Div- Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto. land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Dominion Engineering Agency, Toronto, Ont.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamb, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hsmilton.

HEATERS, F.M.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Waynesboro, Franklin, Co., Pa

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montre
Canadian Johns-Manville Co., Ltd., Torouto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn. N. Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWE
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Canada, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenberg Mfg. Co., American Steam Gauge & Valve Co. Division. Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Dominion Engineering Agency, Toronto, Ont.

OILS
Imperial Oil, Ltd., Toronto.

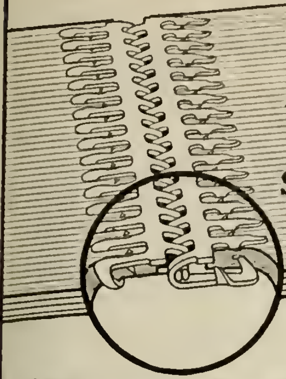
OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turbine Equipment Co., Ltd., Toronto, Ont

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio

OIL SEPARATORS
V D. Anderson, Cleveland, Ohio.
C. A. Dunham Co., Ltd., Toronto
Superheater Co., Ltd., The. Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.



ALLIGATOR

Scientific

STEEL BELT LACING

There is Science In Belt Lacing

ALLIGATOR teeth penetrate lengthwise of the belt, leaving the long burden-bearing fibers intact. Each tooth clinches down over its group of fibers, compressing them so firmly that there is no internal friction and wear at the belt end.

The sectional steel rocker hinge pin is the only metal pin that avoids wear to the joint.

Keep these vital features in mind when you buy belt lacing, for the cost of any lacing is nothing as compared to the cost of the belt on which it serves.

Just a Hammer to Apply It
"Never Lets Go"

Sold at Wholesale and Retail the World Over

Flexible Steel Lacing Company

46 7 **Lexington Street, Chicago**

In England at 135 Finsbury Pavement, London, E.C.2

AIR Engineering Service

The American Blower Company offers the co-operation of a competent Engineering department in the solution of any problem along the following lines:

- MECHANICAL DRAFT
- HEATING & VENTILATING
- GENERATOR COOLING
- AIR WASHING
- FANS AND BLOWERS
- STEAM ENGINES

American Blower service and mechanical equipment represents the development of forty successful years. Write for descriptive Bulletins.

CANADIAN SIROCCO CO., LTD., WINDSOR, ONT
BRANCH OFFICES IN ALL PRINCIPAL CITIES 322

"Sirocco" Products

TRADE MARK — BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

FREE!

SMOOTH-ON NO. 3 — for making perfect screw-thread joints

For ________________

____

Pr. Hs. Sep. ________________

if you fill in here and return this tag

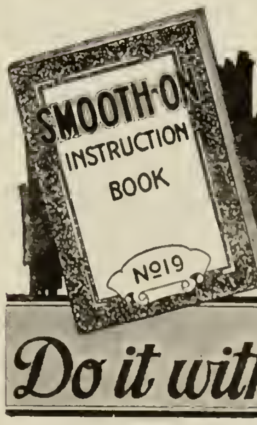
SMOOTH-ON No. 3 is much better than ordinary for screw-thread joint fillers.

Joints made with Smooth-On No. 3 stay tight because the metallic iron body can't dry out or shrivel from heat or time. Yet the joint can be taken apart if line changes become necessary.

In order that you may know this as well as we do, we urge you to fill in the tag as requested above and return so that we can send you the free sample.

You can get more at your dealer's in 1, 5 and 10-lb. gray-labeled tins, or, if he is out of stock, send us his name and we will see that you are supplied.

The Canadian Asbestos Co.
Dept. 52, Montreal, Que.



Get this book free!

This 144-page book of simple directions and diagrams will post you well on Smooth-On, where to use each grade, how to apply for best results and what to expect from the finished job. Mailed free if you return the tag.

Do it with **SMOOTH-ON**

PACKING, AMMONIA, STEAM AND WATER
Beveridge Suppy Co., Montrea.l
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor. Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto

PACKING, OIL
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago. Ill.
Flexible Metallic Packing Co., Windsor. Ont.

PACKING, COMPRESSED ASBESTOS SHEETS
Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Kirby & Co., Toronto, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armatrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont

PIPING, STEAM
Babcock & Wilcox, Ltd,, Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford,

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont,

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCullooh Co., Galt.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS
C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalitown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt,
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady. Hartford, Conn.

PUMPS, BOILER FEED
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati. Ohio.
Pratt & Cady, Hartford, Conn
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke. P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Wateroua Engine Works Co., Brantford.

PUMPS, DUPLEX
The John H, McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co , "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL
Albany Pump Co., Toronto, Ont,
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY
Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO
Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co, Cincinnati, Ohio.

PUMPS, STEAM
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P Q
Goldie & McCullcoh Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS. VACUUM (HEATING)
Albany Pump Co., Toronto. Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL
Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's, Limited, Montreal

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES
C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio
Jenkins Bros., Limited, Montreal, Que.

RAGS
Shell Bar Boico Supply Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa

RECORDING INSTRUMENTS
Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division. Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

REFRACTORY MATERIALS
Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P Q
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
Refrigerating Engineers, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.
Wilson & Sons, J. L., Toronto, Ont.

REGULATORS, TEMPERATURE
Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York. N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto
Taylor Instrument Co., Toronto. Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATING VALVES
H Mueller Mfg. Co., Limited, Sarnia. Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co, of Canada. Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS
Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto. Ont

RUBBER MILL DRIVES
Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)
Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY
Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can. Ltd., St. Catharines. Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE
C A. Dunham, Co.,
Laurie & Lamb, Montreal,

SMOKE BOXES
Babcock & Wilcox. Ltd., Montreal.
Goldie & McCulloch Co., Galt
Waterous Engine Works Co., Brantford

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto. Ont.
Jeffrey Mfg Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal
Waterous Engine Works Co., Brantford

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt,

STEAM, AIR AND ELECTRIC HOISTS
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM TRAPS
Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd,. The, Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF
Waterous Engine Works, Co., Brantford

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE
Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

TANKS, GASOLINE
Imperial Oil, Ltd., Toronto.

TANKS, OIL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharinea, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York. N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co. Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES
Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING
Grant E. Cole Co., **Toronto, Ont.**

TACHOMETERS, INDICATING AND RECORDING
Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Piley Packing and Flue Brush Mfg. Co. St. Louis, Mo.
Kirby & Co., Toronto, Ont.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F,, Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal,
Can. Fairbanks-Morse Co., Montreal.
Edward Valve & Mfg. Co., East Chicago, Ind.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lytle Engineering Co., Montreal, Que.
D Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont
Reading Steel Casting Co., Hartford, Conn
Shell Bar Boico Supply, Ld., Toronto.
Valve Engineering Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Underfeed Stoker Co., Toronto, Ont.
Wilson & Sons, J. L., Toronto, Ont.

WALKWAYS, (Irving Subway)
Irving Iron Works Co., Long Island City N. Y.

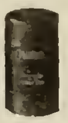
Less Work—More Wear

THIS plastic furnace lining, in unbaked form, is pounded into place by anyone who can use a mallet. When vitrified, it forms a jointless, air-tight, gas-tight lining that resists temperatures to 3,100 deg. F. and that outlasts ordinary fire brick two to four times.

Plibrico is delivered only in steel containers of distinctive appearance as shown opposite. Warehouse stocks in principal cities. Your copy of the free fifty-page booklet shown opposite is ready. Ask for it.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal: Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B.C.: Winnipeg Supply and Fuel Co., Winnipeg: Building Products & Fuel, Limited, Saskatoon; Dominion Lim & Fuel Co., Regina, Sask.

PLIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO
[illegible] CLAY ST CHICAGO



Specialists in the production of—
PUBLICATIONS, CATALOGUES
BOOKLETS, HOUSE ORGANS, FOLDERS
ADVERTISING LITERATURE

PRINTING

FORTY YEARS' experience—backed by one of the largest and best-equipped printing plants in Canada and the men who know how—enables us to offer you a complete printing service.

Send us samples of your catalogue or other printed matter, and write us fully as to your requirements. We will give your proposition thorough consideration and advise you intelligently. This will incur no obligation on your part, and may mean greatly increased effectiveness of your printing.

Commercial Printing Division
The MacLean Publishing Company, Limited
143-153 University Avenue, Toronto, Ontario

Bronze to Bronze DART **At the Joints**

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

Established 1907

POWER HOUSE

Member A.B.C.

B G. NEWTON, Manager
CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740. Montreal: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. Winnipeg: 810 Confederation Life Bldg., Tel. Main 3449.

S. S. MOORE, Advertising Manager
UNITED STATES—New York: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. Chicago: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. Boston: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—London: The MacLean Company of Great Britain Limited. 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960, Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

Anderson Co., V. D. 18
Armstrong Cork and Insulation Co., Ltd. 11
Audel Co., Theo 45
American Steam Pump Co. 16

Babcock & Wilcox 41
Betson Plastic Fire Brick Co. 46
Bristol Co., The 19
Buyers' Directory 50, 52, 54
Bird-Archer Co., The 16
Beveridge Supply Co. 51
Burnett, J. A. 45
Bell Fire Brick Co. 49

Can. Fairbanks-Morse Co. 4
Can. Ingersoll-Rand Co. 13
Celite Products 47
Classified Adv. Section 45
Conveyors Corp. of America Front Cover
Cunerty, T. J. 48
Can. Sirocco Co 53
Carhartt Co., Hamilton 48
Crane, Ltd. 15
Crane Packing Co. 46

DeLaval Steam Turbine Co. 43
DeLaval Co., Ltd., The 51
Dart Union Co., Ltd., The 55
D'Este Co., Julian 18
Diamond Specialty, Ltd. 8
Durabla Mfg. Co. 1
Dunlop Tire & Rubber Co. 45

Elk Fire Brick Co. 48
Engineering & Machine Works of Canada 17
Edward Valve Mfg. Co. 49

Foxboro Co. 14
Flexible Metallic Packing Co. 46
Frick Company 12
Flexible Steel Lacing Co. 53

Garlock Packing Co. 7
Garth Co., The 48
Goldie & McCulloch Co. 20
Greene, Tweed & Co. 3
Gutta Percha & Rubber, Ltd. 6
Green & Sons, Ltd., E. 8
Gates Engineering Co. 46

Hints to Buyers 48
Hepburn, John T., Co. 51
Hays Co., Jas. W. 49

Jardine, A. B. 49
Jenkins Bros. 9
Jointless Firebrick Co. 55

Kerr Engine Co. 5

Laurie Engine Co. 12
Laurie & Lamb 18
Lytle Engineering Co., Ltd. 53
Laughlin's Products, Ltd. 45
Linde Can. Refrigeration Co., Limited 10
Leitch Co., Ltd., A. S. 43
Ladd, Geo. T. 49

Mueller Mfg. Co. 16
McLaren, D. K., Co. ....Front Cover
McGowan Co., John H. 52
Magnolia Metal Co. 56
Moncrieff Ltd., John 49
Morrison Brass Mfg. Co., Jas. Outside Back Cover

Northern Crane Works 49

Pilley Packing & Flue Brush Mfg. 48
Pratt & Cady Co. 46

Reading Steel Casting Co. 46
Refrigeration Dept. 10
Refinite Co. of Canada 48
Refrigerating Engineers 12
Rule, Chas. 49

Schaeffer & Budenberg Mfg. Company 5
Smooth-On Mfg. Co. 53
Superheater Co. 56
Sturtevant & Co., Ltd., B. F. 45
Shell Bar Boico Co. 49
Sterne & Sons, G. F. 51
Stephen Chemical Co. 49

Taylor Instrument Co. 12

Underfeed Stoker Co. of Canada The 2

Vilter Mfg. Co. 10
Valve Enginering Co. 53

Wall, W. J. 49
Waterous Engine Works Co. 1
Watson, M. Barry 45
Watson & McDaniel Co. 48
Wilson & Sons, J. L. 12

Yarnall-Waring Co. 19
York Mfg. Co. 11

MAGNOLIA

Magnolia Metal has been a widely used favorite for over a third of a century. Government tests prove it to be superior in bearing qualities to any other bearing metal, and its users know that it is uniform in composition, dependable in service, pours, melts, peens and scrapes in easily. For minimum bearing maintenance expense it will pay you to standardize on Magnolia Metal.

MAGNOLIA METAL COMPANY of CANADA Limited
37-39 SHANNON ST., MONTREAL, P. Q.
Magnolia Factories also at London, New York, Chicago, San Francisco

TRADE MARK

ANTI-FRICTION METAL

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

Genuine British Oak Tanned
Leather Belting

FLAWLESS back portions of specially selected hides are used for D. K. McLaren's Leather Belting. This, with any ordinary process of manufacturing belting, might seem enough to ensure strength and wearing qualities. But it isn't enough to obtain the perfection desired. In addition to care in the selection of hides, D. K. McLaren's Belting is all **British Oak Tanned.** This process imparts toughness to the leather. It gives it greater strength, greater durability and makes it as stretch-proof as leather belting can be made.

The quality reflected in D. K. McLaren's Belting, as a matter of fact, reduces transmission costs.

D. K. McLaren
LIMITED

Head Office and Factory:
351 St. James St., Montreal, P.Q.

Toronto, Ont.
194 King St. West.

St. John, N. B.
90 Germain St.

Calgary, Alta.
Gormans, Limited.

Edmonton, Alta.
Gormans, Limited.

Vancouver, B.C.
1158 Homer St.
T. M. Grindley Co.

Morrison Steam Goods

"I know no way of judging the future but by the past," said Patrick Henry.

The modern power plant engineer paraphrases this by saying, "I know no way of judging the service which I shall secure from a line of steam specialties but by their past performance."

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ontario

POWER HOUSE

Fostering Economy in the Development of Power for All Industries

Vol. XXVI—No. 18

Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.

September 20, 1923

Architects: Grant & Henderson. *Engineers: Leck & Company.*

The Vancouver General Hospital is equipped with Jenkins Valves

Architects and Engineers know well that the Jenkins "Diamond" and Signature are the guide to valves that live up to their reputation—valves that are carefully made, critically tested and fully guaranteed in all uses for which they are recommended.

The complete Jenkins line is described in Catalog No. 9—Free on request.

JENKINS BROS., LIMITED
HEAD OFFICE AND WORKS: 103 St. Remi St., Montreal.
SALES OFFICES: Toronto, Vancouver.
EUROPEAN BRANCH: 6 Great Queen St., Kingsway, London, W.C. 2, Eng.
FACTORIES: Montreal, Bridgeport, Elizabeth.

Always marked with the "Diamond"

Jenkins Valves

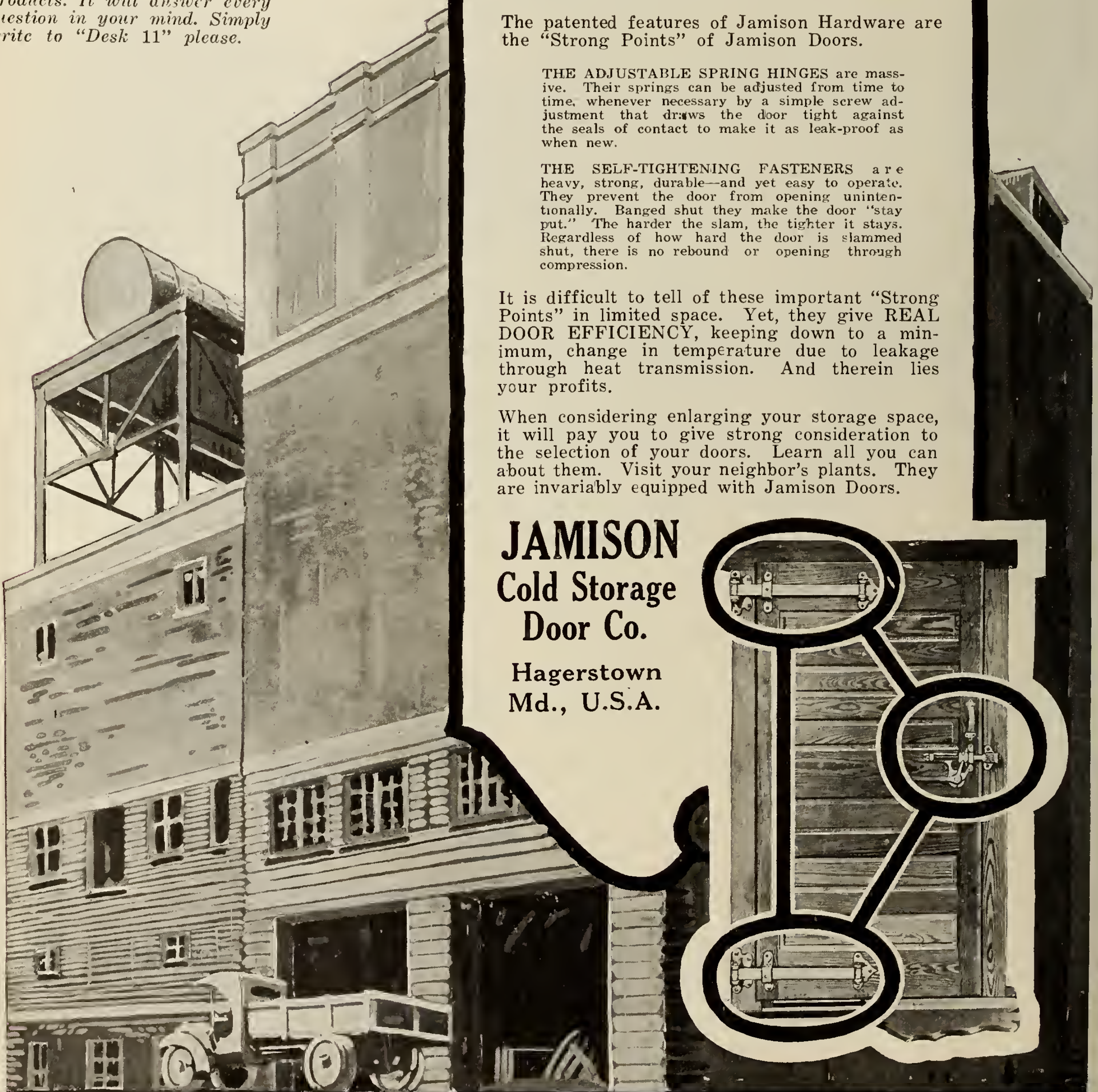
SINCE 1864

CENTS A COPY

$2.00 A YEAR

Jamison Doors

Our Catalog No. 10 gives a detailed description of Jamison Products. It will answer every question in your mind. Simply write to "Desk 11" please.



Give Assurance of Efficiency
Where Efficiency is Needed Most

These doors, bearing the "Seal of Satisfaction," strong, tough, durable, made to withstand the hard, every-day usage of heavy service—place the responsibility for their efficiency upon their HARDWARE.

For it is the superiority and difference in HARDWARE that makes the REAL DIFFERENCE in doors.

The patented features of Jamison Hardware are the "Strong Points" of Jamison Doors.

THE ADJUSTABLE SPRING HINGES are massive. Their springs can be adjusted from time to time, whenever necessary by a simple screw adjustment that draws the door tight against the seals of contact to make it as leak-proof as when new.

THE SELF-TIGHTENING FASTENERS are heavy, strong, durable—and yet easy to operate. They prevent the door from opening unintentionally. Banged shut they make the door "stay put." The harder the slam, the tighter it stays. Regardless of how hard the door is slammed shut, there is no rebound or opening through compression.

It is difficult to tell of these important "Strong Points" in limited space. Yet, they give REAL DOOR EFFICIENCY, keeping down to a minimum, change in temperature due to leakage through heat transmission. And therein lies your profits.

When considering enlarging your storage space, it will pay you to give strong consideration to the selection of your doors. Learn all you can about them. Visit your neighbor's plants. They are invariably equipped with Jamison Doors.

JAMISON
Cold Storage
Door Co.

Hagerstown
Md., U.S.A.

Waterous

BRANTFORD, ONTARIO, CANADA

Steel Plate Work

Waterous Steel Plate Work is built to give Service, first, last and all the time. THE WEAR IS THERE. It's put in in the building. We use the best materials only, build right up to specifications, and turn out this work in a modern shop by modern methods.

Are You Finding It Hard to Get This Sort of Work?

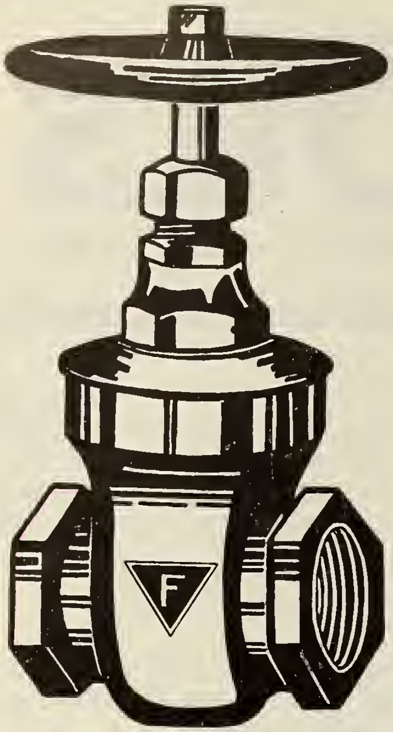
Put your next job up to us. We'll turn it out as it should be — it won't cost you more than the other kind and will last twice as long.

Air Tanks
Gas Tanks
Storage Bins
Pressure Tanks
Washing Tanks
Steel Reservoirs
Steel Retorts

Any Size, Any Style

Send Us Your Sketches for Quotations

The Waterous Engine Works Co., Limited, Brantford, Can.



Built to more rigid specifications than ordinary standard gate valves---FAIRBANKS GATE VALVES

Besides being of heavy pattern and better metal, these celebrated Gate Valves have the following features:

Reversible wedge—fits perfectly either way.
Pressure may be applied on either side of the wedge.

Of course they may be packed under pressure when wide open.

Service records prove their value.

Write for specifications and prices.

The Canadian FAIRBANKS-MORSE CO., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver, Victoria.

67

Durabla Gaskets Make Tight Joints

Withstanding all Temperatures and Pressures

Wherever a permanent Gasket is required, use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids.

Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla Trade Mark which guarantees strength and quality.

Made in Canada in Stock Sizes 36″ wide x 150″ long, in thicknesses of 1/64, 1/32, 1/16, 1/8″.

Let us send you a trial shipment

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

Cochrane Flow Meters

for

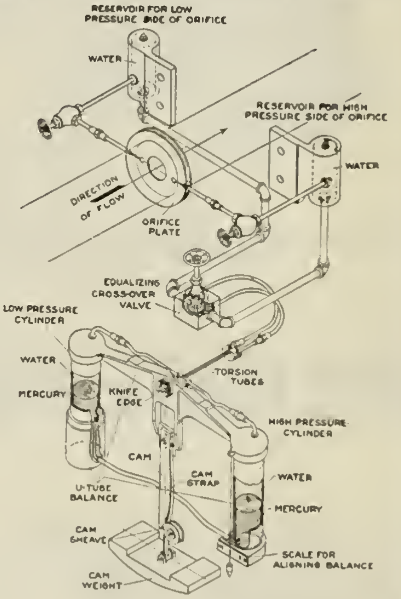
Measuring Water, Steam and Air in Pipes

Their Uses Are Manifold

IN CHECKING up the steam consumption of engines, pumps, turbines, heating systems, and processes,—

AND IN

DETERMINING the water fed to boilers, the circulating water consumption, the delivery of pumps and air compressors, etc.



HERE ⟶

—Is shown the essential working parts of the Cochrane Flow Meter, including orifice in pipe line, torsion tubes by which the pressures are led to the tilting manometer (U-tube), and rectifying cam and weight by which the deflection of the manometer is made proportional to the rate of flow.

Write for Bulletin 1099--Yours for the Asking

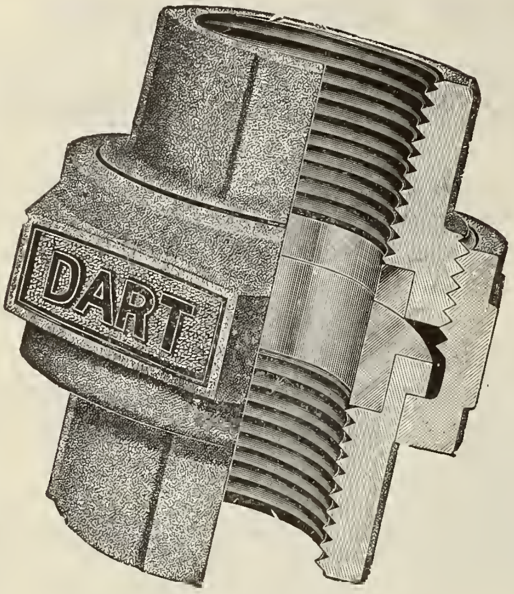
CANADIAN
ALLIS-CHALMERS
PRODUCTS
Hydraulic Turbines
Centrifugal and Steam Pumps
Steam Power Plant Equipment
Mining Machinery
Crushing and Cement Machinery
Flour and Saw Mill Machinery

CANADIAN ALLIS-CHALMERS LIMITED

Head Office—KING AND SIMCOE STREETS, TORONTO

BRANCH OFFICES: HALIFAX, SYDNEY, ST. JOHN, MONTREAL
QUEBEC, OTTAWA, HAMILTON, LONDON, WINDSOR, COBALT, SOUTH PORCUPINE
WINNIPEG, CALGARY, EDMONTON, VANCOUVER, NELSON AND VICTORIA

DART UNIONS



Stay Tight Permanently

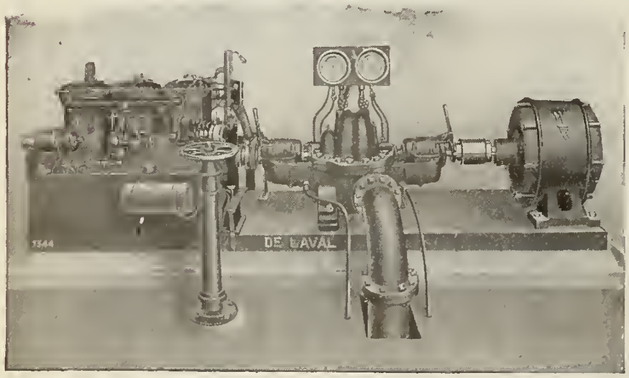
No Upkeep Cost
No Replacement Cost
No Loss from Leaks

Because—THEY ARE BRONZE TO BRONZE AT THE JOINT

Your Jobber Sells Them

Manufactured by
DART UNION CO., LIMITED, TORONTO, ONT.

DUPLICATE POWER SUPPLY FOR PUMPING



THE De Laval centrifugal pump shown herewith was built for the City of Lindsay, Ont., and is arranged to be driven either by an induction motor, or, when electrical power is not available, by a 6-cylinder gasoline engine. A clutch is provided for disconnecting the engine when not in use. The unit is rated at 1,325 gal. per min. at 1,450 r.p.m. With a duplicate power supply there is practically complete assurance of being able to deliver water at all times. The characteristics of the De Laval centrifugal pumps are ideal for such service, as there is practically zero starting torque, and, due to the power-limiting characteristic, the De Laval pump cannot possibly overload the motor.

Ask for Our Complete Catalog B-100

DE LAVAL STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast

Flue gases can be reduced 50 degrees by careful firing and clean boiler surfaces

Such is the substantial saving that can be effected by recording and measuring your flue gas temperature with

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE.
Recording Pyrometers

Of course, the temperature of outgoing gases can be decreased by economizers, or by a change in the baffling — but such changes are costly and the economy depends upon the cost of coal.

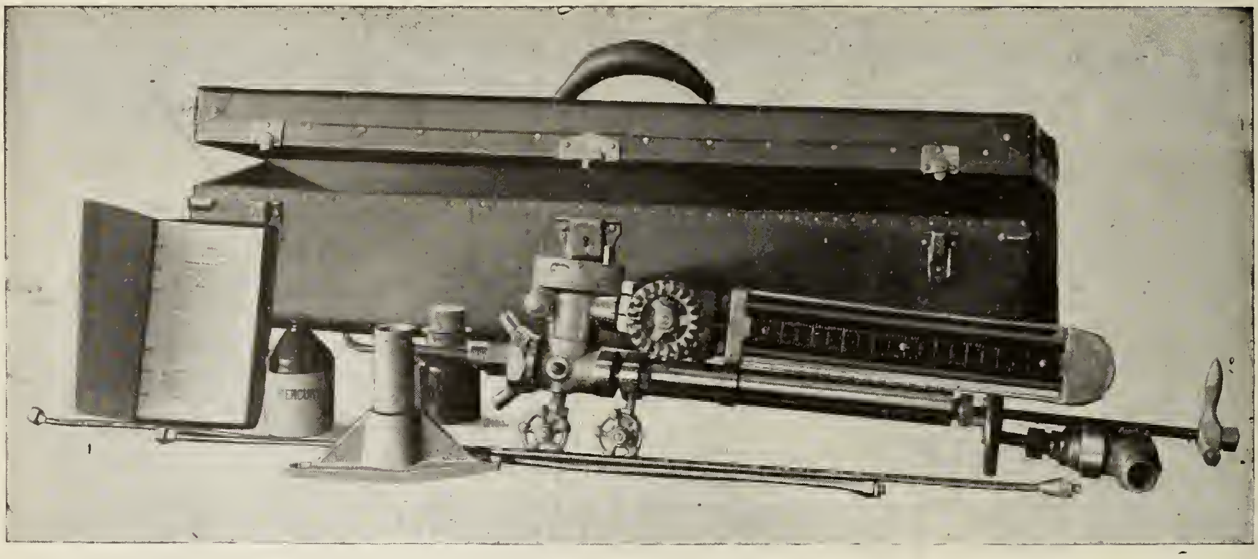
The information supplied by Bristol's Pyrometers, as to the temperature of uptake gases leaving the boilers, is of prime importance as an aid to super-efficient plant operation.

Hundreds of Bristol's Pyrometers are recording flue gas temperatures in prominent power plants. Let us tell you more about what they could do in your plant. Our new Catalog O-1401 is waiting for your address.

The Bristol Company, Waterbury, Conn.

Canadian Distributors:
Eastern Territory: Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory: Gorman's, Ltd., Edmonton.

Fig. 1007
A suit has been filed in the United States Federal Court against a Pyrometer manufacturer who is infringing patents owned by the Bristol Co. covering Automatic Cold End Compensation for Thermo-Electric Pyrometers.



Cory-Royer Flow Indicator
Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

CHAS. CORY & SON INC.

183-7 VARICK STREET - - NEW YORK CITY

VANCOUVER
P. A. Goepel,
525 Pender St. W.

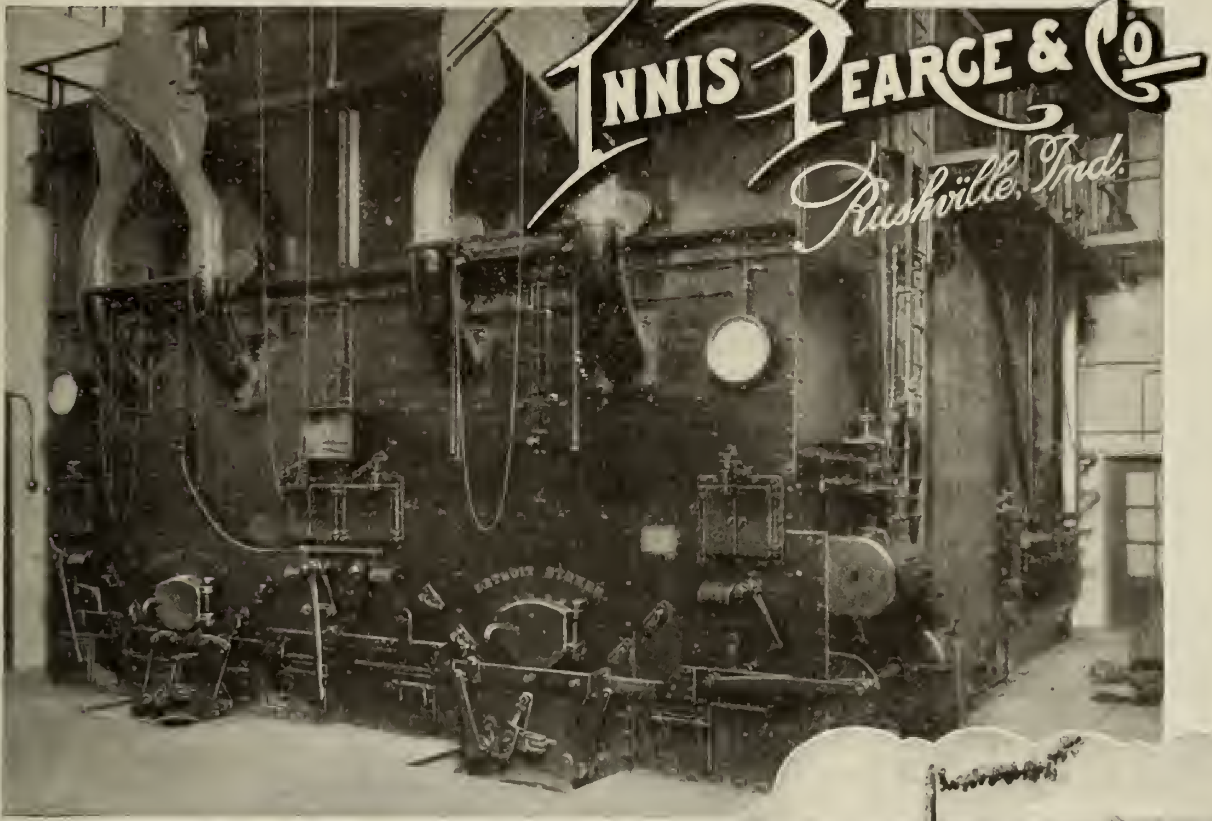
Est. CORY

TORONTO
The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers

Detroit V-Type Stokers

Save daily 5 Tons of Coal

and one man's labor for



This well known furniture manufacturing company burns large quantities of wood refuse on its Detroit natural draft stokers. These stokers are particularly adapted to burning hogged fuel, shavings, and refuse, when installed with flat suspended arches.

Mr. W. H. PEARCE writes:

"The refuse which goes into our boilers is blown from the wood hog into the separator on the top of the boiler-room and the dust then freed and the shavings gravitate into the furnace. In order to utilize the full value of this type fuel, the flat suspended arch has been used instead of the crown arch, thus giving much more combustion space.

"We are burning Eastern Kentucky coal with complete satisfaction, the grates being free from any clinkers, despite the large quantities of wood refuse. The Detroit Stoker installation is very satisfactory and efficient. Our new stoker equipment is saving 5 tons of coal each 24 hours besides the labor of one man."

Savings such as these can be effected in your plant. Remember that besides natural draft stokers we manufacture Detroit Underfeed Stokers, single retort for small and medium size boilers, and multiple retort for large boilers.

Ask for Bulletin No. 338

DETROIT STOKER COMPANY
Underfeed Forced Draft and Overfeed Natural Draft Stokers
338 GENERAL MOTORS BUILDING DETROIT, MICHIGAN

DETROIT **STOKERS**

ASSURE CHEAPER **STEAM PRODUCTION**

BOILER CHEMICALS

Made in Canada for You

Do it Now

Not a hit-and-miss ready-made compound, but made for you on scientific principles.

Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

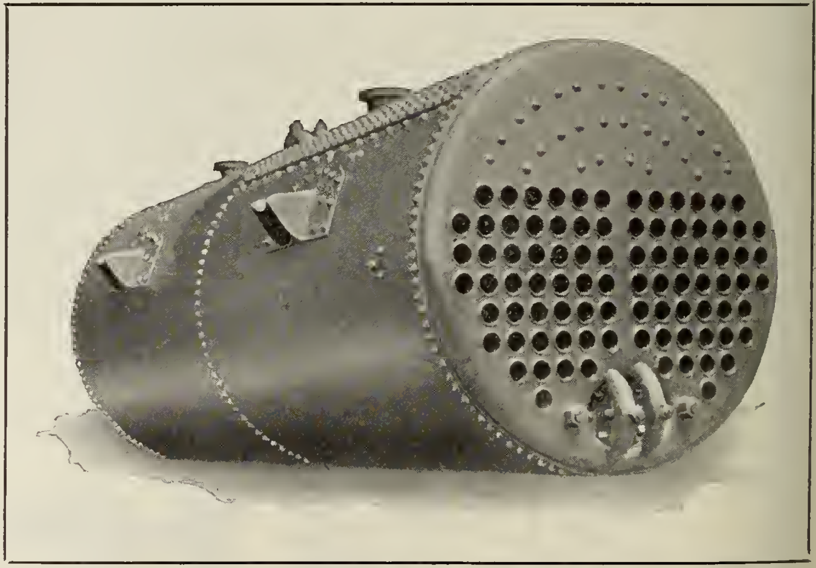
Office: McGill Bldg., Montreal **Factory: Cobourg**

A Modern New Boiler Pays!

We build Boilers of all types of the highest quality—we have been at it for 35 years.

Second-hand Boilers are sometimes tempting—like second-hand motor cars—but no one ever knows just how much life is left in them. Frequently much dearer than new ones.

A modern, new Boiler, from us, pays.



Engineering and Machine Works of Canada, Limited
ST. CATHARINES, ONT.
Eastern Sales Offices: HALL MACHINERY CO., Sherbrooke, Quebec, and Birks Bldg., Montreal

A Sure Way To Conserve Pressure

Assume you have a job requiring a certain amount of low pressure exactly so much and no more—

That if the low pressure requirement is interrupted you want the delivery of all low pressure to cease until the requirement is renewed.

When you can give a mechanical device a job like that to do, and go away and know that it will be done more dependably and accurately than if you had a man stationed right there to attend to it—

We claim it is an unusual regulator.

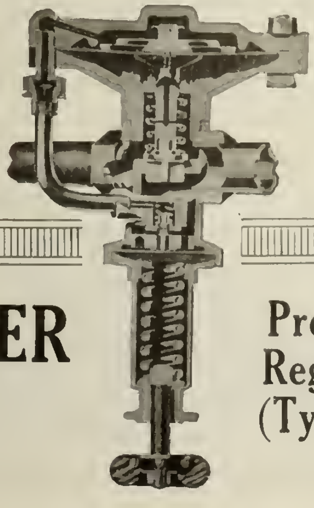
That's what FISHER Pressure Regulator, Type 90, is doing in thousands of plants all over the world.

For automatic control and conservation of reduced pressure, its equal doesn't exist.

We have a book, "Power Plant Specialties", which gives full information about this wonderful regulator and other FISHER Power Plant Specialties. May we send it to you? A card will do the trick.

THE FISHER GOVERNOR COMPANY

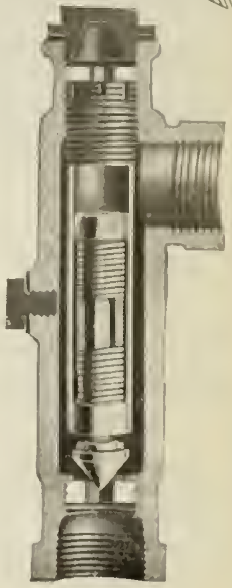
949 Fisher Avenue Marshalltown, Iowa



FISHER **Pressure Regulator (Type 90)**

For greater Steam Trap efficiency I resolve to install the Steam Trap Sarco as soon as possible

Make that "Sarco Resolution" NOW!



If a resolution is good on January 1st, why isn't it just as good or *better* NOW?

Resolve *to-day* to put the Steam Trap Sarco into your plant in place of the obsolete, wasteful traps you are now using, and start saving money, time, lost motion and wasted energy *at Once*.

Hundreds of thousands of Sarco Steam Traps are in use, demonstrating daily their efficiency in large and small plants of every type. Wherever a Sarco takes the place of an ordinary bucket or float type trap its efficiency speedily becomes apparent.

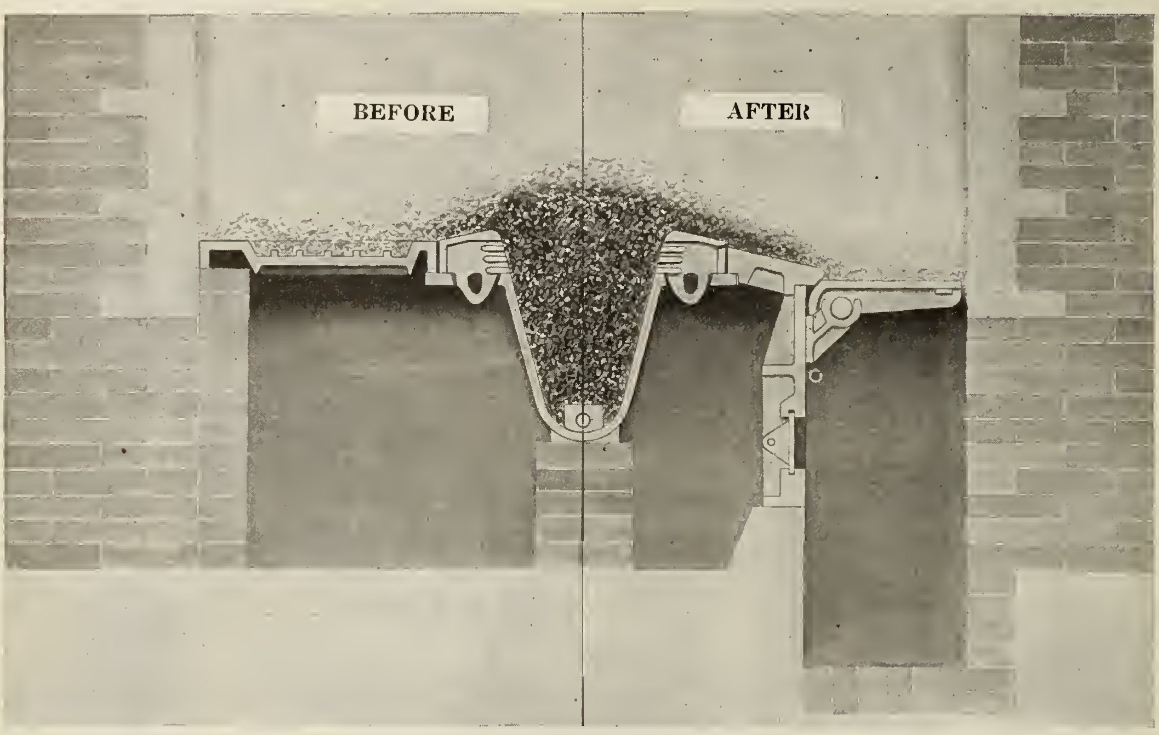
Built with but a single movable unit, its operation is the very acme of simplicity. Sarco maintenance is practically nothing, as there are no fussy parts to get out of order. And it costs only one-third as much as a bucket or float trap.

Every argument for economy and certainty of operation calls upon you to make that "Sarco Resolution" *now*.

Write to-day for Booklet J-44 and details of our 30-Day Free Trial Offer.

SARCO CO. INC.
239 Broadway, New York City
PEACOCK BROS., Limited, Montreal

STEAM TRAP SARCO



The Coupon brings the cost of the change

See how easy the change is—just substitute the dump plates for the dead plates.

Make a side-dump stoker of your "Jones Standard"–cheap!

ANY user of "Jones Standard" Stokers can, by adding the side dump attachments, convert his hand cleaned stokers into self-cleaning side dump stokers.

As shown in the illustration above, the change is a simple one. In place of the hand cleaned dead plates (left) sloping combustion grates and hand operated dump plates (right) are used. All of the features which have won fame for the "Standard" Stoker—simplicity, rugged construction, low maintenance, high efficiency and great capacity, to mention only a few—are retained.

The cost of the change is very low. No expensive ash pit construction is needed; an excavation of only a few inches is necessary.

Here is an opportunity for every "Jones Standard" Stoker user to get an ultra-modern side cleaning stoker for practically nothing. Don't pass it up. Send the coupon opposite to the Under-Feed Stoker Co., of Canada, Limited, 146 King Street, Toronto, for the cost of converting your hand cleaned stokers into self cleaning ones.

"Jones" and "Riley" Stokers

"Murphy" Furnaces

Branch Offices:

Alta. & West. Sask.:
Mr. J. Twomey,
Camrose, Alta.

British Columbia:
E. A. Earle, Ltd.,
Vancouver, B.C.

Man. & East. Sask.:
W. W. Hicks & Co.,
Winnipeg.

Quebec: Cleaton Co.,
(Canada), Ltd.,
Montreal, Que.

RILEY JONES
The UNDER-FEED STOKER COMPANY OF CANADA LTD.
MURPHY

The Under-Feed Stoker Co. of Canada, Ltd.,
146 King Street, Toronto.

I'd like to know the cost of adding dump plates to my stokers.

Firm.......................................

Address.......................................

....

My Name.......................................

P.H.9-20-23.

They Give Less Trouble

D-152.
One of our types of vertical pumps.

ARE you giving the proper amount of consideration to the several uses of the vertical packed piston pumps?

Grit and pieces of steel cannot lodge in the cylinder-head and wear away the smooth surface of the piston and piston-rods.

Write us for particulars on our various types of vertical pumps and how they can be used to your advantage.

Fisher Steam Specialties—Order from us

The Smart-Turner Machine
Company, Limited
HAMILTON, ONTARIO

Representatives in Toronto, Montreal, Winnipeg and St. John.

The Livest Firms and Progressive Towns will use

High Powered Gasoline Engines on Centrifugal Pumps, Air Compressors, Shovels, Locomotives and Electric Generators

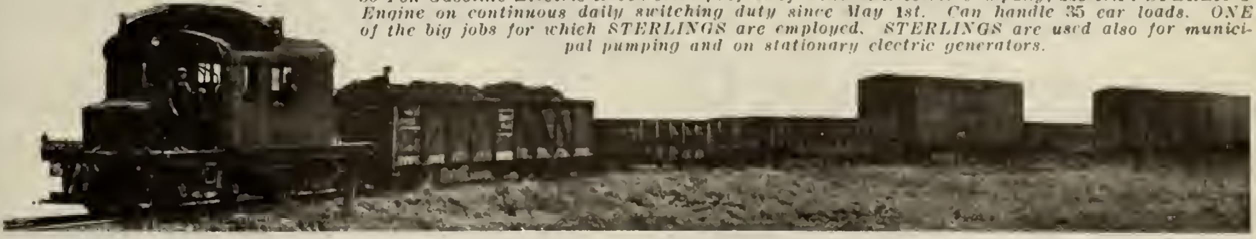
Because—

They cost less than any other form of power.
Are cheaper to run than a steam plant, particularly in isolated districts.
Are easily transported, readily installed.
Can be run by any intelligent engineer.
Are built in **large** sizes for big pumps and generators.

The contractor with this equipment carries the smaller investment, can work faster, with less labor, finish the job sooner; underbid the other fellow and handle more jobs at a profit. The city or manufacturer that uses STERLINGS for emergency has an unfailing source of power.

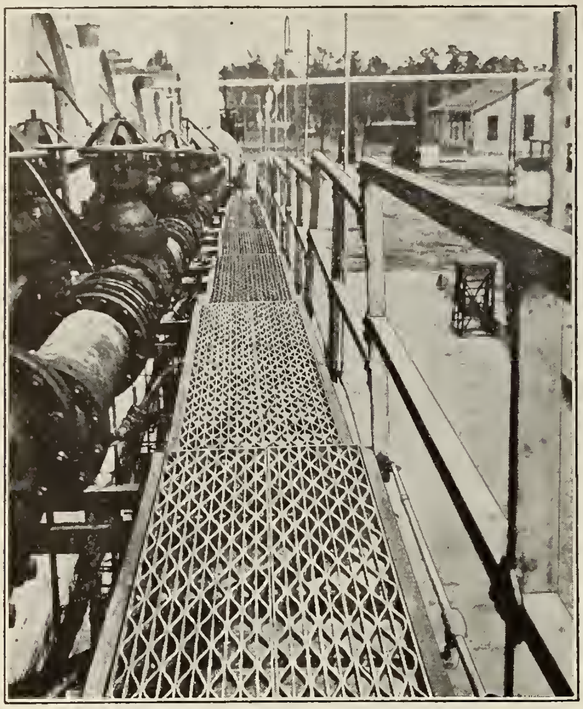
Send for a Catalog.

Sterling Engine Co. (Dept. C4) Buffalo, N.Y., U.S.A.



50 Ton Gasoline Electric Locomotive project of General Electric Company, 225 H.P. STERLING Engine on continuous daily switching duty since May 1st. Can handle 35 car loads. ONE of the big jobs for which STERLINGS are employed. STERLINGS are used also for municipal pumping and on stationary electric generators.

IRVING SUBWAY TRADE MARK (PATENTED) THE FIREPROOF VENTILATING FLOORING



IRVING SUBWAY TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

Purchase price, installation cost, maintenance cost—by all means consider them all, where industrial flooring is to be bought. But don't overlook the fourth factor—the "service-ability," which is the ability of a particular type of flooring to meet most of the service conditions involved in the particular job. We invite comparison of Irving Subway with any other flooring made, on a basis of these four factors in industrial flooring economy. Write for Catalog 4A50.

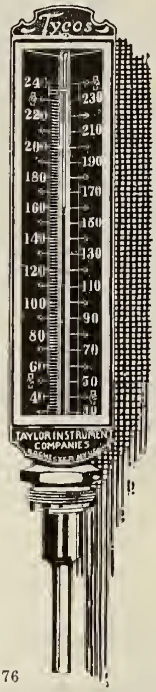
IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Canadian Agents:
Montreal, P.Q., 304 Coristine Bldg. (St. Laurent).
Winnipeg, Man., 141 Bannatyne Ave.
Welland, Ont., Standard Steel Cons. Co.

Manufacturers of

IRVING SAFSTEP TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS

Tycos and the Boiler House



Tycos Indicating, Recording and Controlling Temperature Instruments enable the operator to figure out how much his power is costing as well as increase the efficiency of his plant. The points in the boiler house where *Tycos* Temperature Instruments can be applied effectively are

Atmospheric Relief Valve,
Barometric Pressure,
Blow-Off Lines,
Boiler Room Temperature,
Calorimeter Test,
Condensers,
Drafts,
Economizers,
Feedwater Pressure,
Flue Gas Temperatures
Furnace Fires,
Heating Systems,
Hot Water Tanks,
Humidity of Boiler Room,
Outside Temperature,
Recording Boiler Pressure Gauges,
Saturated Steam Line,
Superheated Steam Lines,
The Coal Pile.

Send for Power Plant Catalog Number One.

Taylor Instrument Companies
110-112 Church St.,
Tycos Bldg., Toronto

There is a *Tycos* or *Taylor* Temperature Instrument for every purpose.
Indicating, Recording, Controlling

Tycos REG. TRADE MARK ROCHESTER, N.Y.

876

FLEXCO TRADE MARK

Lamp Guards

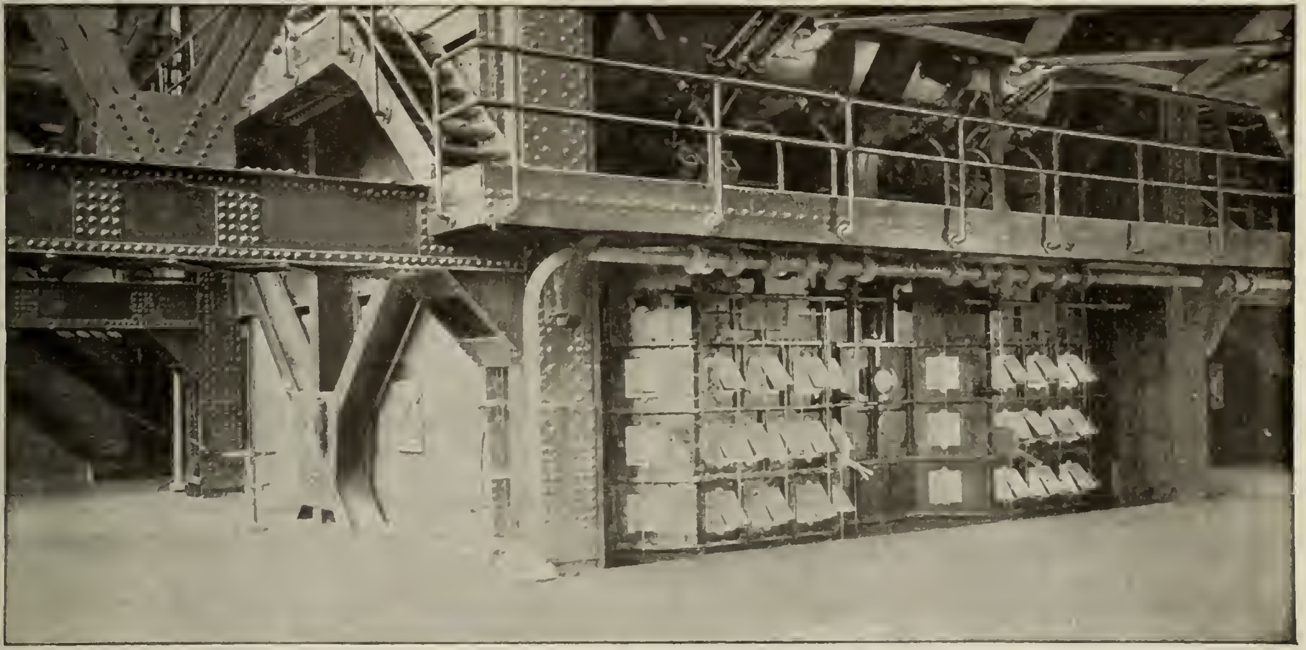
You'll Soon Need Guards

Guard every lamp that is in danger of breakage or unauthorized removal. Protect yourself from losses and accidents. Flexco and Flexco-Lok [patent locking] guards cost less than new lamps. Last for years.
Expanded metal reenforced construction. Attractive in appearance. Very rigid and strong. Made with key locking or plain round head screws. A style for every lamp.

Free sample 50 watt guard and complete information sent on letterhead request, mentioning socket size.

FLEXIBLE STEEL LACING COMPANY
4669 Lexington St., Chicago, Ill.

BREAKING RECORDS



Furnace Front of a Lopulco Installation

LOPULCO Pulverized Fuel SYSTEMS

Write for "Advantages To Be Gained from Pulverizing Canadian Fuels"

Have broken the records for large boilers equipped, high efficiencies obtained, and variety of fuels burned.

Far-sighted engineers investigate the possibilities of Lopulco pulverized-fuel systems before specifying equipment for new installations.

COMBUSTION ENGINEERING CORPORATION
LIMITED

A.J.T. Taylor, President
John T. Farmer, Chief Engineer

MAIN OFFICE: TORONTO
VANCOUVER MONTREAL WINNIPEG

"Everything in the boiler room except the boilers"

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

Buy In The Coil
Cut Your Own Rings

Style 100 (to left) is spirally wound babbitt foil impregnated with purest graphite. Channel types style 300 (asbestos) and 400 (duck) (to right) have a core and wearing face of spirally wound babbitt.

Used alone or in combination these three styles will handle any packing job other than floating types under 450 degrees F.

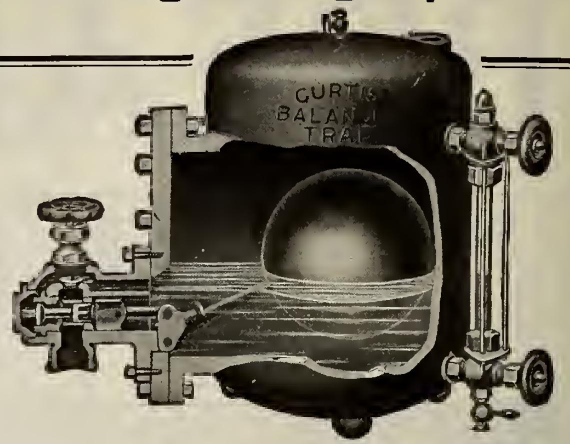
Engineers who have standardized on "JOHN CRANE" Packings —who cut their own rings from the coils are enjoying a packing service and economy otherwise unattainable.

New Packing Chart Ready

Shows wide range of combinations and uses. Our complete illustrated text book "Metallic Packing" also sent on request.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, B. C.

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

Send for descriptive circular of this trap.

Sole Distributors for Canada:
DARLING BROS., 120 Prince Street, Montreal, P. Q.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.

Boiler Setting
Service

THE Gates Engineering Co., Limited, are in a position to contract for and specify on all boiler brick work with the least possible delay. Our Engineering Department is qualified to look after your interests, having made a close study of Combustion Problems.

Our Motto—Service and satisfied clients. The confidence of those who use Gates' Patented Air-Cooled Arch, etc., is unqualified, and is retained, because of the low maintenance cost and the guaranteed results.

Ask for our Descriptive Catalog.

Gates Engineering Co., Limited
314 Notre Dame Street W., Montreal

Keep Your Boilers Efficient

The Basis of most Boiler compounds, often sold under special names, is nothing but Silicate of Soda.
It is a fact that straight Silicate of Soda, properly graded, will positively remove and prevent all boiler scale.
"Boiler Brand" is sold for what it is—just one of our many grades of Silicate of Soda. You'll find its action similar to the most expensive compound.

with

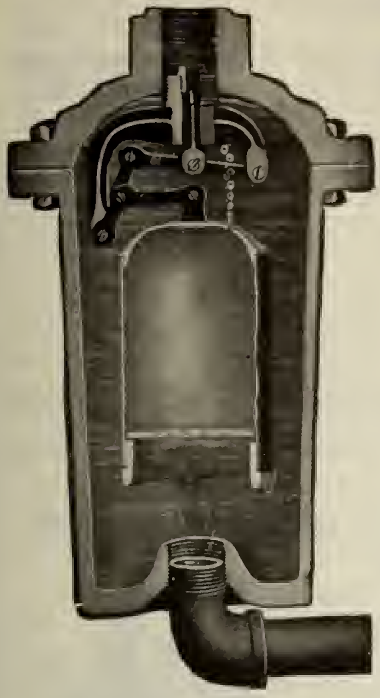
BOILER BRAND
Silicate of Soda

No condition of boiler scale has yet been found that "Boiler Brand" will not handle if used in proper quantities. It stops pitting and corrosion by neutralizing the corrosive acids in the water. It protects and lengthens the life of packings and fittings.

No Mystery--Just Chemistry

Let a Technical Firm
Do a Technical Job

G. F. STERNE & SONS, LIMITED
Chemical Manufacturers, Consulting Chemical Engineers
BRANTFORD - CANADA



Why you should use the

Armstrong Steam Trap

Will not become air-bound—Air passes through vent and goes out with discharge.

Self-Scrubbing—Direct through flow at high velocity. Dirt carried out with discharge.

Little Wear on Valves—Open and close quickly, preventing wire drawing.

First Cost is Low—Compared on basis of capacity in pounds of water per hour, Armstrong Traps are low in price.

Upkeep Negligible—Thousands in service that have never required repairs or replacements.

Dependable—Many records on file of from four to six years' operation with absolutely no attention.

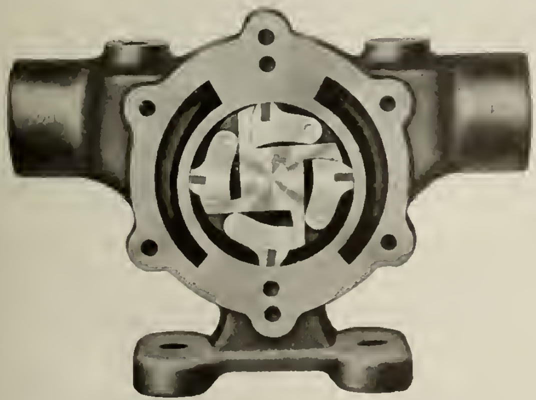
Satisfaction Guaranteed—Armstrong Traps guaranteed to fulfil all claims made for them.

Write for Details

THE ARTHUR S. LEITCH COMPANY
Kent Building, Toronto LIMITED
HIGH GRADE POWER PLANT AND PUMPING EQUIPMENT

ROTO ROTARY PUMPS

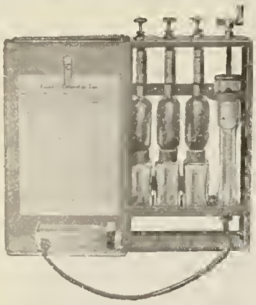
designed for handling various liquids such as alcohol, brine, cutting compound, gasoline, syrup, varnish, vinegar, water, etc.



Interior view of Roto Rotary Pump, showing suction and discharge chambers, also rotor and vanes —note anti-friction facings on vanes.

Supplied for belt drive or for direct connection to motor without gear reduction. ' Double suction feature prevents side thrust and eliminates ports from the cylinder wall. Made of iron or bronze as required. Give us your requirements and let us quote you on pump best suited for your conditions.

YOUNG PUMP COMPANY OF CANADA
96 Mary St. - Hamilton, Ont.
Manufacturers of the Young Centrifugal Vacuum and Boiler Feed Outfit



Hays Improved Gas Analyzer.

Are You Wasting Fuel?

Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO$_2$, O$_2$ and CO; 1-chamber Analyzer for CO$_2$ only. Stocked by Canadian Agents listed below.

HAYS DRAFT GAGES, "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts and Draft Regulation."

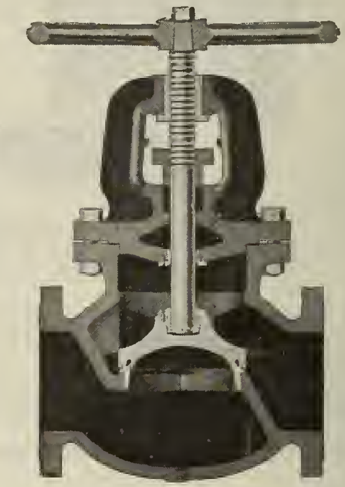
P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
Michigan City, Indiana

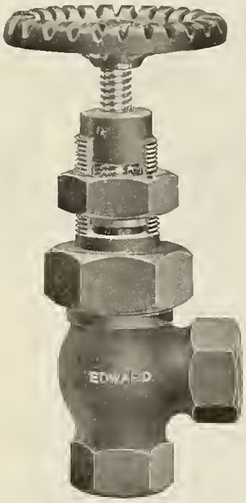
General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.

EDWARD *Extra Heavy* Cast Steel Stop Valves

Designed to offer the least resistance to the flow, with full sized opening through seat, with body, bonnet and gland made of Electric Steel and flanges drilled in accordance with American Extra Heavy Standard of 1914, these EDWARD Stop Valves will give satisfaction under the most severe service.



Superior Valves for Exacting Duty



THE EDWARD PROTECTED SEAT AND DISC

This positive protection of the most vital organ of the valve—the seating surface — is used only in Edward Valves. It prevents cutting from wire drawing, especially under high pressures and temperatures where very small leaks rapidly grow owing to the terrific erosion action.

Send for descriptive catalogue of the Edward line.

The Edward Valve & Manufacturing Co.

General Office & Works: East Chicago, Ind.

CANADIAN AGENTS: Lytle Engineering Co., Limited, Montreal; Valve Engineering Company, Toronto.

Why Individual Boiler Feed Water Treatment

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)

Distributors: William C. Wilson & Co., 21 Camden Street, Toronto
Phone Adel. 1054 or write for full particulars.

SMOOTH JOURNALS KEPT SMOOTH

A lining of Magnolia Anti-Friction Metal never squashes out of a properly designed bearing, yet is soft enough to let dirt and grit sink in below the critical surface, instead of cutting the journal in trying to push the contact surfaces apart. That this positive protection is actually present and does not appreciably diminish the anti-frictional qualities of the bearing, has been thoroughly established. Long life has characterized Magnolia anti-friction metal bearings in cement plants, brick yards, etc., where other bearing metals proved themselves to be costly luxuries.

PRACTICAL ENGINEER POCKET BOOK
—Over 600 Pages—

A valuable reference work imported from England and sold as an advertising medium at the low price of 50c post paid—less than the actual cost of importation.

ADDRESS NEW YORK OFFICE.

Magnolia Metal Company
113 Bank St. - New York

Chicago	San Francisco	Montreal
Fisher Bldg.	Pacific Bldg.	37 Shannon St.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK

Your copy is ready—

THERE'S a copy of this book waiting for your request. It shows how furnaces may be lined to last two to four times as long as fire brick linings—to resist temperatures to 3100 deg. F. to be air and gas tight—to cut down heat radiation.

Where shall we send it? Put your name and address on the coupon below.

Fifty pages of furnace facts—FREE

FIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO
1142 CLAY ST CHICAGO

Jointless Fire Brick Co., 1142 Clay St., Chicago.
Please send me my free copy of "Modern Furnace Building."

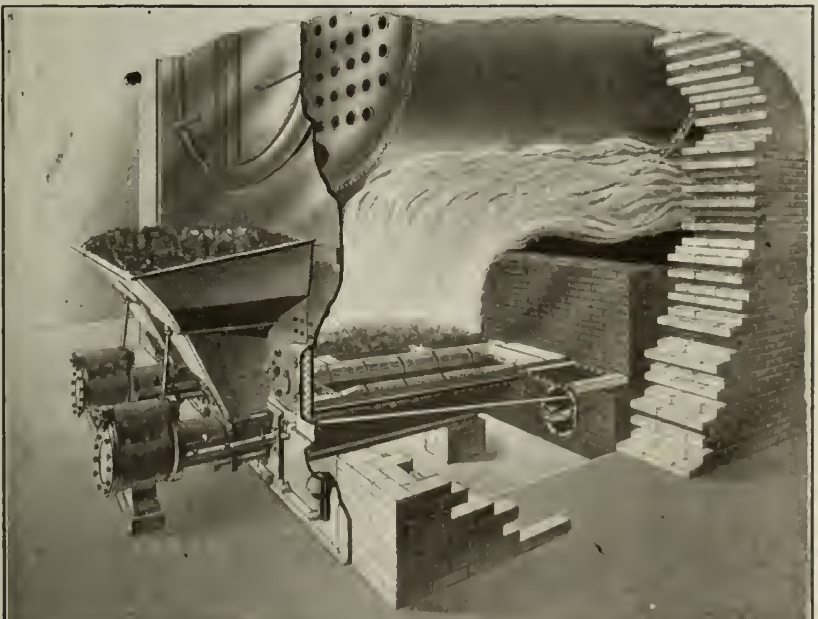
Firm ....

Address ....

....

Your name........................ Position........
P.H. 9-20-23

MACLEAN STOKERS



"The Coal it Saves Soon Pays its Cost"

There are many reasons why your next stoker should be a MACLEAN. Look over the following features—you know best what they would mean in your plant.

Coal Consumption is **greatly reduced.**
Cost of Upkeep is **materially lessened.**
No Special Brick is **required.**
No siftings of unburned coal.
A Smokeless Chimney is maintained.
Cleaner Tubes and heating surfaces due to the complete combustion.
Steaming Capacity of the boilers is increased.
Easy to Install and Operate.
A Constant Steam Pressure is carried, regardless of varying loads.
Responds Immediately to sudden demands for steam.

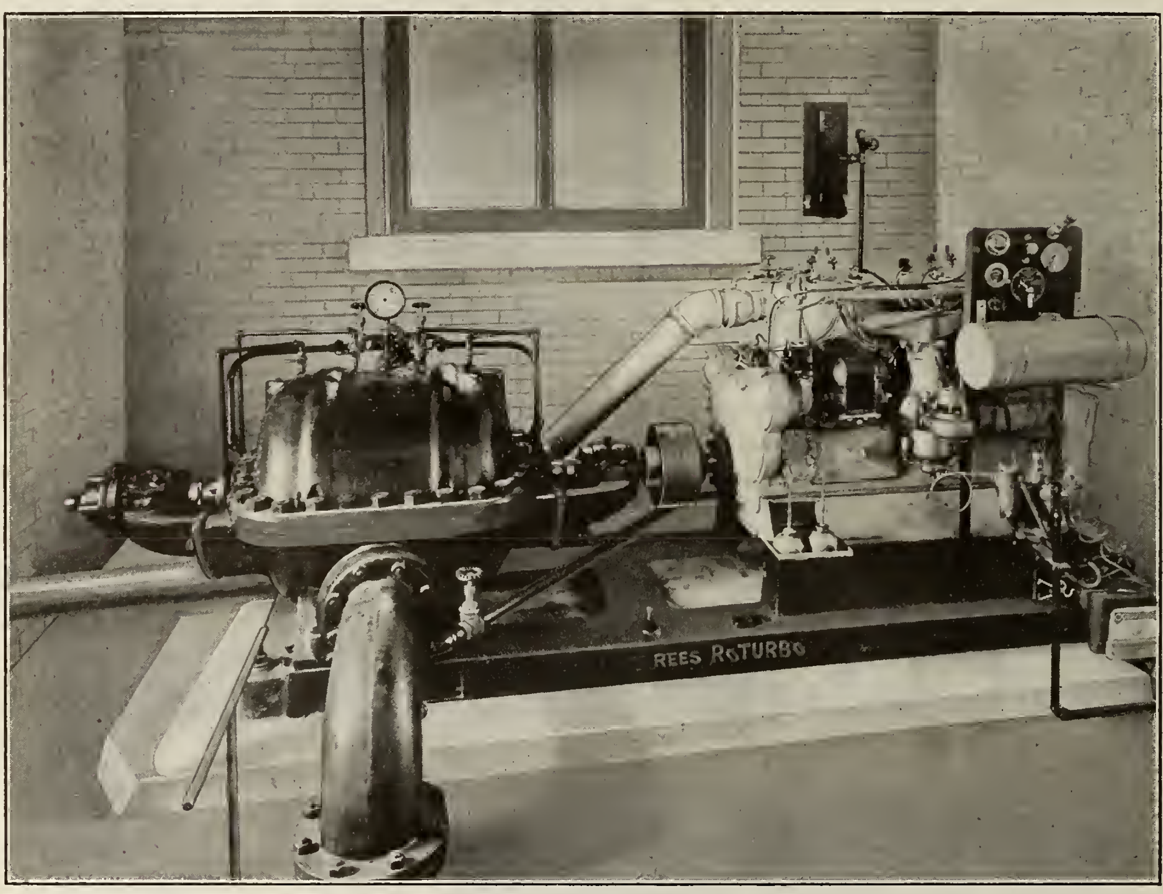
Let us estimate the saving to be made in your plant

MACLEAN UNDERFEED
STOKER CO., LIMITED
95-97 King Street East, Toronto

THE REES RoTURBo

THE GOLDIE & McCULLOCH CO LTD
DEPENDABLE
POWER PLANT
& PUMPING
EQUIPMENT
GALT-CANADA

A Centrifugal Pump for Any Service



Showing a REES RoTURBo Pump at the Waterworks Pumping Station, Grimsby, Ont., with Sterling Gasoline Engine Drive.

REES RoTURBo PUMPS ARE SELF REGULATING

They automatically adjust themselves to sudden Drop or Overload without injury to themselves or the prime mover, and they assure a high and constant efficiency over a wide range of duties.

Municipal and Industrial Plants all over Canada are installing REES RoTURBo PUMPS.

Mr. C. H. Bromley, Town Engineer, Grimsby, Ont., in a letter recently sent us makes the following statement:—

"I have nothing but praise for both pump and engine. They both more than fulfil your guarantee for efficiency and are mechanically perfect."

Catalogs and further information on request

THE GOLDIE & McCULLOCH COMPANY, LIMITED

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bldg.

WESTERN BRANCH:
248 McDermott Ave,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig,
400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B.C.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

N. C. SHATFORD
News Editor

Slaves of the Present Day

ANCIENT Greek civilization, we are told, was sustained by the servile Helots, each family having on an average five of these slaves who supplied a great part of the Greek energy. The Canadian family of 1923 has at its service 150 slaves in the form of electrical, mechanical and hydraulic energy harnessed to carry on the production of the necessities of our mode of living.

Prevalent methods of utilizing our power producing plants are far from perfect; the smaller plant or locomotive makes use of only twenty per cent. of the energy consumed, while in the more perfect installations equipped with modern fuel saving and steam generating equipment, not more than probably sixty per cent. of the energy delivered, is utilized.

To-day, every Canadian worker has, on an average, nearly two horse power available to aid his production, or almost twice as much as his brother worker in Great Britain.

The manufacture of power is the fundamental industry upon which the whole economic structure of civilization depends. The problems relating to more economical power production are paramount in importance to any other single industrial problem, for the product energy is a basic commodity indispensable to the existence of modern society.

The history of the progress of mankind from the Promethean fire and arts of Hephaestos, down to the mechanical stokers and superheaters of modern industry, is simply the story of the development of power and its application to man's use.

* * * *

Setting Air In Motion

AN OLD theory of ventilation was founded on the belief that decidedly harmful substances were present in respired air and as a result the removal of such air and its replacement with fresh air was practically the only factor considered worthy of discussion.

Foul air was considered as air that had been contaminated by human respiration and fresh air its antithesis, provided always it was obtained from out of doors and not from any place inside a building.

These terms, unfortunately, still encumber much of the literature of "aerology" and prevent to a great extent, the proper appreciation of what ventilation means at the present time and what really can be accomplished by properly designed mechanical equipment.

Leonard Hill, in his report of the recent experiments in the Physiological Laboratory of the London Hospital Medical College, says:

"Heat stagnation is the one and only cause of the discomfort arising from the so-called vitiated atmosphere of crowded rooms. The moisture, stillness and warmth of the atmosphere are responsible for all the factors and all the efforts of the engineer should, therefore, be directed toward cooling the air in crowded places by setting the air in motion by fans."

It is, therefore, apparent that the physical condition of the air is of great importance, indeed it is the determining factor so far as physical comfort is concerned. At the same time the engineer cannot safely neglect the dust content of the air, the bacteria it may contain, odors that may be present, an excessive amount of carbon dioxide, a deficient supply of oxygen or the presence of deleterious gasses.

In solving ventilation problems, each must be given its proper weight as a part of the whole.

* * * *

The Power of Example

IF I WERE in charge of a power plant I would clip every fuel saving idea published in Power House, and I would post each clipping where everybody could read it and it would confront me every time I entered the boiler room.

That's what I'd do, for in these days of high operating costs you can't afford to cease trying to reduce fuel bills.

You know the power of an example before the eyes. If you don't, let me tell a little story. It goes like this:

A man tied a donkey's head to a thistle. After a while the donkey ate it.

"I'm surprised," said the man, "that a donkey would eat a thistle."

"Why be surprised?" said a friend. "With the thistle before his eyes—with nothing else in sight—why the donkey would be an ass if he hadn't eaten it."

And there is the moral of keeping fuel saving facts before your foremen. To see—to know—how much others are saving, encourages men to save more!

* * * *

If In Doubt Ask

WHEN in doubt, ask. And that is what Canadian engineers are doing. It is what we want them to do. Power House tries to be more than a newspaper. It is a clearing house—a service station. Every month dozens of questions are answered by mail; dozens of things are done to help engineers.

Tell me the correct way to line up a Corliss engine. Will potato water keep boilers from forming scale? If the compression chamber of a gas engine is made smaller, will it give more power? How can I obtain a third class certificate? Will you send me a sample copy of Power House, a friend tells me it's one real bet?

Those are a few of dozens of questions answered this month. Send in your questions. Arthur Murphy doesn't know everything. No, indeed—not by a long shot. But he has lines that reach out to advisors and counselors. And these advisors and counselors, taken all together, know about everything that's worth knowing in the poper plant. field.

High Vacuum a Big Aid to Maximum Efficiency

By F. JOHNSTONE TAYLOR*

Modern Methods of Removing Air and Water from Condensers—Reasons for Extraction of Incondensible Vapors—General Description of Ejector Systems

IT IS now a well established fact that in conjunction with modern steam turbines it is necessary to expand the steam down to the very lowest pressure in order to maintain the maximum efficiency.

Under conditions of very high vacuum the volume of air to be dealt with becomes so great that the single reciprocating air pump, dealing with both air and condensate, becomes impracticable and other methods have to be resorted to.

The idea of dealing separately with the air and condensate originated with Sir Chas. Parsons in the shape of the vacuum agumenter, in which a steam jet was employed to extract the air at a point just above the bottom of the condenser. This may be regarded as the forerunner of a number of systems now in vogue for extracting air and other incondensible vapors from the condenser.

These in the main involve some form of ejector, which, while extremely simple in action, yet call for considerable skill in design to suit the particular conditions under which they are required to operate.

Ejectors in General

The action of the steam ejector is well known, that is to say, a jet of steam issuing at high velocity, from a nozzle placed axially in a pipe, will draw air through that pipe and this application of the ejector for maintaining a vacuum is quite a common one. In the case of condenser work however, the problem is not by any means so simple as it might at first appear to be.

With the single steam jet air ejector there is the difficulty of dealing with the air after it is extracted from the condenser, particularly when it is desired that it shall not mix with the condensate again.

Owing to risk of corrosion it is now regarded as bad practice to return the air to the condensate after it has been extracted from the condenser, in consequence it is necessary to raise its pressure slightly above that of the atmosphere before it can be conveniently discharged.

The single steam jet ejector cannot effect this efficiently, hence the adoption of a two stage ejector and in some instances a three stage one, both of which are. as will be shown, often combined with an intermediate condenser.

Thus a further development of the Parsons vacuum augmenter is seen in the two stage ejector in which steam is used for the first stage and either steam or water for the second, the three stage system merely carrying the process a step further.

In all these arrangements the condensate is dealt with by a separate pump of the centrifugal type.

Two Stage Ejector

Fig. 1 shows a modern type, consisting of two ejectors working in series.

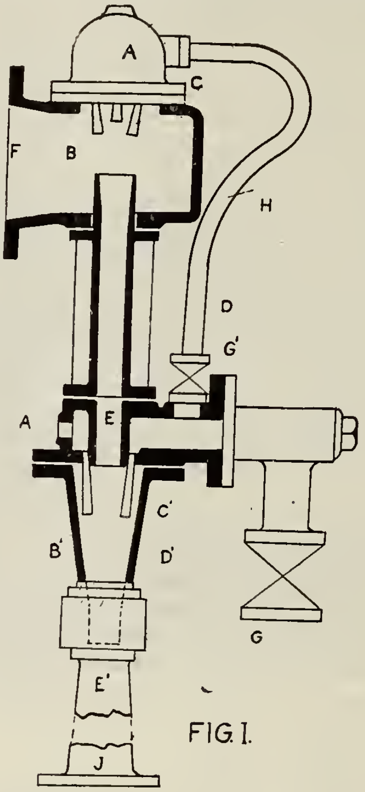


FIG. 1.

There are two compression stages each of which is under the control of a group of steam nozzles operating in series.

Each stage consists of a steam chest as shown at A and A,, air suction chambers at B and B^1, a group of convergent nozzles at C and C,, convergent and divergent compression pipes at D and D^1 terminating in diffusion pipes E and E^1.

The inlet branch F is connected to the condenser and the steam supply pipe to main inlet G on the second stage steam chest while branch H, fitted with a stop valve G, conveys a supply of steam to the first stage nozzles.

The first stage group of nozzles, c, give the initial motion to the air and gasses which are partially compressed in the first stage ejector, while in flowing through the second stage they attain considerable velocity, the final velocity being imparted by the second group of nozzles C^1—C^1.

On passing through the second stage compression pipe D^1 the mixture enters diffuser pipe E^1 wherein the kinetic energy is converted into useful work in overcoming the atmospheric discharge pressure at the discharge end J.

This type of ejector may be taken as typical of the simpler forms and by slight alteration in the general construction it may be combined with an intermediate condenser between the stages, an arrangement which as will be shown, has several advantages.

Development of Ejector

One of the great defects of the earlier forms of ejector air pumps was their very high steam consumption which rendered the production of high vacuum costly. The efficiency of a steam operated ejector depends to a large extent upon the amount of friction surface which can be provided between the air and the steam. A large steam nozzle is capable of passing a large weight of steam but it is only the outer surface of the jet which is available for producing vacuum.

Hence the adoption of several small nozzles in place of one large one while the distance between nozzles and diffuser throat is made as great as possible.

These improvements considerably reduced steam consumption but there still remained other troubles, the principal of which was instability. This is liable to occur at high vacuum with varying load conditions and is due either to the steam jets not filling the diffuser throat or to their being choked in the throat.

Various methods have been adopted to overcome this trouble amongst which may be mentioned the stabilizing valve, the annular diffuser, and the water jacketed nozzle.

Water Jet Ejectors

Water jet air ejectors are principally used in conjunction with the kinetic system. A water jet ejector of orthodox design is shown in Fig. 2. It consists essentially of four stationary parts.

Nozzle box A is a cast iron chamber with branch B for the air pipe from the condenser. A nozzle C of bronze extends downwards from the top of the box to within a short distance above the bottom flange while the water supply pipe is bolted to the top of the nozzle box, the purpose of the nozzle being to convert the pressure of the water into velocity.

---

*Specially written and illustrated for Power House.

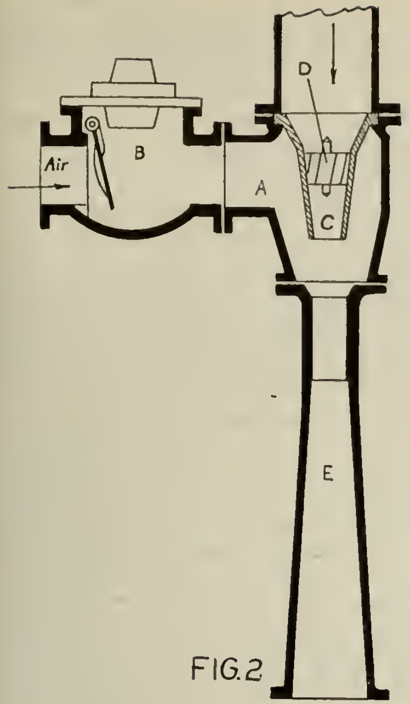


FIG.2

Inside the nozzle is cone part D, having vanes arranged on an angle. These give a rotary motion to the water and at the same time break up the surface of the cone of the water, thus ensuring its being able to entrain the air with maximum efficiency. The water discharges into diffuser E bolted to the bottom of the nozzle box.

In the diffuser the entrained air is compressed from the vacuum pressure to atmospheric pressure, the compression being carried out isothermally.

After the water has been passed through the air ejector it can be returned to the suction culvert, where, owing to the fact that the pump suctions are not very near the ejector discharge, the air separates out.

When cooling towers are in use this water for the ejector may be shunted off the circulating system, but if the water is led to the circulating pump through a closed pipe it is necessary to provide an air separator between the air ejector discharge and the pump suction.

An Air Separator

This air separator, shown in Fig. 3, consists of a conical vessel in which the water entering at the small end is reduced in velocity as it travels towards the large end.

With the velocity falling to about 1 ft. per second the air is separated from the water and is discharged through a vent pipe, A, at the top, while the water returns to the main circulating pipe suction. Should the water levels involve either pressure or vacuum in the separator, float control valves are fitted.

As the air becomes separated from the water it accumulates in the top of the vessel and gradually depresses the water level, thus lowering the float, B, and slightly opening the air valves, A, at the top so as to allow the air to escape.

Conversely if there is a tendency for the pump to draw the water out at a greater rate than that at which it enters the separator, the float, continuing to fall closes the water outlet valve, C, at the bottom.

Kinetic System

The value of the kinetic system lies in the greatly increased capacity of the water jet by first withdrawing the air and compressing it by a steam jet followed by a system of water jets.

The latter, moving at a high velocity, have been in use for many years for the production of vacuum, but a water jet has a relatively low capacity of assimilating and withdrawing air, and if the amount of air to be removed is large, the quantity of water or the pressure necessary for the jet becomes considerable and excessive power is expended in the process. If, however, the air to be extracted is previously compressed by the use of a steam jet ejector then the air withdrawing capacity of the water jet device is considerably increased.

In the case of a kinetic plant the steam is introduced into the air suction pipe through a high velocity nozzle which thus entrains the air and mixes intimately with it. The steam is condensed on the secondary sprays of the water jets and the resultant liquid carrying with it all entrained air and gases is ejected by the main water jet to the kinetic tank, from which the air and gases escape to the atmosphere. Either live steam or exhaust steam (if available at a pressure of over 10 lbs.) may be used, the quantity varying from ½ to ¾ per cent. of the steam condensed according to the size of the installation. The water for the kinetic jet is condensate already removed.

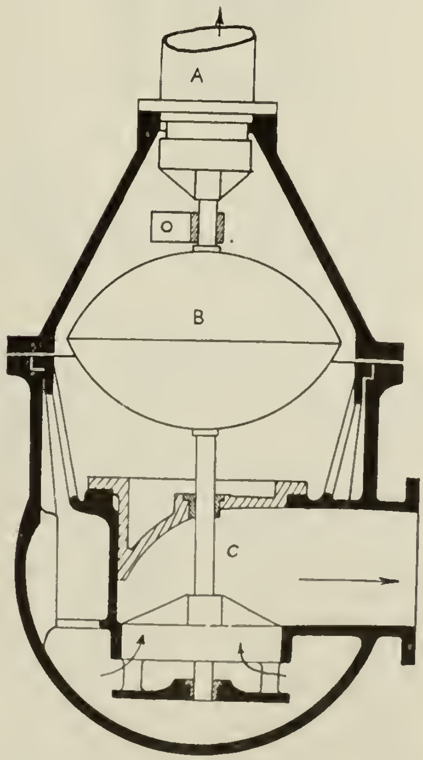


FIG 3

The whole of the latent heat contained in the steam used in the steam nozzle is absorbed by this water, which in consequence reaches the feed tank at a higher temperature than when it left the condenser. The condensate is withdrawn from the condenser and discharged into the kinetic tank by a centrifugal extraction pump. The general layout of a system of this kind is shown in Fig. 4.

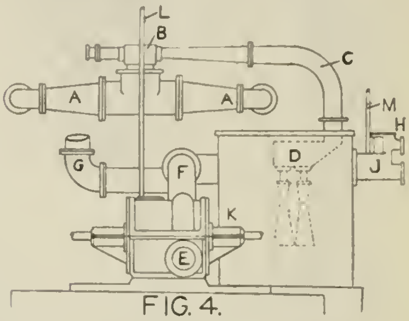


FIG. 4.

Referring to the lettering on the diagram, A is the air suction pipe, B the steam jet, C the air pipe to kinetic ejector, and D the kinetic ejector itself.

The kinetic pump suction pipe is shown at E, and the discharge pipe at F, while G is the condensed water pipe to the extraction pump and H the feed water delivery pipe. At J is a float controlled delivery valve, K is the kinetic tank, L a vent pipe and M the bypass from tank to condenser.

The exponents of the kinetic steam and water jet system claim that it is much more economical than systems employing high pressure steam jets in series and that it is the most efficient air pump extant, because practically the whole of the energy expended reappears in the form of heat in the kinetic tank whence it is returned to the boilers subject only to a small loss through radiation.

Withdrawal of Air

Reverting to Fig. 4 withdrawal of air from the condenser is effected by a steam jet, B, followed by the action of kinetic ejector, D, supplied with water by kinetic pump through pipe F, and discharged into kinetic tank K. Condensate water flows through pipe G into the extraction pump which discharges into the suction of the kinetic pump through a non-return valve in the pump casing.

The excess of water in the tank corresponding to the feed water is delivered by the kinetic air pump by means of pipe H and float controlled valve J, into the feed tank which may be placed overhead.

The Intermediate System

It was before stated that the introduction of a subsidiary condenser between the stages of a two stage ejector had been found of considerable advantage. By the introduction of this small "Intercondenser" between the

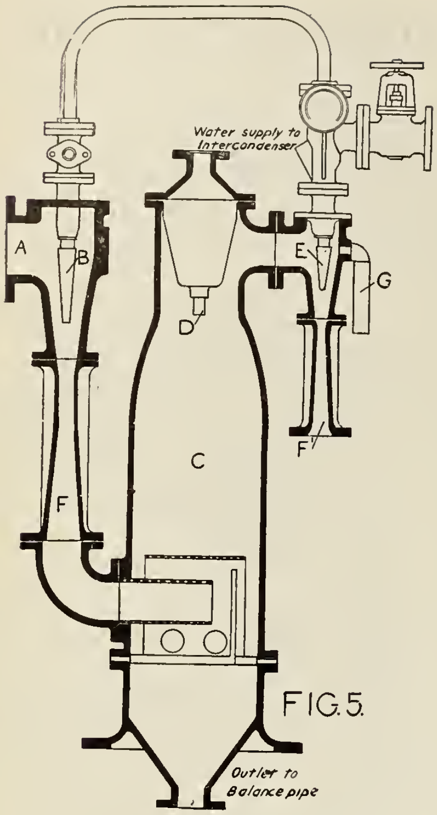


FIG. 5.

stages the work to be performed by the second stage is very largely reduced enabling the same results as regards weight of air extracted to be achieved with practically half the steam.

The intercondenser system permits of complete condensation of the steam and separation of air from the condensate while maintaining a high rate of heat transmission, and the second stage compression is thus carried out under the most favorable conditions. The operation of an ejector air pump with an intercondenser is precisely the same as that of one without, while the intercondenser may be either of the surface or jet type, according to individual design.

Two Stage Ejector

An air pump of this class is shown in Fig. 5. Air is drawn in from the condenser at A compressed by steam jet, B, the steam-air mixture being discharged into the intercondenser, C, where the air is cooled and the steam condensed by water jets from D. The air is withdrawn from the intercondenser and discharged to atmosphere or feed heater by second stage jet E. The water used in the intercondenser is condensate from the main condenser and it is drained away by passing it back to the extraction pump suction by means of a pipe termed a balance pipe. This pipe in addition to draining the intercondenser provides and maintains the balance of pressure between the latter and the main condenser.

Stability Essential

Reference has already been made to instability under varying load, and in this connection stabilizing valve G should be noted.

It must be remembered that the density of the mixture discharged through the throats of the combining tubes will vary according to the steam condensed and to such an extent that the required compression cannot at times be effected. This is very important especially as regards the second steam jet, inasmuch as atmospheric air will rush in to the auxiliary condenser until the required density of the mixture is established when the second jet again begins to discharge.

Stabilizing valve G is fitted to guard against this. It is simply an automatic air inlet valve to the suction pipe from the auxiliary condenser. By setting this valve to admit air at a suitable vacuum in the auxiliary condenser the density of the mixture handled by the second jet is prevented from becoming too low thus ensuring the stability of the whole apparatus.

Nearly the whole of the heat of evaporation of the steam used in the jets is recoverable, that from the first jet being added to the condensate withdrawn from the main condenser. The heat from the second jet is usually absorbed by a feed heater, the condensate from the main condenser providing the condensing medium.

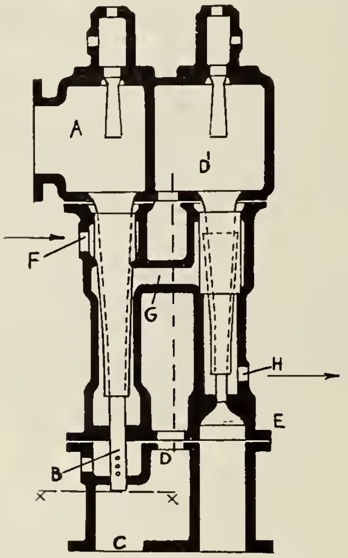


FIG. 6.

Water Jacketed Jets

The system of admitting a supplementary supply of air through a stabilizing valve is not regarded with favor by all designers, some of whom claim that not only is the method incomplete owing to the inflow of air being intermittent but that the re-compressing of the stabilizing air requires additional work and reduces the efficiency.

The arrangement shown in Fig. 6 originated on the assumption that it is necessary to keep the convergent nozzle cool by the introduction of a water jacket, which may be regarded as the essential feature of the system.

Fig. 6 shows a two stage ejector arranged to work with an intercondenser. Air from the condenser enters at A and is compressed for the first time as far as X—X. A jet of injection water enters holes B, and condenses the steam in the first stage, while the injection water and condensed steam flow away through C, returning to the condenser through a U tube.

The incondensible gases freed from the steam follow the line D—D^1 and are compressed a second time as far as E whence with the steam of the second stage they are discharged to the atmosphere, usually through a feed water heater in which the steam is condensed, the heat being absorbed by the feed water. The circulating water enters at F, passes along G and out at H.

The Annular Diffuser

The annular diffuser is another arrangement introduced with a view to getting over the trouble of instability. By this means the entrainment surface is considerably increased for a given weight of steam per second, while the length of the jet can be kept within reasonable proportions. Thus internal losses due to eddying are eliminated and the penetrative effect of the jet in the diffuser is increased. At the same time the areas of all the passage ways can be made large enough to ensure absolute freedom from choking.

It is a well known fact that in the ordinary type of ejector apparatus, the dimensions of the various parts require to be extremely accurate to secure economical working, and further, these

(Continued on page 39)

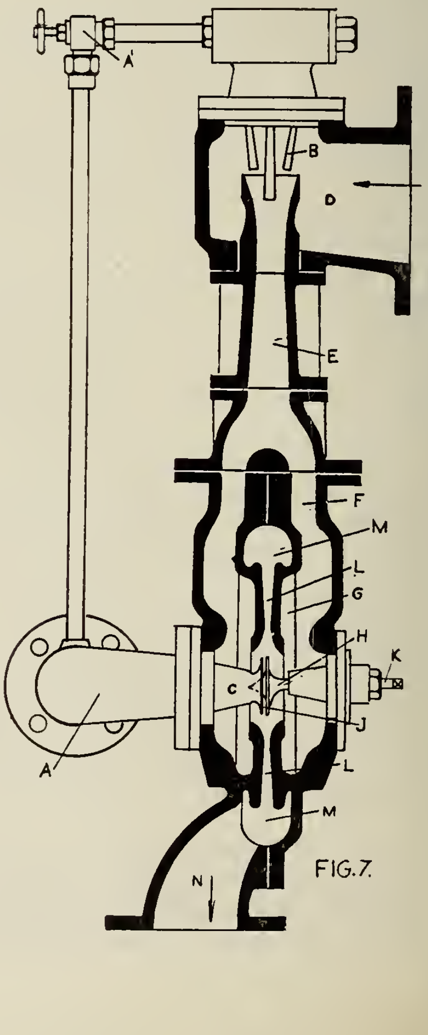


FIG. 7.

Demonstrating Vacuum Heating System Savings

Tests in Building Containing 6,400 sq. ft. of Direct Radiation, or its Equivalent, Show Saving of 345,000 lbs. of Steam in Seven Months

IN A recent report of the Heat Utilization Committee of the National District Heating Association, a section is included on vacuum heating, by J. E. Seiter, in which the results of two interesting tests are presented to demonstrate the savings possible in large buildings with the use of a vacuum in the steam heating system.

Both tests were run in office buildings, in a city, where mild weather with outside temperatures between 40 deg. and 70 deg. Fahr. constitutes about 50 per cent. of each heating season; moderately cold weather, with outside temperatures between 20 deg. and 40 deg. Fahr., and only 5 per cent. can be classed as "severely cold."

To determine the saving, if any, of operating under a vacuum, the first test was run in a four-story brick building, containing 200,000 cu. ft. of space. The heating system was re-designed and rebuilt by an experienced heating engineer in 1916, at which time it was remodelled into an overhead-feed, thermostatically-operated, two-pipe gravity system, with thermostatic traps on all radiators.

It contains 2,170 sq. ft. of direct radiation and 700 sq. ft. of indirect radiation, making a total of 6,400 sq. ft. of equivalent direct radiation. While the system was operating as well as any system of this type, the engineer in charge of the building asked to have a vacuum pump installed.

Pump Was Installed

Last summer a pump was installed, but before the changes were completed it became necessary to use heat in the building and the ventilating equipment was not connected to the vacuum pump which therefore operated on the direct radiation only during the past winter.

The building is used by departments which have men working twenty-four hours per day. During the night the ventilating system is shut off, but the direct radiation is left on.

During the heating season the vacuum pump was run only during the day and the system was operated by gravity at night, as there was no engineer on duty during the night.

Comparison of operation of the system before and after vacuum pump was installed.

Month	Steam Consumption, lbs.		Steam Consumption, lbs. per °F. below 70°F.		Saving % by vacuum	Steam Consumption 1922-23 cor. to temp. in 1921-22
	1921-22 pressure operation	1922-23 vacuum operation	1921-22 pressure operation	1922-23 vacuum operation		
Oct.	361,595	231,200	2055	1445	23.4	250,000
Nov.	477,295	410,796	1535	1520	1.0	472,500
Dec.	572,650	532,966	1455	1300	11.9	512,000
Jan.	724,750	704,076	1570	1636	loss	756,000
Feb.	585,845	588,500	1410	1300	7.8	543,000
Mar.	555,685	524,000	1678	1345	19.8	446,000
Apr.	360,885	457,173	1650	1450	12.1	318,000

Total consumption from October 1 to May 1, 1921-22, lbs.	3,642,505
Total consumption from October 1 to May 1, 1922-23, corrected to temperatures for 1921-22, lbs.	3,297,500
Saving in seven months by using vacuum pump, lbs.	345,000
Average saving per month, lbs.	50,000
Estimated total saving for season by use of vacuum pump in lbs.	395,000
Estimated total savings in dollars, with steam at $1 per 1,000 lbs.	$395.00
Total actual cost of pump and piping installed	$658.00

These results are self-explanatory and the savings are evident. During January a loss is shown which can only be accounted for by the fact that in January, the pressures were varied for test purposes. These tests consisted of running at a pressure for one week and a vacuum for one week. During the latter part of January the system was operated at about 3 lbs. pressure. It may be that operating under these pressures offset any saving which might have been effected. For this reason, the saving during February is also low.

The results by operating under pressure one week and vacuum the next are shown in Fig. 1. The points plotted indicate data obtained on days with the outside temperatures ranging from 25-35 deg. Fahr. It was not possible with these outside temperatures to increase the vacuum much above 5 in. and still heat the building. The system is thermostatically operated and theoretically no saving should be shown, but actually it is very marked.

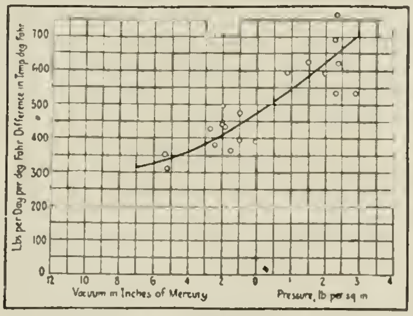


Fig. 1—Operating Results in a 4-Story Building.

Tests were then run in a ten-story brick building, containing 40,000 sq. ft. of radiation, the system installed being an overhead feed, vacuum system, having all returns above the vacuum pump. The thermostatic equipment in the large rooms is of the so-called positive type in which the radiator valve is either wide open or tightly shut. In the smaller private offices the thermostats operate modulating valves permitting the radiators to heat fractionally.

The results of these tests are shown in Fig. 2. The points shown are for tests of eight hours each, during which the pressures were kept constant. The curve drawn through these points was obtained by calculating the steam consumption for various steam temperatures and a 70 deg. Fahr. room temperature.

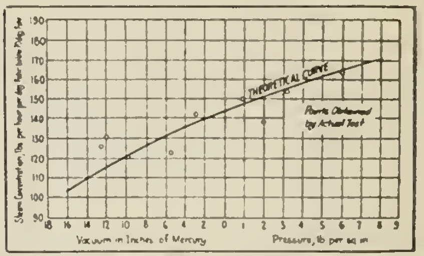


Fig. 2—Operating Results in a 10-Story Building.

Later in the season the test was repeated to check these results by operating for longer periods than eight hours. This was a difficult task, due to the wide variation in the outside temperature, and because of the difficulty in holding a constant pressure over extended periods. When complaints became too numerous, that the building was not comfortable, (usually too hot), the test had to be discontinued until more favorable conditions presented themselves. For this reason there are no points between 1 lb. pressure and 4 in. of vacuum. All the results are plotted in Fig. 3.

The points obtained are averages for periods of about five days each. The curve drawn through them was obtained in the same manner as in the previous test.

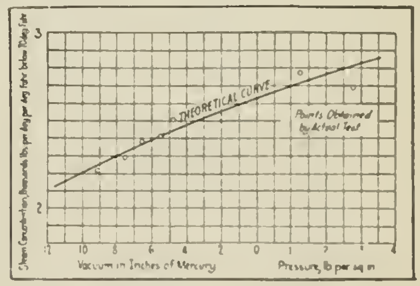


Fig. 3—Results of Second Test.

In all of these tests, the vacuum or pressure referred to was at the reducing valve and not at the pump. During all of the tests, the vacuum at the pump was maintained so as to give between 4 in. and 7 in. of mercury pressure drop through the system, that is from the reducing valve to the pump.

During the test, the pressures were watched throughout the building. At the time steam was turned on the building in the morning, there was a 3-in. pressure drop between the pent house and the risers at a point on the 6th floor. This drop was 2 in. through the remainder of the day.

The drop in pressure between the trap discharge of a radiator on the sixth floor and the pump was 5 in. when the steam was first turned on. During the balance of the day, this dropped to 2 in.

All the pressures were for a day of 26 deg. Fahr. outside diameter. They vary for other temperatures, being less in mild weather and greater in cold weather.

The pressure drop through the thermostatic traps on radiators equipped with the positive type of thermostatic control, varies with the reducing valve setting and the pump vacuum, acting as a sort of shock absorber and taking up any excess pressure which may exist. This drop can be kept as low as required by watching the circulation in the building.

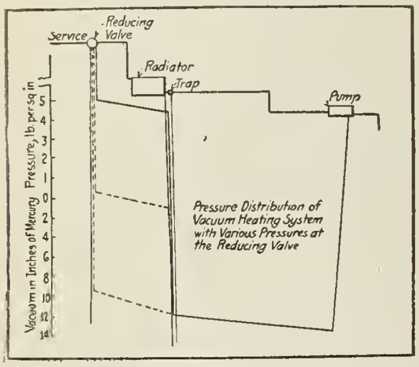


Fig. 4—Pressure Drop Through System.

This pressure drop through the system is diagrammatically shown in Fig. 4. It will be noted that the pressure drop from the reducing valve to the radiator and from radiator trap discharge to the vacuum pump remains practically constant, for any reducing valve setting varying with the density of the steam while the pressure drop across radiator trap varies with the reducing valve setting.

Where the radiators are equipped with modulating valves the excess pressure in the system is taken in these valves instead of the traps.

The occupants of the building do not like pressure above atmospheric on the radiators. The radiant heat is too great and the thermostats do not maintain uniform temperatures.

Extremely high vacuums work very well where there is piping large enough to supply sufficient steam to all radiators.

Previous discussion of vacuum heating by the committee brought out the objection of vacuum heating due to the pressure drop across the radiator trap, causing them to permit vapor to enter the return lines. This condition was carefully watched; no appreciable amount of vapor was noticed passing through the traps at high vacuums. The drop across the trap can be as low as required approaching that of an atmospheric system. No cold water jets were used or were necessary to maintain a high vacuum. No vapor was ever noticed around the meter. An economizer was used for heating domestic water but was on the discharge side of the meter. Steam used for heating water was not considered in the test.

Tests Heating Value of Lignite Char

Ottawa Believes Carbonizing Oven May be Invaluable Should Anthracite Supply Fail

CONSTRUCTION of an oven that turns lignite into a substance with similar heating properties to anthracite has resulted from experiments conducted by the U. S. Department of the Interior through the Bureau of Mines.

An appropriation of $100,000, for the purpose of investigating lignite, was made four years ago. The Bureau of Mines made the discovery in co-operation with the Canadian government, and as a result, lignite char should be available in the Northwest in any periods of hard-coal famine that may occur in the future.

One Third Lignite

Of the continent's coal resources, it is estimated that 1,057,290,000,000 tons, or nealry one-third, are lignite. The lignite of the Northwest is brown, dull, markedly woody in texture, has no coking quality, and carries a great percentage of moisture. Its disintegration on exposure is so rapid as largely to prevent its shipment any distance, except during the excessively cold northern winters, when it is, of course, frozen.

Lignite takes fire quickly from spontaneous combustion, so that its safe storage in even small quantities is exceedingly difficult. It does not "coke," in the sense that bituminous coal cokes, but rather crumbles when being carbonized, or when thrown into the fire, and thus gives rise to difficulties in firing and substantial loss, as unburned fuel, through the grate bars.

Carbonizing Oven

Experiments have been made by various agencies in the past looking toward the utilization of the northwestern lignites in carbonized or powdered form, or in the form of briquets. While all this experimental work has held some promise of success, the commercial development of these vast fields of lignite has not been worked out. An appropriation of $100,000 for an investigation by the Department of the Interior, through the Bureau of Mines, to determine the commercial practicability of producing a benefited solid fuel from lignite, was made in 1920. As a result of this experimental work, a carbonizing oven, which has every indication of being a practical, commercial oven, was designed, constructed, and operated, during the summer of 1922. Quantities of the oven's product, known as lignite char, have been tested and found to possess heating properties very similar to those of anthracite coal.

The Canadian government has expended nearly $1,000,000 in an exhaustive research looking toward the production of benefited solid fuel from lignite, but seeing the carbonization oven in operation, decided to construct a similar oven and to give it a thorough test. The tests of the oven have been highly successful, and the Canadian engineers conducting the experiments have reported to the Department of Mines at Ottawa that the oven is a practical and commercial oven, now past the experimental stage.

C. A. S. E. Notes

At the meeting of the C.A.S.E., Ottawa Lodge No. 6, on Sept. 4, 1923, the chief topic under discussion was the membership campaign suggested by the Grand President of the association, James J. Sullivan, and a committee was formed to consider ways and means of procuring new members. Ottawa Lodge No. 6 are taking over new quarters at Boileau's Hall, Booth Street, Ottawa, where the first meeting in October will be held. Plans are being made to have a "house warming" in the form of a social evening, and also to open the membership campaign.

Many engineers will be invited and will be acquainted with the aims of the C. A. S. E.

A motion of congratulation to James J. Sullivan, on his election to the grand presidency, was carried unanimously, and confidence in his efforts was expressed.

Mr. Sullivan stated that he intends to do his best to show that the confidence placed in him by the members of the association was not misplaced, and that he thoroughly realizes the honor conferred upon him. Ottawa Lodge No. 6 feel honored that one of their members was chosen as leader, and they realize that a more conscientious man, or one who would place more interest in the work of the C. A. S. E. would be hard to find. Mr. Sullivan has the united support of his entire lodge.

The meetings will be held on the first and third Thursdays of each month, and all visitors are assured of a sincere welcome at any time they care to visit the association.—FRANK DAVIS, Rec. Secy.

Boiler Room Piping for Power and Steam Pumps

Attention to Details by Stationary Engineer at Time of Installation Greatly Simplifies Repair Work in Years to Come

NOTHING so greatly aids the stationary engineers of Canadian power plants as a proper initial installation of the pumps in the boiler room.

This article is written to illustrate the connections past experience has proven most adaptable.

The vertical receiver, 2, shown in Fig. 1, receives th edischarge of hot water from several traps in a heating system through the tee 3. A tee is used here instead of an ell in order that the plug may be removed to inspect the interior of the receiver. These returns are not sufficient to supply the boiler, hence the supply is augmented by cold water under pressure through the balanced, automatic valve, 4, which is controlled by the float, 5, maintaining a nearly constant supply of water in the receiver. A vent pipe, 6, allows steam from the hot water to escape from the receiver, thereby preventing pressure from accumulating, but the cold water discharges into this pipe through a perforated pipe in the tee, and condenses the vapor, thus saving the heat.

The power pump, 7. is driven by a belt from the engine shaft. The suction pipe, 8, receives its supply from the receiver and delivers it through 9 to the boiler. As this pump must run at a constant speed, and as the supply of water must be varied to meet changing conditions, a by-pass valve, 10, is provided, hence, by opening this, a part, or all, of the water may be returned to the suction pipe.

Feeding a Battery

Fig. 2 illustrates the steam end of a pair of duplex steam pumps, used for feeding a battery of six boilers. They are located in a small pit about 10 feet deep without room enough to walk around them.

The supply is received from a horizontal tank, or, receiver, into which the condensate from a large heating system gravitates under atmospheric pressure only. The speed of these pumps is regulated by a float valve, according to the supply of water coming to the receiver. The steam is delivered to the tee, 2, to which is attached the brass oil cup, 3. This is for emergency use only, as a slight feed lubricator discharges oil into the main steam pipe. The steam is distributed in both directions by the tee, 4. Both pumps may be shut down by the globe valves, 5 and 5. Brass unions are shown at 6, 7, 8 and 9, which were provided for the following purpose:

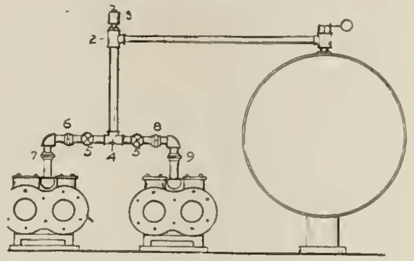


Fig. 2

The steam chests of these pumps are bolted to the tops of the cylinders in the usual way, with sheet packing in the joints. When this packing blows out it must be replaced in a short time, hence when these four unions are disconnected the steam chests can be lifted from their places (so far as these pipes are concerned), and the old packing cleaned off. When the new packing is on, the steam chests and unions are replaced.

Remove Exhaust Pipes

It is necessary, however, to remove the exhaust pipes which are connected into the exhaust chests, as shown in Fig. 3. Flange unions are shown at 2, 3, 4 and 5, and when four bolts are removed from each of them, they can be quickly removed, so that the steam chests can be lifted without touching the upper parts of the flange unions.

This plan called for considerable extra work to instal, but that was done when there was time enough for it. When this packing must be replaced, there is no time to spare.

The angle valves, 6 and 7, are necessary, because the exhaust steam goes into a heating system, hence they must be closed when the pumps are shut down. A long sweep tee is shown at 8. This causes the exhaust steam from each pump to be turned upward into the vertical pipe instead of squarely meeting the exhaust from the other pump, as it would, if a short tee was used.

Attention to such details by the engineer makes all of the difference between smooth operation and less efficient results.

Nipples in Both Ends

Fig. 4 illustrates the water ends of these pumps, also the piping for the same. The suction pipe is laid between the two water cylinders, connecting into a tee at 2. Nipples in both ends of this tee carry angle valves at 3 and 4. Water is discharged through the angle valves, 5 and 6, into the cross, 7. Thence it goes through the vertical check valve, 8, and the gate valve, 9.

An outlet nipple and valve are provided at 10 in order to discharge water to the sewer whenever it becomes necessary to do so.

When one of these pumps has been laid off for packing the pistons, it becomes filled with air, hence by opening 10, this air is disposed of in much less time than it would go through the pet cock that was on the water chest, and the water which comes with this air goes to the sewer, instead of on the floor.

The receiver which forms a part of this system deserves special attention, as it shows an opportunity for much improvement. See Fig. 5.

"Home Made" Receiver

The condensate is discharged at 2, and the suction pipe is connected at 3, hence sediment from pipes in the heating and return systems falls directly in front of the suction pipe, and some of it goes to the pumps. This is a "home made" receiver, as the body was made in a boiler

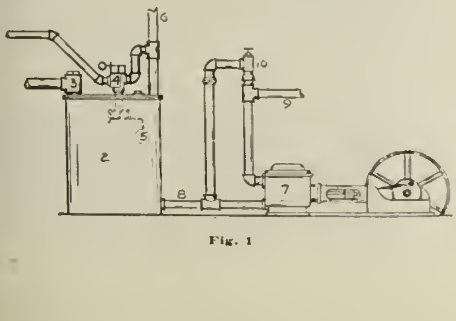


Fig. 1

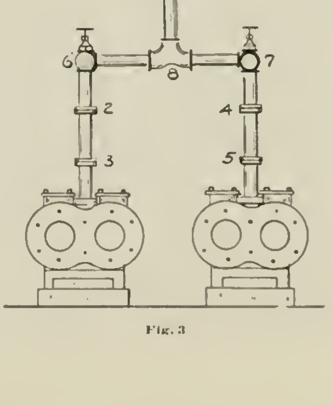


Fig. 3

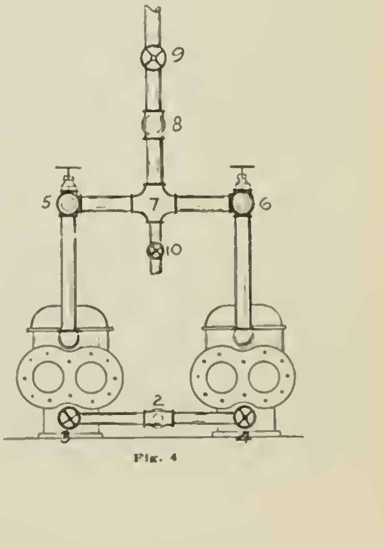


Fig. 4

shop, and the holes were bored with a ratchet drill on the job. It should have been designed with the inlet at one end, and the outlet at the other, thus allowing sediment to collect on the bottom until it could be removed through the manhole, 4.

A blow-off valve was provided at 5. but no pressure is carried on this receiver, hence the sediment could not be blown out, and it soon filled the pipe and rendered it useless until it could be taken out and cleaned. This pipe was removed and the hole plugged. A drip pipe and angle valve was installed at 6, through which the water can be drawn off from the receiver, and it carries a portion of the sediment. It has never been clogged with foreign matter so that it could not be used. The automatic balanced valve, 7, controls the speed of these pumps, according to the amount of water coming to the receiver as before mentioned.

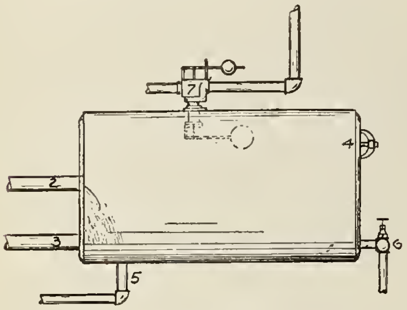


Fig. 5

Letters patent have been issued incorporating the Pemaco Oil, Limited, Moose Jaw, Sask. Capital $300,000.

The Hydro Electric Power Commission are preparing to commence work on the construction of the two new electrical power units which are to be installed at Cameron Falls, Ont.

The Minister of Public Works, Winnipeg, Man., has been receiving tenders for stokers for water tube boilers at power house, Hospital for Mental Diseases, Selkirk, Man.

The Provincial Department of Telegraphs and Telephones, Victoria, B. C., are receiving tenders for a telephone exchange building estimated to cost $10,000. Plans and specifications are with the superintendent of the department.

The consolidation of the Schaeffer & Budenberg Manufacturing Co., and American Steam Gauge & Valve Manufacturing Co., was effected a year ago. Announcement is now made that hereafter these companies will be known as American Schaeffer & Budenberg Corporation. This corporation manufactures a complete line of valves and instruments for indicating, regulating and controlling pressures, temperatures and speeds.

Watson Stands Pat on Superheat Views

Author of "Easy Lessons in Engineering" Glad to Receive Criticisms, but Insists His Objections Are Real

A LETTER of criticism has been received regarding M. Barry Watson's article on the "Use of Superheat" in the August 20th issue of Power House, and since the information given may be of interest to many readers of Power House, part of the article to which exception has been taken, follows:

"Another type of superheater consists of a number of close bent tubes, one of which is illustrated. The two ends of each bend connect to headers in the smoke box, while each bend extends into one of the fire tubes of a fire tube boiler. This type is extensively used in locomotive practice. Its chief objections are the extra resistance to the draft, and the fact that the superheaters must be removed when the tubes are to be cleaned."

The criticism reads as follows:—

"In this connection it has been our experience that it is not necessary to remove the superheaters in order to clean the large and small tubes. We are quite safe in saying, that with something like 40,000 locomotves on this continent using fire-tube superheaters, if it was necessary to remove the units in order to clean the flues, the fire-tube superheater would have been a dead issue years ago, owing to the cost and delay of such removals.

"The cleaning of large flues in which the units test is very easily carried out in the roundhouse, by a ¼ in. or ⅜ in. iron pipe connected to an air supply. All that is necessary is systematic and regular cleaning. If this is neglected, the use of a rod to punch out the accumulation of cinders, becomes necessary, but the fact that such a large number of locomotives are in regular daily service, equipped with this type of superheater, is in itself evidence that there is no need of removing the units to clean the flues.

"The same thing applies to marine practice, in which there are some thousands of fire-tube superheaters in regular service.

"As regards the effect on the draft, the diameter of the large flues, as well as that of the unit pipes, is carefully proportioned, so that there is no material effect on the draft."

Mr. Watson is not a locomotive engineer, but from his experience with fire-tube boilers as a stationary engineer, he cannot apply the above criticism to stationary practice, for with certain types of coal, especially when using natural draft and small loads, the soot and ash dust sometimes stick to the inside of the fire-tubes so tightly that no matter how often the flues may be blown through it is necessary to have them thoroughly cleaned at comparatively short intervals with some type of mechanical cleaner. This cleaning would necessitate the removal of the type of superheater mentioned.

In the case of the locomotive, it is quite likely that the trouble experienced with dirty flues in a stationary boiler is less serious on account of the very intense draft induced in a locomotive furnace at quite frequent intervals, which gives a sufficiently high velocity of the gases through the flues to carry away most of the soot and cinders which may have settled on the tube surfaces under light load conditions.

For the same reason the draft in a locomotive boiler would be much less obstructed than in a natural draft stationary boiler by the presence of this superheater because such intense draft is induced by the exhaust steam that there is always plenty of draft for the fire.

In respect to the proportioning of the tubes to prevent interference with draft, this would of course only apply to new boilers designed for superheaters, as the sizes of the fire-tubes in an old boiler would not be changed if it were decided to install a superheater.

Mr. Watson still maintains, therefore, that the objections he mentioned are real objections, though under certain conditions they may become negligible, and it is always the best compromise of advantages and disadvantages which determines the choice in the matter and to make the best choice even minor disadvantages should not be overlooked.

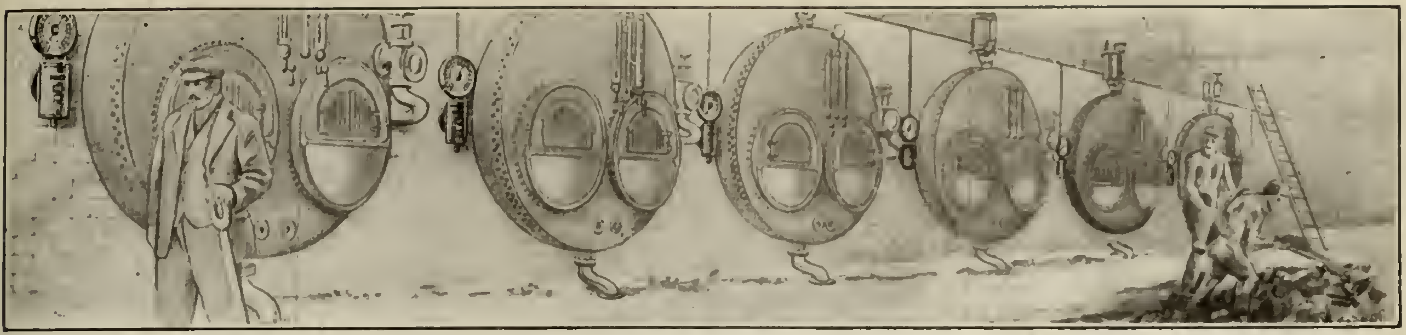
Mr. Watson was very glad to receive this criticism, and will be pleased at any time to receive criticisms or to hear of differences of opinion on any of the topics discussed in this series of lessons.

The Schofield Woollen Co. Ltd., Oshawa, Ont., are the owners of a power house being constructed at Oshawa.

The Municipal Electric light and power plant at Melville, Sask., was gutted by fire on September 2, causing a loss estimated at $100,000.

Tenders have been received by James McDole, secretary-treasurer, Elgin, Mich., for the contract of equipping the Elgin Consolidated school, Elgin, Man., with hot air plant.

Tenders are being received by Morrow & Beatty, general contractors of North Temiskaming, Que., for reinforced steel in connection with the hydro power development at North Temiskaming, Quebec.



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.
Director of Engineering, Central Technical School, Toronto.

WET STEAM

SATURATED steam always contains more or less moisture in the form of minute drops of water suspended in the steam, much in the same way that small particles of water are suspended in the atmosphere during a fog, although there is seldom sufficient moisture in steam to make it visible like a fog.

The reasons for this water content of the steam are two in number. First, the steam in the boiler is formed on the heating surfaces, which are always below the water line. Thus the steam is formed as bubbles in the heating surface, which as they become large enough detach themselves from the surfaces where they are formed, float to the top of the water, where, as each bubble bursts, a fine spray of water is thrown off in all directions.

Most of this spray settles back to the surface of the water, or collects on the sides of the boiler shell where it drips down; the smallest particles, however, remain suspended in the steam, forming what we call "wet saturated steam."

Even if we should have perfectly dry saturated steam leaving the boiler, there is always a loss of heat from this steam through the headers and piping, on its way to the engines, no matter how well insulated they may be, though, of course, the better they are insulated, the smaller the loss of heat.

This loss of heat causes condensation of part of the steam, thus introducing moisture and causing wet steam to be supplied to the engines, etc.

The Quality of Steam

When we speak of the quality of steam we are referring to a method of expressing the proportion of moisture in the steam. This moisture is commonly called priming. It may be expressed in either of the following ways: First, as a percentage of the moisture in the steam. Thus suppose that in 100 pounds of wet steam, which is really a mixture of steam and water, we find there is two pounds of water. The steam may, in this case, be said to contain two per cent. moisture, or two per cent. of priming, or be two per cent. wet.

Secondly, as a percentage of dryness, thus, the above mentioned steam obviously contains 98 lbs. of dry steam in 100 lbs. of the mixture, and it may be said to have a quality of ninety-eight per cent., or to be 98 per cent. dry, or it may be stated that the quality is 0.98.

Quality Not Constant

In the majority of boiler plants the quality of the steam generated varies within large limits from time to time, as a result of various combinations of conditions of which the following are a few examples:

The inherently local nature of the generation and use of steam power prevents it from becoming a commodity. The contrary is true in regard to electric power. The characteristic of electric power constituting it a true commodity, the fact that it can be generated in bulk and sold at retail, the ease and flexibility of its transmission to a distance from its point of generation by means which can be extended at will, make natural the centralization of its generation.

When a boiler is carrying a heavy load, there is more steam being liberated from the surface of the water than when the load is light, thus there is bound to be more splashing and more moisture in the steam. Also the time between the liberation of the steam from the water and its entrance to the delivery nozzle is much shorter than when a light load is being carried.

In this way the small drops of water do not get as much time to settle out of the steam, and more and larger drops are carried into the steam header with the steam, because the velocity of the steam leaving the boiler is so much higher.

From the above reasons alone it is quite evident that at large loads, especially at a much above rated load, the priming will be greater.

When a boiler is nearly full of water, the surface where the bubbles burst is much closer to the steam outlet than when the water is low, thus more of the splash caused by the bursting of the bubbles will reach the steam outlet, and will be carried along by the current of steam.

In the case of horizontal cylindrical boiler shells where the normal water level is about the centre line, it is obvious that as the water rises higher its top surface becomes smaller in area, thus causing more agitation and splash for the same amount of steam generated. In this way it is clear that low water will give drier steam than high water.

Effect of Load

When no load is being carried by a boiler under steam, the water lies quietly at the bottom and any steam that is required to make up for condensation on the boiler top evaporates quietly off the surface of the water.

When, however, a load is being carried the greater part of the steam is formed under water on the heating surfaces and the space below the water line will be partly filled with water and partly with bubbles of steam.

It can therefore be seen that if the quantity of water in the boiler remains the same, the level of its top surface will be higher when carrying heavy loads. This effect is more noticeable the bigger and the more sudden the load, and it explains why the water level seems to rise in the gauge glass as soon as a sudden large load is put on a boiler.

In the control of feed water to a boiler it is usual to endeavor to keep constant fire conditions by supplying water when a small load is being carried and vice-versa.

This is, of course, fuel economy and makes available for peak loads of short duration the maximum boiler capacity, but if carried too far may cause trouble through priming.

Suppose that all load is suddenly shut off a boiler when showing half a glass of water. The water settles down and appears to lower its level perhaps to three-eighths of a glass. If now the pumps are speeded up until the boiler is showing, say, three-quarters of a glass or more, the fire can be kept pretty hot, ready for the next load, the excess heat being used to heat up the fresh water instead of to make steam.

Suppose now that a big load is suddenly thrown on the boiler, the level of the water will rise to near the top of the glass, and the combination of large load, high water, cool piping, etc., gives the most favorable conditions for heavy priming. This is especially so in horizontal cylindrical boilers.

Preventing Priming

Most of the cylindrical boilers built previous to the last quarter century had as an integral part a steam dome, the shape and position of which is familiar to all engineers, for the purpose of allowing the steam to be collected as far as possible from the surface of the water, where it is likely to contain least moisture.

Steam domes always constituted a weak point in boiler shell construction, and modern boilers do not have steam domes, in fact they are not permissible in many districts.

To cut down the amount of priming, leaving a modern boiler with the steam, a "dry pipe" is almost universally used. This consists of a horizontal pipe suspended below and attached to the main outlet nozzle of the boiler, capped at its end but perforated with numerous holes or slots along its top side for the admission of steam. Drops of water do not, therefore, splash directly into the flow of steam to the nozzle. Apart from the dry pipe the only piece of apparatus used in connection with the boiler to insure dry steam is the superheater which adds more than sufficient heat to the steam, after it has been removed from the boiler proper, to evaporate any moisture it may contain.

The superheater always, as a matter of fact, adds so much heat that there is still some to spare before the steam starts to condense.

To insure a supply of comparatively dry steam to engines and other apparatus, where superheat is not used, separators are made use of on the steam pipe feeding the apparatus, with the object of separating most of the moisture from the steam. Obviously the separators should be placed as close to the engine as possible to prevent much loss of heat through the walls of the pipe and the formation of more priming before the steam arrives at the engine.

Apart from the above, the obvious means to prevent priming are in the hands of the engineer in charge, namely, do not keep the water level higher than necessary, especially when handling big loads, and keep all steam headers and pipes as well insulated as possible.

Objections to Priming

Some of the evil results of excessive priming are so well known to engineers in general as to require no comment here. The chief disadvantage is, of course, the lowering of the efficiency of the engines through admitting water into the cylinder, thus increasing the water rate.

Also the danger of serious accident, such as blowing off a cylinder head, or breaking a piston or cross-head through water in the cylinder. There is also a direct loss in the heat carried from the boiler to the exhaust by the water.

Priming and Foaming

Some young engineers confuse priming and foaming. Such men probably have never really seen a boiler foaming, or else see it so constantly that they do not realize the difference.

They are, however, entirely different things, except that when a boiler foams, serious priming is bound to take place.

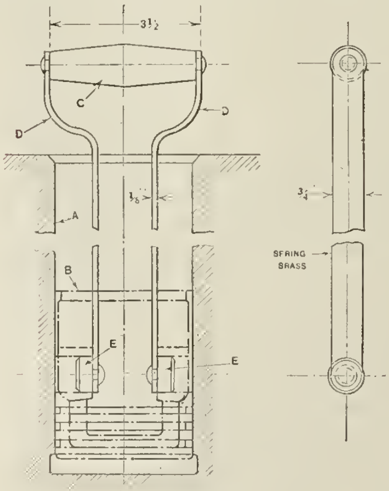
Foaming is caused by impurities in the water, which make the steam bubbles less easy to burst and to break away from the position where they first form. In this way the whole body of the water in the boiler becomes filled with large "bunches" of bubbles which break away and rise to the surface, causing violent churning of the water in the boiler.

At the surface the bubbles may pile up as high as the steam outlet when, of course, the priming will be so excessive as to do some damage.

Foaming always causes violent commotion in the boiler, which can be noticed by rapid changes in the apparent level in the gauge glass. The immediate remedy for foaming is to reduce the load in order that the bubbles may get more time to burst, while fewer of them will be made. The more permanent remedy is to blow down the boiler and fill it with clean, fresh water, thus reducing the viscosity and adhesive qualities of the boiler water so that the bubbles will burst easily.

PISTON FITTING TONGS

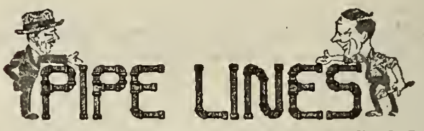
The tongs shown in the accompanying illustration are designed to facilitate sliding a piston up and down in a cylinder block when fitting the piston to the cylinder bore. The cylinder bore is shown in section at A, while the piston is represented by dot-and-dash lines at B.



Tongs for Fitting Pistons.

The tongs are made up of a handle C and two straps D made of spring brass. To the end of each of the spring strips is riveted a small plug E. These plugs are made about 0.005 inch smaller than the wrist pin hole so they can be easily inserted.

In attaching the tongs to the piston, it is only necessary to press the two straps together, insert the ends in the piston, and then allow the straps to spring back so that the plugs E will enter the wrist-pin holes. — FRANK OWEN.



PIPE LINES

UNCOVERED IN ANY OLD SPOT

The starting torque of an induction motor varies as to the square of the voltage at its stator terminal, that is, if the voltage is reduced by two, the starting torque will be decreased by four.

* * *

Have you ever noticed that about the time you grow chesty and hold your head high, you step on a banana peel you accidentally dropped?

* * *

Unbalanced voltages on a circuit supplying an induction motor may cause the machine to operate at a high temperature, even when only partly loaded, due to the motor acting on a voltage balancer.

* * *

A young fireman living in Rome
Got muddled up in his dome;
He had the right key
In the keyhole, you see,
But the keyhole was in the wrong home.

* * *

The full-load speed of an induction motor will be about 2 per cent. in large machines and about 10 per cent. in small sized machines lower than the theoretical speed.

* * *

Now don't get rings beneath your eyes
When you're supposed to advertise,
Just shout your business to the skies
And keep agoin'.

* * *

In an armature which is series, or wave wound, there will be a burnt spot on the commutator for every pair of poles, that is, if the machine has four poles there will be two burnt spots; if six poles three burnt spots, etc. Connecting the segments together across either one of the burnt spots (not both) will remedy the trouble.

* * *

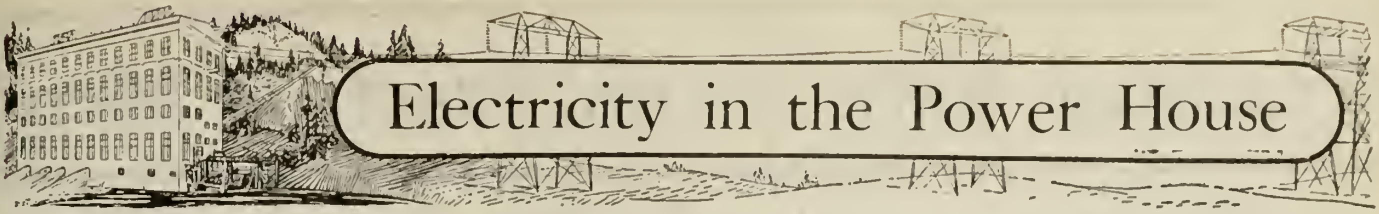
The man who is looking for something soft, can usually find it under his hat.

* * *

The speed of a synchronous motor is equal to 120 times the circuit frequency divided by the number of poles.

* * *

One thing can be said for wood alcohol —no one ever inherited a taste for it.



Electricity in the Power House

By J. A. BURNETT, M.E.I.C., Consulting Engineer, 205 St. James St., Montreal.

THE SYNCHRONOUS MOTOR

THE synchronous motor is now receiving special attention from manufacturing companies and it is satisfactory to note that the starting conditions have been simplified, no manipulation of switches being required.

This equipment is now almost as simple as the induction motor. Recently there have been installed in Ottawa two 200 h. p., synchronous motors, 164 r. p. m., direct connected to refrigeration compressors.

These are self-starting with auto-transformer taps at 80 per cent. line voltage. The starting rush of current is said to be 150 per cent. of full load, and time to accelerate and attain full speed, 50 seconds.

In case a synchronous motor is installed of a certain rating, for power factor correction, this equipment will simultaneously deliver about 50 per cent. in mechanical load, at a trifling additional loss as compared with an induction motor.

Driving Line Shafting

The synchronous motor may be used to drive line shafting when the starting torque required does not exceed, say, 50 per cent. of the normal rating of the motor. The synchronous motor may also be used to drive centrifugal pumps or fans when the pull in torque demanded near synchronous speed does not exceed approximately 40 per cent. of the normal rating of the motor, and use is made of a suitable low resistance squirrel cage winding, which decreases the starting current and increases the pull-in torque.

The synchronous motor is especially adapted for the direct drive of low speed air compressors, since these generally require about 50 per cent. of normal torque for breaking from rest and there is seldom difficulty experienced in pull-in torque requirements. Further, an induction motor for such low speed has a very low power factor.

The cost of the synchronous motor is considerably in excess of the induction motor, however. It is usually installed in a plant in order to raise the plant power factor to contract requirements.

Typical Connections

The diagram shows typical connections for this type of motor, with self-starting features.

As regards the operating features of this type of equipment, it may be noted that it is mostly a case of "built right—run right."

The exciter is usually furnished by the manufacturer, direct connected, making a very compact unit.

For example, a 75 h.p. synchronous motor recently installed by the writer was run at 1,200 r.p.m. and was provided with a 2½ k.w. exciter.

The self-starting feature is usually due to the fact that the current is applied to the stator (field). The motor is permanently connected to the exciter armature, which provides the slight external resistance necessary to give the rotor the desired starting torque.

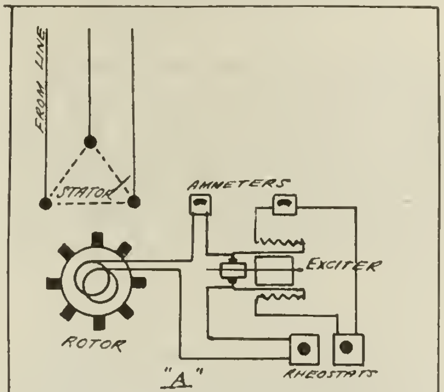


DIAGRAM OF CONNECTIONS FOR SELF STARTING SYNCHRONOUS MOTOR

The amount of excitation required is usually 3 per cent. of synchronous motor rating, and while the exciter is a comparatively small unit by itself, it is of great importance to select a well designed and well made exciter.

The temperature of any part of the machine should never exceed 90 deg. Centigrade. This is the absolute "dead line." In case this temperature is exceeded the insulation will deteriorate rapidly and the life of the machine will be shortened.

In case a machine shows signs of distress due to overload, the application of an ordinary 12 in. electric desk fan, at one end of the rotor or stator, will send a current of comparatively cool air through the machine, giving the desired relief.

A few spare stator (armature) coils should be kept on hand so that there will be no undue delay in making replacements—in case of breakdown due to lighting or overload.

The mechanical drives may be direct connected; belting; chain or spur gearing. In case direct connection is used, it is well to ascertain if the mechanical load is not excessive at time of starting, in which case a clutch cut-off coupling may be necessary to ease off at starting.

In This Issue

Editorial Point of View 19
By Campbell Bradshaw

High Vacuum Aids Efficiency 20
By F. Johnstone Taylor

Vacuum Heating Savings 23
Actual Tests by J. E. Seiter

Lignite Char as Fuel 24
Carbonizing Oven Tests by Ottawa

C.A.S.E. Notes 24

Piping in the Boiler Room 25
Methods of Simplifying Repairs

Superheat Views Criticized 26
Watson Insists Objections Are Real

The Quality of Steam 27
By M. Barry Watson, B.A Sc., M.E.

Pipe Lines 28
Piston Fitting Tongs

The Synchronous Motor 29
By J. A. Burnett, M.E.I.C.

Practical Ideas 30
Wall Coils
Voltage Regulator Trouble
A Simple Boiler Feeder
Straightening Line Shaft
Frozen Brine Cooler
Two Motors on Load
Branches Under Floor
Hunting Refrigeration Trouble

Problems with Answers 33
Oil Press
Loose Pulley Heats
Gas Engine Compression
Lining Up Corliss Engine
Preventing Scale
Boiler Bridge Wall
Engine Pounding
Motors in Step
Water Jacket Scale
Cushioning Pump

Comments of Engineers 36
Brown Denies Injustice
Text Book Data
John Quinlin "On The Job"

New Equipment 40
Ljunstrom Air Preheater

Plans are being prepared for power development at Hemmings Falls, Que., for the Southern Canada Power Co., 20 St. Nicholas St., Montreal. Bids will be asked during September.

The following contracts have been awarded in connection with the $11,750 boiler house being erected for the Royal Alexandra Hospital, Edmonton. Heating, Standard Plumbing & Heating Co.; electric, Carey Electric Co.; both Edmonton firms.

Work on the power development plant at St. Albans, Que., is going forward, and the owners, La. Cie Hydrolique de Portneuf, are in the market for two generators, 2,000 K.W. motor and turbine. The general contractors are the Estru & Conradi Construction Co., St. Catharines, Ont.

Practical Ideas From Practical Men

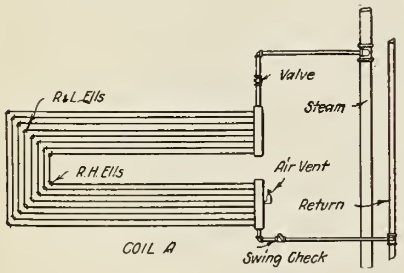
WALL COILS

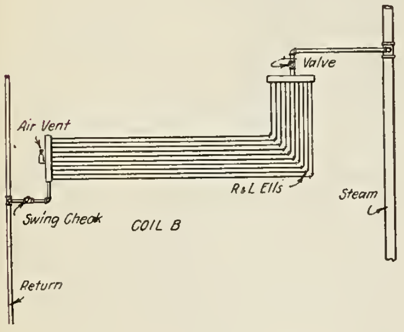
THE engineer is often called upon to increase the radiation in sections of a plant and in this connection there is an infinite variety of methods of piping wall coils. The object to be attained, of course, is free and unrestricted heating of the entire surface, and the freedom of the coil to expand and contract without strain.

Figs. 1, 2, 3 and 4 show two-size steam coils, on a low-pressure gravity system, having a control valve on the inlet side of each set, and a check valve and air vent at each return.

Coil "A," shown in Fig. 1, is a "U" shaped miter coil. This design is good where there is a minimum of wall length, and a large amount of height, and is of advantage where it is desired to keep the supply and return risers together.

Coil "B," in Fig. 2, is an ordinary "L" shaped miter coil, having supply riser at one end, and the return riser at the opposite end.





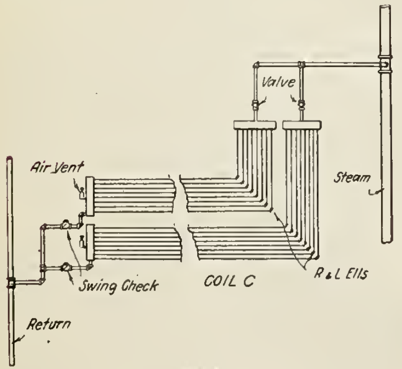
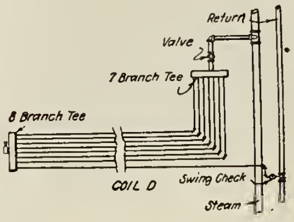


Fig. 3

Coil "C" in Fig. 3 is a double "L" shaped miter coil with supply and return risers at opposite ends. This grouping is good where close control in individual units is desired, it being supplied with two sets of control valves, and two sets of check valves and air vents.

Coil "D" in Fig. 4 has the supply and return risers together, and is of interest because of the manner in which the return is run; it is the lower pipe of the coil, pitching opposite to the coil, and the unit made up with a seven-branch tee at the supply end, and an eight-branch tee at the return end.



In all coils, the standard method of connecting the check valve four or five inches below the return of each coil is followed. This leaves a head of water, to help in opening the swing check.

VOLTAGE REGULATOR TROUBLE

The automatic voltage regulator for alternating generators is usually somewhat puzzling to the power plant engineer, especially if it is new to him. Recently, a regulator was added to an industrial power house to regulate the voltage of two 1,500-kw. generators, the regulator controlling one of two 75-kw. exciters. It was found desirable to have a regulator on account of the fluctuating nature of the load and to prevent disturbance on a tie line connecting the station with a larger industrial power plant.

The behaviour of the regulator was somewhat erratic. For a time it would function perfectly and then apparently would suddenly go wrong and the generator would drop its load and the tie-line switch between stations would kick out before the generator could be cleared from the line.

It was found that this condition usually occurred when the generator was running near full load, or when the load was shifted from one generator to the other preparatory to shutting down one of the generators. A careful check of the connections and adjustments of the regulator indicated that the trouble was not in the regulator itself. As the characteristics of the generators were standard, possibility of trouble from that source was dismissed.

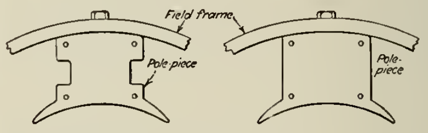
Attention was then centered on the exciters, which were furnished originally with overcompounded fields and whose maximum voltage was 150 at full load. In order to adapt the exciters to the regulator, it had previously been necessary to change the compounding shunt of the machines so as to give a slightly drooping characteristic to the voltage curve of the exciters. This was necessary since an overcompounded exciter will not allow a regulator to function to properly control the voltage of the system.

This change cut down the maximum voltage of the exciter to 130. It was necessary to leave some of the main field rheostat of the alternators cut in the field circuit in order to regulate the distribution of wattless current between generators, consequently it will be seen that some of the 130 volts remaining would be lost in this rheostat.

By cutting the regulator out of circuit for a few days and restoring the overcompounding of the exciter, it was found that a maximum of 140 volts was required with the main-generator field rheostat set in the position determined for proper operation in connection with the regulator.

Referred to Manufacturer

As the exciters were of the same make as the automatic regulator, the data secured from the foregoing tests were referred to the manufacturer to secure a remedy for the trouble, as apparently nothing further could be done by the operators. The manufacturers supplied new polepieces, Fig. 2, for each exciter to replace those which were originally installed and which, when the machines were dismantled, were found to have a reduced cross-section at one point. The new polepieces therefore allowed a lower reluctance in the magnetic circuit, giving a greater amount of magnetic flux with the same shunt winding. The exciters, after being fitted with the new polepieces, gave about 155 volts at no load and about 145 volts at full load when operating as a shunt machine. The regulator and the various rheostats were adjusted with the new voltage characteristics of the exciters and have given satisfactory regulation and no trouble has been experienced since the higher voltage has been available from the exciters.



The cause of the generator dropping its load under the conditions described, was evidently due to some sudden increase of load either from starting a large motor or a decrease in voltage of the main generating station. This increase of load, coming on when practically the maximum field current available existed in the generator field, caused a sufficient demagnetization of the generator field to lower the voltage of the motor driving the exciter, which in turn, by a reduction in speed further lowered the exciter voltage.

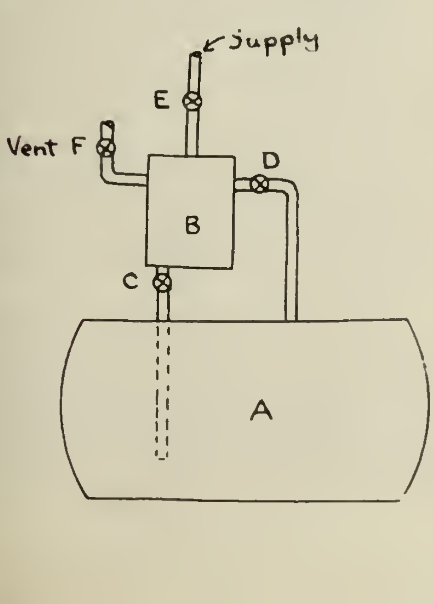
This condition acting cumulatively would quickly drop the station voltage to zero after the field of the generator was reduced to an unstable point with respect to its load. When the exciter has a sufficient surplus of voltage to increase the alternator's field current, any sudden demagnetization of the generator field, due to increase of load, is counteracted and equilibrium is obtained under almost any condition whether operating as an isolated station or tied up in with other stations. To illustrate this effect with the voltage regulator cut out, a 200-hp. motor driving an air compressor was started, the generator carrying 1,200 kw. on an isolated system. Without changing the field rheostat setting, the voltage dropped from 2,200 to 1,400. When the voltage reached 1,400, if the exciter voltage was not raised, that of the generator dropped from the 1,400 point to zero. The generator speed variation was less than 1 per cent. during the tests, therefore it could not have been in any way responsible for the drop in voltage.—TORONTO HYDRO ENGINEER.

A SIMPLE BOILER FEEDER

The figure herewith shows how water can be fed into a boiler under pressure without the use of an injector or pump of any kind.

"A" is the boiler that is to be fed with water. "B" is a tank or vessel capable of withstanding as high steam pressure as the boiler itself.

Close valves "C" and "D" and open valve "E" and vent "F" so that tank "B" will fill with water through the supply pipe. Then close valves "E" and "F" and open valves "C" and "D." Steam will enter "B" through the valve "D" and the water from "B" will flow downward through "C" due to gravity, because the vessel "B" is now nothing more or less than a part of "A" and since water naturally seeks its level in pressure vessels, as well as in the open atmosphere, it will flow downward, "B" will empty, and the water level in "A" will be raised. After "B" is empty, close "C" and "D" again, and open "E" and "F" and repeat the above process.

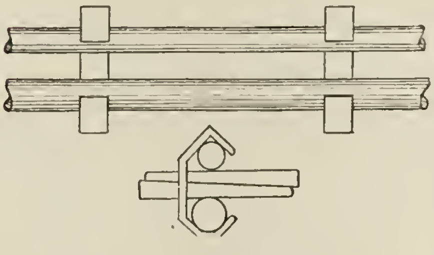


The writer is informed that a boiler-feeding device of this kind is now on the market, and that it is proving to be a success on large as well as small boilers. Its simplicity should certainly attract attention.

It is well to note in this connection, however, that some steam is required to do this work. When all of the water is emptied out of "B," that vessel is full of steam, hence the volume of steam used is equal to the volume of water fed into the boiler. It is, therefore, a simple matter to compute the amount of steam required to feed a given quantity of water into a boiler with this apparatus.—W. F. SCHAPHORST, M. E.

STRAIGHTENING LINE SHAFT

In every factory where line shafting is employed for the transmission of power it is quite common for a length of shafting to become buckled, due to bad alignment or to hot bearings. If bad alignment is the cause, it is obvious that when re-erecting the shaft after straightening, care must be taken, by adjusting the hangers, to ensure that the alignment is made perfect.



Fixture for Straightening Line Shaft.

A simple straightener which the writer has tried out is shown in the illustration. It is necessary to take the shaft down and if there is a lathe with a bed sufficiently long it should be set between the centres. If this is not possible a couple of Vee blocks resting on the floor will serve the purpose, although they are not as convenient because of the difficulty of rotating the shaft, which is necessary in order to locate the high places. It is advisable to screw a steady to the floor on which the hand can rest while holding a piece of chalk.

The straightening device consists of two forged steel pieces two to three inches wide. These hooks are suspended from the line shaft, the bend being downwards. On the bottom hooks a piece of straight shafting of larger diameter than the shaft being straightened is placed, or, for preference, a short length of carbon steel may be used. Folding wedges are now driven between the two shafts. A single wedge may be used but it will be inclined to slip back. It is necessary to make the shaft convex on the top side to secure a permanent set. While in tension the shaft must be struck several times with a hammer on the top side. The operation may have to be repeated several times before the flaw is eliminated.—J. McLACHLAN.

FROZEN BRINE COOLER

Some time ago in a small plant where a 10-ton refrigerating machine was used to carry a freezer, the brine cooler froze up. Sodium chloride, which has a fairly high freezing temperature, was used for brine instead of calcium chloride. The engineer asked me to come around, and on arriving I found that the centrifugal brine pump was frozen up and would not work.

I immediately turned on the condensing water and started the compressor turning over slowly. When the regulating or expansion valve was opened, the ammonia liquid flowed into the coil much faster than the compressor could remove the vapor, and as a result the coil pressure and boiling temperature rose.

The warm liquid ammonia from the receiver immediately thawed out the coils without damage, and the brine pump could be started. Although the pump was handling a rather bulky solution of ice crystals and salt solution, it was able to keep up the circulation. I suggested the use of 24 per cent. calcium chloride solution, which has a freezing temperature of —17 deg. Fahr.

The engineer could not understand how it was possible to thaw out the brine by running the compressor. I explained to him that the hot ammonia liquid from the receiver entered the shell cooler at about 80 deg. Fahr., and, being much hotter than the brine, of course warmed the latter until the solution was in condition to be handled by the pump.—GEORGE LEA, Hamilton, Ont.

TWO MOTORS ON LOAD

Two similar direct-current motors may be successfully operated in parallel to drive the same load from a single controller, provided their pulley or gear reductions are such as to drive the load at the same speed.

In special cases where a motor of proper voltage rating has been unavailable, two motors of half the line voltage rating have been connected in series and operated from a single controller, as if they were a single motor of proper voltage rating. Where motors are to be operated in series, it is necessary to connect them to the same load, otherwise their speeds will be unstable and one of the motors may even stop. This will cause full-line voltage to be applied across the running motor, which will attain a dangerous speed.

With squirrel-cage-type alternating-current motors, aside from the motor ratings and speed requirements, no special precautions need be observed when it is purposed to operate two motors from the same compensator, especially if the motors are to drive the same mechanical load. When they drive different mechanical loads, the motors may be started one at a time. In some cases a number of motor connections have been arranged to start each motor individually from the same compensator. In this case a double-pole switch is used to connect the motor to the compensator for starting, and after it has been brought up to speed the switch is thrown over to connect the motor directly to the line. Where slip-ring motors are to be applied to the same load and operated from the same controller, there arises a condition that must be observed, otherwise the blowing of fuses may render operation entirely impracticable.

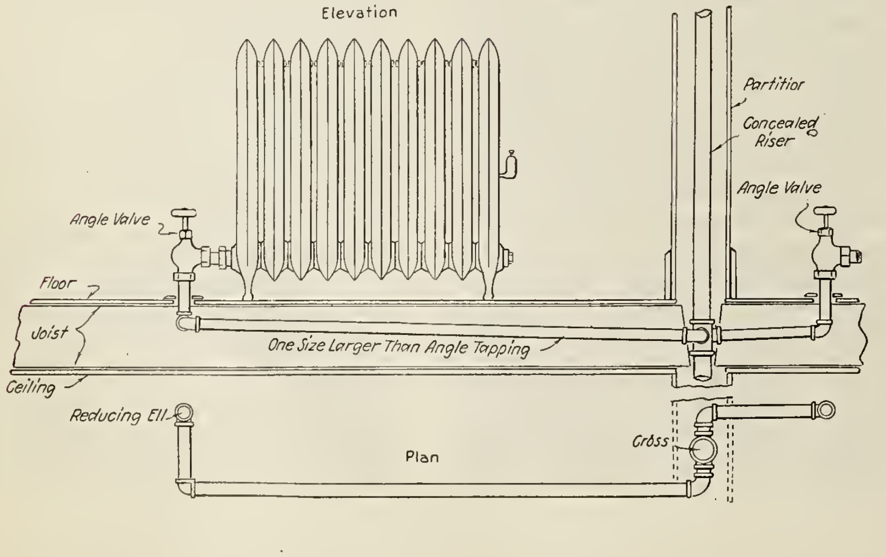
Since each rotor generates a voltage, they are similar to two alternating-current generators and must be treated as such when connected in parallel. The rotors will have to be phased out and connected together, in the same way that two alternators must be when the proper rotor positions have been located, they must be permanently connected together mechanically, otherwise they may get out of phase during starting and will produce a condition similar to connecting two alternators in parallel out of phase.

Heavy currents, could circulate between the two rotors without going through the starting resistance. Unless it is necessary, it will be found a good practice not to try starting two such motors in parallel from the same controller, since they will require careful adjustments for satisfactory starting.

A. R. K.

BRANCHES UNDER FLOOR

There is shown in the drawing an elevation and a plan view of a riser for a one pipe steam job, having two connections. Provision is made, by placing the cross longitudinally with the partition, for expansion of the riser. This is necessary if the riser serves a building over three stories high; one of three stories or less may omit the provision for vertical movement of the riser from the radiator supply branches, and take care of the small movement in the branch from the main in the basement.



But the method shown in the drawing is very good practice on any concealed riser job.

If there is likely to be considerable movement of the riser, connection may be made to the farthest end of the radiator, as shown at the left, and the branch given a good pitch and increased one size, making reduction at a reducing elbow at the base of the "stub" immediately below the angle valve. If there is but little or no movement of the riser, the branch may be short, connected to the nearest side of the radiator as shown at the right, and the branch may be of the same size as the angle valve it supplies.

If it should happen that there is an excess amount of radiation which would tend to condense a large amount of steam in the radiator, the top connections sometimes cause a large amount of condensation to collect in the bottom of the radiator, which would in severe climates at low temperatures cause the condensation to freeze.

Using the steam type radiator with bottom connection prevents this.

HUNTING TROUBLE

The writer recently took part in a trouble hunt which illustrates the well-known fact that the simplest things are often the easiest to overlook.

The trouble was in a small brine system, two units of which were not producing satisfactory results. The plant was not a new one but had been in use for several years and up to a few months ago gave good service.

There was nothing unusual about the layout, a machine and brine tank in basement, brine circulated by centrifugal pump directly connected to 1,200 r.p.m. motor, 2½ in. suction, 2 in. discharge.

There were four cooling rooms or boxes in this system, three of which were on the first floor and one on the second floor. Two of the boxes on the first floor were small and were located close to the brine pump. These boxes worked nicely. The other box on the first floor was a fairly large box and located about 100 feet or more from the brine pump. The box on the second floor was the same size and located directly above the large box on the first floor.

Simplified Piping

The suction line to the brine pump connected directly into the end of the tank, about 3 inches from bottom. It was a straight run without obstructions of any kind except a gate valve. The discharge went straight up from pump to ceiling of basement, about 8 feet, where it was split by a bull-headed 1 in. x 1½ in. x 2 in. tee. The one-inch line ran straight out about 10 feet, where it was split by a bull-headed ¾ in. x ¾ in. x 1 in. tee. Each of the ¾ in. lines ran to one of the small boxes. The 1½ in. line ran back to the large boxes and in the 100 feet of pipe there were 10 elbows. The line could have been put in with 6, but 10 were used. The line went up into the large box on the first floor where there was a 1½ in. x 1 in. x 1 in. running tee. Our one-inch line went up to a box on the second floor, the other feeding the coils in box.

The return line was practically a duplicate of the feed line, except that it entered the other end of the tank about 6 inches below the top of the tank.

The arrangement of the coils in the boxes were the same in each box. There were two stacks of coils, one on each side near the top of the room. All were made from 1¼ in. pipe, using 6 in. centre return bends. The feed supply entered at the bottom and circulating up through the coil on one side of the room then crossed over and went down through coil on other side and out through return line through floor. The feed and return were the same size, ¾ in. on the small boxes, 1 in. on the large boxes.

Hunting the Trouble

The complaint was that the box on the second floor would not frost and that the first floor box would not get cold, although the pipes would frost. When the complaint was first made the brine tank had been refilled and the brine level was above the return discharge. Thinking that the trouble was caused by the higher coils air locking, they were advised to remove enough brine to clear the discharge.

It was not convenient to do this for a time and as nature helped out with some zero weather the trouble was allowed to ride for a while. When the discharge was cleared there was no improvement, however, and the trouble had to be located elsewhere. The amount of brine returning to the tank seemed very small and when the feed valves on the two small boxes were closed it almost stopped. This seemed to indicate a stoppage in the brine line serving the two large boxes.

There was a union just above the feed valve in the large box on the first floor. On disconnecting this it was found that the feed valve could be opened wide yet the brine only flowed over the top of the pipe, no pressure at all. When the feed valves on the two small boxes were closed it made no difference. The brine

(Turn to page 39)

Every-day Problems With Answers

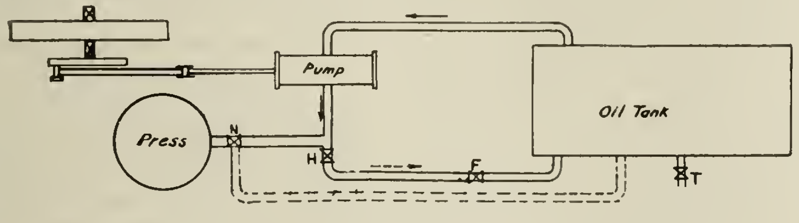
Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

OIL PRESS

THE accompanying sketch shows a power operated oil press, which for some reason or other fails to operate.

The method tried so far is to first fill the tank with oil, then turn on the air pressure and force the oil into the pump. After the ram has moved up to the work the air supply to the tank is shut off by means of the three way cock T and the air pressure relieved from the tank. The pump is then started to obtain the required pressure on the ram, but so far it has not been possible to obtain any pressure by the pump. The system works only with the air pressure on the oil tank.

At present there are no check valves in any of the lines. Would it help any if check valves were placed on the suction and the discharge sides of the pump? Is there any cause other than a leak in the pump which would cause the failure to operate?—B. HAWKINS, Hornepayne, Ont.



Answer:—If the sketch you send is complete, the failure of the pump to operate the ram is quite evident. You do not mention in your letter anything in regard to the globe valve F on the overflow line from the press. Assume that the valve F is open and the pump started. There will be a clear passage for the oil from the pump to flow back directly into the oil tank as shown by the dotted arrows; no pressure then could be produced in the pipe line leading to the press. If the valve F is closed, then, provided the pump is in working order, pressure will build up on the ram, but it might be disastrous to the pump since there is no provision to relieve the pressure. The pump would last about one stroke if the valve F was closed, because the eccentric or the cylinder would give way.

Pressure will build up in the whole system with air pressure on the oil tank regardless of whether the valve F is open or closed. This explains the working with the air and the failure of the pump.

To make the system work, a relief valve should be placed in the overflow line at H or in place of the globe valve F, and set to the pressure required on the ram. Pressure will then build up on the ram and any oil pumped in excess of that required by the press will escape back to the tank through the relief valve. The globe valve F must never be closed when the pump is in operation.

If the pump valves are in bad condition it would be helpful to put check valves in the suction and the discharge lines; if the pump is in good condition there is no need of them. To cut down the power required by the pump when the press is not in use, a 3-way valve should be fitted as shown at N, which will shut off the press and allow the oil to flow back to the oil tank shown by the dotted pipe line.

LOOSE PULLEY HEATS

I have considerable trouble with a loose pulley on a small machine. The pulley keeps binding on the shaft and finally gets heated up so that it binds sufficiently to make the whole machine move. It will run quite free for a short time after taken off and oiled, but the trouble soon starts again. Can you suggest a remedy?—R. INNES, Winnipeg, Man.

Answer:—There may be several causes for the heating of a loose pulley on the shaft. A common cause of trouble is dirt getting in the bearing between the pulley and the shaft, causing some cutting and making a rough surface. When such a condition once starts it is almost impossible to keep the pulley from heating. The remedy is to smooth the shaft or replace with a new one.

Belts that are too tight often cause heating of the loose pulley, especially if the speed is high. The pressure may be sufficient to break through the thin film of lubrication and once a slight heating has started the oil becomes thin and runs off, leaving the bearing practically dry, when further heating is bound to result.

As a remedy for your troubles the following suggestions are offered:

Remove the pulley and make sure that the shaft and the bore of the pulley are smooth and clean.

If the belt is too tight add a short piece and run the belt as loose as possible to handle the work satisfactorily.

Fit a grease cup to the pulley and use a good grade of grease. If oil is used in a grease cup centrifugal force will, unless the speed of the pulley is very low, prevent it reaching the bearing.

If none of these methods is successful in preventing heating of the pulley, then some special form of bearing will have to be used in the pulley, such as ball or roller bearing.

GAS ENGINES

If the compression chamber of a gas engine is made smaller, will it give more power? What effect has altitude on the power of an internal combustion engine? What effect has the brine of a refrigerating machine on the cooling action?—W. F. JOHNSTON, Medicine Hat, Alta.

Answer:—Making the compression chamber or clearance volume in a gas engine smaller results in an increase of compression pressure.

The thermal efficiency of an internal combustion engine increases with an increase in the compression pressure. In this way, by an increase in efficiency, the power of a given engine is increased.

In addition, increased compression pressure results in an increase of the power per unit of volume of piston displacement, and permits the use of a leaner mixture which otherwise could not be readily ignited.

Thermally, it is advantageous to increase the pressure, but practical considerations limit it. If the pressure at the end of the compression stroke is excessively high, with correspondingly high temperatures, pre-ignition may result. Pressures in common use seldom exceed 150 lb. per sq. inch at the end of compression.

The formula for the efficiency of a gas engine is

$$\text{Eff.} = 1 - \left(\frac{P_1}{P_2}\right)^{\frac{K-1}{K}}$$

where P_1 = pressure at the beginning

of compression, P_2 = pressure at the end of compression, and K a constant.

$\frac{P_2}{P_1}$ is known as the compression ratio.

Using a value of K as 1.35 the theoretical thermal efficiency varies from .355 for a compression ratio of 3.5 to 1 to .553 for a ratio of 10.0 to 1.

Actually the increased efficiency resulting from high pressures is partially nullified by increased losses past the piston rings and the slightly increased friction loss.

The net effect of making the combustion chamber smaller, provided, of course, that the resulting pressure at the end of compression is not sufficient to cause pre-ignition, and if the rings are in good condition, will be an increase in power from the engine.

At high altitudes the atmospheric pressure is much lower than at sea level, or the air is less dense. The displacement volume of an internal combustion engine remains the same, but at high altitudes, due to the decreased density of the air, less weight is drawn into the cylinder on the suction stroke, therefore the power from each explosion is less than it would be for the same engine working at sea-level.

Makers of gas engines guarantee their engines to give a certain rating at sea level and advise purchasers to allow about 3 per cent. loss of power for each 1,000 feet above sea-level.

The brine in a refrigerating system acts as a heat carrier, to remove the heat from the room, or the substance being cooled, and give it up to the cool ammonia, in the case of the ammonia machine. Direct expansion coils may be used and brine dispensed with entirely; in fact this is often done. Brine is, in many places, a convenient method of carrying the heat, as it can be pumped long distances.

LINING UP CORLISS ENGINE

I would like to see in Power House a description of the correct method of lining up a Corliss engine.

Could a Corliss engine be changed to a throttling governor type by setting the grab claws solid? — A. E. SPEAKMAN, Glassville, N. B.

Answer:—In lining up a Corliss engine the chief consideration is to get the shaft at right angles to the direction of travel of the piston and cross-head.

The method following is one used and recommended by the Goldie and McCulloch Co. of Galt, Ont.

If the engine is in running condition and the alignment is to be checked, the cylinder head must first be taken off. Remove the piston, the cross-head and the connecting rod.

Stretch a line tightly through the centre of the cylinder and the stuffing-box, past the centre of the shaft as shown in the drawing.

A silk fish line or a fine wire tightly stretched will answer the purpose.

The line can be held in the centre of the cylinder at A by means of a clamp bolted through one of the cylinder head bolts. Caliper this very carefully; it must be as near the centre of the cylinder as it is possible to get it. Then do the same at the stuffing-box. The line then should pass by the centre of the main shaft.

The alignment of the cross-head guides may be checked with calipers, but if the engine has been properly constructed in the shop it is not necessary to do any checking in the field.

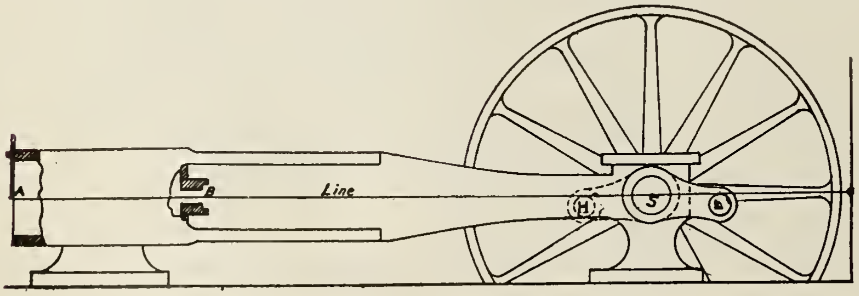
Roll the crank until pin is at the position L just touching the line. With the line in the centre of the crank pin bearing caliper the distance between the face of the main shaft and the line. Then roll the shaft until the crank is in the position H (shown dotted). Caliper the distance between the line and the end of the shaft as before.

If the distance is the same in both cases the main shaft in then in its proper place. If not the axis of the shaft is not at right angles to the direction of travel of the piston.

If all parts are in correct alignment the line though the centre of the cylinder and the stuffing-box will pass the centre of the shaft and the centre of the crank pin bearing in either position L or H.

A Corliss engine can be changed to a throttling governor type by setting the grab claws solid. The cut-off then is fixed as in the simple throttle governing engine.

It is advantageous to have a fixed cut-off if the engine is to work at light loads for long periods.



PREVENTING SCALE

For the past eighteen months I have been using potato water in boilers to prevent scale from forming, with good results. The potatoes are boiled along with peelings from the kitchen, and the water strained off and put in the tank from which we pump the feed water.

I have been informed that potato water is very injurious to boiler plates and tubes. What is your opinion on the matter?—W. J. McFADDEN, Ontario Hospital, London, Ont.

Answer.—There appears to be a difference of opinion regarding the use of potato water in boilers.

A prominent consulting engineer says he sees no reason why potato water should do any damage to a boiler; on the other hand, he knows of nothing in it which could do much good in preventing or removing scale. A small amount of soda ash, in his opinion, is much more effective, and certainly much less labor is required in preparing it.

An engineer in one of the large boiler shops in a Western Ontario city has used potato water in his boilers for years. He claims that so far no damage has resulted and that it cleans the boilers thoroughly.

H. P. Stephens, of Toronto, does not recommend the use of potato water, claiming that it causes pitting and corrosion. The corrosion may go on, and being under the surface, may be very serious before it is detected. The starch in the potato water, he claims, prevents scale by forming a scale itself, which is even worse than ordinary scale in preventing heat from entering the water.

BOILER BRIDGE WALL

In a horizontal return-tubular boiler setting, is 0.3 of the boiler diameter sufficient clearance between the top of the bridge wall and the bottom of the boiler? Where bituminous coal is used. has the flat-top bridge wall any decided advantage over the older type which curved like an inverted arch following the shape of the boiler?—JAMES ATKINS.

Answer:—In an ordinary setting of a return tubular boiler, the furnace bridge wall is for the purpose of preventing the coal from falling off the grates, and for baffling the draft to force the air to pass up through the whole fuel bed.

The shape of the wall, whether flat on top or curved to correspond with the shell of the boiler, or whether the wall is provided with vertical or with sloping sides, appears to make little difference.

The area over the wall must be at least large enough not to check the draft afforded by the total tube area. With a flat top for the bridge wall, sufficient area is obtainable when the distance from the top of the wall to the under side of the boiler is 25 per cent. of the boiler diameter.

A flat wall is easier to build and is preferable to an inverted arch form. as the latter is more likely to cause greater concentration and impingement of the heated gases against a girth seam of the boiler.

ENGINE POUNDING

We operate a 28 x 48-in. Corliss engine that has been running over for 15 years and recently had to reverse the engine; that is, it now runs under. The engine has a loud knock in the main journal bearing. How can we get rid of the trouble?—G. S.

Answer:—When running over, transmission of the load from the piston to the connecting rod causes the crosshead to exert pressure on the lower guide in addition to the pressure from the weight of the crosshead and connected parts.

When the engine was reversed, the pressure of the crosshead, less the pressure due to the weights, was transferred to the upper guide. Hence, in runing under, the crosshead is not held as rigidly to the guide, and that may be the initial cause of pounding, which is taken up by the main bearing. The remedy for this trouble from the crosshead would be to obtain good alignment of the guides and centre the crosshead with the least possible clearance between the crosshead and guides consistent with maintaining good lubrication of the upper guide.

From long time running, the crosshead pin, crankpin and main journal and their bearings would become worn out of round, and from reversing the engine there would be opposite direction of wear and different distribution of pressure, and if the pins, main journal and all bearings have not been trued up since the engine was run over, those repairs should be made before it can be expected to get rid of the knock in the main bearings by simply adjusting the crosshead.

MOTOR IN STEP

Can an induction motor, which has the same number of poles as the generator that supplies the power, run at the same speed as the generator—that is, at synchronous speed—or must there necessarily be some slip even at no load? If the rotor of the induction motor must run slower than synchronous speed, how does a synchronous motor get into step when started as an induction motor?—A.B.

Answer.—In a polyphase induction motor the relation of the currents in the stator windings are such as to produce a revolving magnetic field. This field revolves at synchronous speed and is equal to 120 times the cycles per second divided by the number of poles.

On a 60-cycle circuit the magnetic field of a four-pole motor will revolve at (120 × 60) ÷ 4 = 1,800 r.p.m., and if the alternator supplying the power has four poles, it will also revolve at the same speed.

If the rotor of the induction motor was revolved at 1,800 r.p.m., its conductors would be moving at the same rate as the stator's magnetic field. Under this condition the conductors would not be cutting any of the lines of force and, therefore, would not have a current induced in them; consequently, the rotor could not develop and turning effort.

In order that the rotor conductors may cut the lines of force, it must run slower than the magnetic field. At no load the difference in speed will be small. At full load the rotor will run from 4 to 10 per cent. slower than the stator's field, depending upon the resistance of the rotor's winding.

When a synchronous motor is started as an induction motor, it cannot pull into step until the field switch is closed. When the motor is started the field switch is left open and the motor brought up to as near synchronous speed as it will come as an induction motor; then the field switch is closed and the motor pulls into step, provided it is not too heavily loaded.

If the motor has a low-resistance squirrel-cage winding in the pole faces, it will not be capable of developing a good starting torque, but can bring the load that it can start up to near synchronous speed, therefore will pull into step easily when the field switch is closed.

On the other hand, if the starting winding in the pole faces has a comparatively high resistance, the motor will develop a good torque, but the rotor will have considerably more slip than the low-resistance rotor. As a result the high-resistance rotor may not pull into step as smoothly as the low-resistance machine. In either case the field switch must be closed before the rotor can come up to synchronous speed.

WATER JACKET SCALE

How can a gas-engine water jacket be cleaned of scale deposited out of the cooling-water?—A. WHITE.

Answer:—The scale deposited out of most cooling waters can be removed by a solution of commercial muriatic acid and an equal quantity of water. Care should be taken that the solvent action of the acid is not continued to the extent of injuriously corroding the walls of the water jacket or other parts of the engine.

After application of the acid solution, the parts that have come in contact with it should be thoroughly washed with clean water.

CUSHIONING A PUMP

How is the cushioning of a duplex steam pump obtained and regulated?—ENGINEER.

Answer:—The steam cylinders are provided at each end with two sets of ports. Each outer port acts as the steam admission port and terminates at the end of the cylinder so as to guide the incoming steam into the clearance space behind the piston; and each inner port acts as an exhaust port and terminates nearer the middle of the cylinder.

When the steam piston passes over the exhaust port, no more exhaust steam can escape and, without cushioning valves, whatever steam is thus entrapped in the cylinder is compressed and acts like a cushion in bringing the piston to rest.

This compression may be excessive and, by means of hand-operated compression valves that connect the outer or steam ports of the cylinder with the inner or exhaust passages, the amount of cushioning can be reduced, by permitting more or less of the compressed exhaust to escape from the end of the cylinder through the steam passage into the exhaust passage.

Power Notes

The Northern Ontario Light & Power Co., Cobalt, Ont., is having additional electrical equipment installed in its plant.

Capital Electric Appliances, Ltd., Ottawa, Ont., has been incorporated with a capital of $25,000 to manufacture and deal in electric stoves, heaters, etc.

The Waterous Engine Works Co., Ltd., Brantford, Ont., have been awarded the contract for boilers in connection with alterations to the Military Hospital, St. Anne de Bellevue, Que.

Wallace & Aikens, Ltd., Winnipeg, Man., have been awarded the general contract in connection with the power house and laundry for Grace Hospital, Winnipeg, Man.

James, Proctor & Redfern, 36 Toronto Street, Toronto, consulting engineers, are preparing plans for a waterworks plant to be erected at Creemore, Ont., including mains, hydrants, valves, etc., and which will cost approximately $40,000.

The Port Arthur Shipbuilding Co., Port Arthur, Ont., has been awarded the contract for building the steel towers for the Hydro electric power lines between Cameron Falls and Port Arthur, Ont., to cost approximately $200,000.

Among those attending the convention of the Public Ownership League of America, held in Toronto from September 11 to 13 inclusive, were F. H. Malby, office manager, and J. G. Glassco, manager of the Hydro Electric Commission of Winnipeg, Man.

Work on the construction of a new gas plant for the Winnipeg Electric Railway is expected to commence shortly. The plant, when in operation, will be capable of producing approximately 2,500,000 cu. ft. of gas. Modern machinery will be installed which will effect savings that will warrant the capital expenditure. The plans at present are not quite completed, but it is expected that the contract will be awarded by the end of September, and it is understood it will cost approximately $1,000,000.

The W. R. Sexton Boiler Setting Co., 114 Grenadier Road, Toronto, have had a particularly busy season, the following work having been completed in the past few weeks: extensive repairs to the firebrick work in the power plant of the Robert Simpson Co., Ltd.; the installation of three Murphy arches for the Toronto Housing Commission, Bain and Logan Aves.; the installation of a new tempering furnace for hand saws in the plant of the H. Disston & Sons, Ltd., 2 Fraser Ave., Toronto, and repairs in firebrick work to travelling oven for the Telfer Biscuit Co., 139 Sterling Road, Toronto.

Comments in the Power Plant Field

DENIES INJUSTICE

ON PAGE 44 of the August 20 issue of Power House, George A. Brown, a well-known Toronto engineer, in an open letter, criticized the statements made by J. M. Brown, chairman of the Ontario Board of Stationary and Hoisting Engineers, at the banquet of the Canadian Association of Stationary Engineers, in the Hotel Carls-Rite, particularly stressing the statement:

"Do not worry, there will not be a surplus of engineers, as I watch the employment situation, and when there is a scarcity of engineering positions, I make the examinations harder."

The letter reproduced on this page, without comment, is the board chairman's answer to the stationary engineers of Ontario.

TEXT BOOK DATA

Many statements in text books are accepted by the majority of engineers without question. Practical experiment has shown that some of these statements are far from correct.

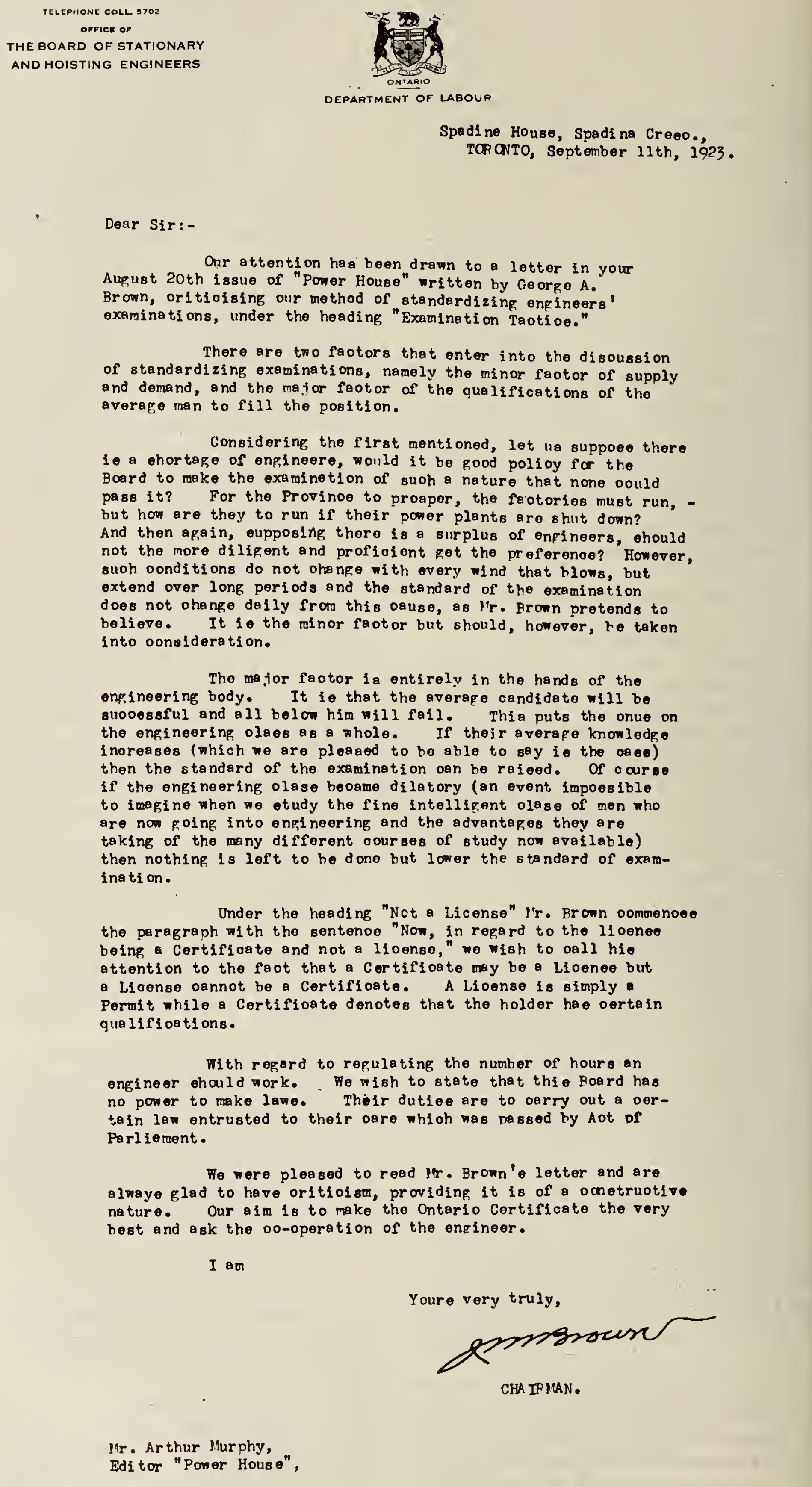
One in particular which I doubt is that 1-16 inch of scale covering the interior surface of a boiler will increase the fuel consumption from five to ten per cent., depending upon the character of the scale.

If this statement is correct, then scale is about the most heat retarding substance in the world. If the heat loss is so great, it would be instructive to tell readers where all this loss goes. Does the boiler setting absorb more heat than would be the case if there was no scale in the boiler or is it accounted for by a rise in the temperature of the escaping gases?

Experiment can be made to demonstrate the relative conductivity of scale and iron, but in actual practice, can it be demonstrated that a thin coating of scale will cause this great increase in fuel consumption?

I would imagine, if there is truth in the statement, that the external surface of steam pipes, heaters, etc., covered with a ½ in. thick coating of plaster material approximating the composition of scale, would be practically free from heat loss by radiation.

It is the discussion of doubtful questions of this nature in the correspondence section of engineering newspapers, such as Power House, which makes the paper of such great value to the engineer looking for helpful information different from the text book theories. Every engineers owes much of his success to text books and engineering schools, etc., but the correspondence section of the engineering journals hold a corner in the regard of the operating engineer which nothing else seems to fill, be-



TELEPHONE COLL. 5702
OFFICE OF
THE BOARD OF STATIONARY
AND HOISTING ENGINEERS

ONTARIO
DEPARTMENT OF LABOUR

Spadine House, Spadina Cresc.,
TORONTO, September 11th, 1923.

Dear Sir:-

Our attention has been drawn to a letter in your August 20th issue of "Power House" written by George A. Brown, criticising our method of standardizing engineers' examinations, under the heading "Examination Tactics."

There are two factors that enter into the discussion of standardizing examinations, namely the minor factor of supply and demand, and the major factor of the qualifications of the average man to fill the position.

Considering the first mentioned, let us suppose there is a shortage of engineers, would it be good policy for the Board to make the examination of such a nature that none could pass it? For the Province to prosper, the factories must run, - but how are they to run if their power plants are shut down? And then again, supposing there is a surplus of engineers, should not the more diligent and proficient get the preference? However, such conditions do not change with every wind that blows, but extend over long periods and the standard of the examination does not change daily from this cause, as Mr. Brown pretends to believe. It is the minor factor but should, however, be taken into consideration.

The major factor is entirely in the hands of the engineering body. It is that the average candidate will be successful and all below him will fail. This puts the onus on the engineering class as a whole. If their average knowledge increases (which we are pleased to be able to say is the case) then the standard of the examination can be raised. Of course if the engineering class became dilatory (an event impossible to imagine when we study the fine intelligent class of men who are now going into engineering and the advantages they are taking of the many different courses of study now available) then nothing is left to be done but lower the standard of examination.

Under the heading "Not a License" Mr. Brown commences the paragraph with the sentence "Now, in regard to the license being a Certificate and not a license," we wish to call his attention to the fact that a Certificate may be a License but a License cannot be a Certificate. A License is simply a Permit while a Certificate denotes that the holder has certain qualifications.

With regard to regulating the number of hours an engineer should work. We wish to state that this Board has no power to make laws. Their duties are to carry out a certain law entrusted to their care which was passed by Act of Parliament.

We were pleased to read Mr. Brown's letter and are always glad to have criticism, providing it is of a constructive nature. Our aim is to make the Ontario Certificate the very best and ask the co-operation of the engineer.

I am

Yours very truly,

JMBrown

CHAIRMAN.

Mr. Arthur Murphy,
Editor "Power House",

POWER PLANT EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA
TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK & WILCOX, LIMITED

Toronto Office
Bank of Hamilton Building

ST. HENRY—MONTREAL

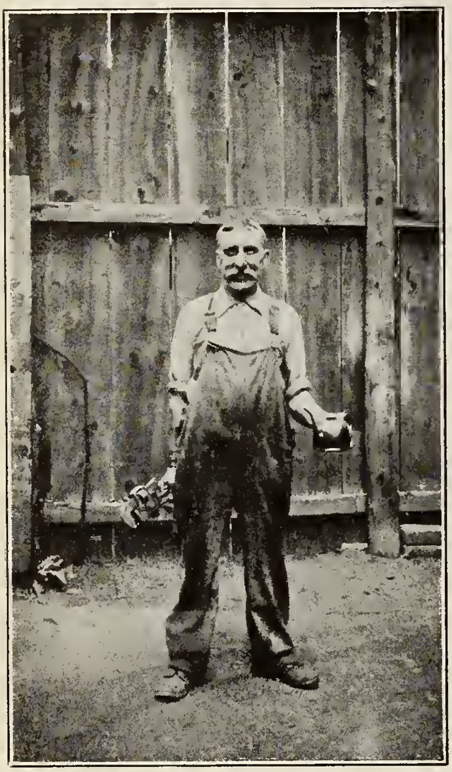
cause some little tip in each issue is of great value to someone or other.—JAMES E. NOBLE, 173 Macdonnel Ave., Toronto, Ont.

"ON THE JOB".

In the last issue of Power House I notice you request readers to forward you practical pointers and photographs.

Some years ago I used to answer many of the questions sent to Power House; and as I had a very limited education, I learned a great deal in this way, as well as by reading other articles in the newspapers. I always regret to hear of engineers who ignore the valuable information contained in Power House.

I have had twenty-three years' experience operating engines, water tube and return tubular boilers. I made an attempt to get a second class certificate, but owing to my lack of general education, failed.



JOHN QUINLIN,

On the job at the Brighton Laundry, 826 Bloor St. W., Toronto.

The photograph I am forwarding you was taken, as you will notice, "on the job." I was snapped just as I had finished tightening a fitting and oiling traps on top of a boiler, this explaining the pipe wrench in one hand and the oil can in the other.

It would be well for you to emphasize in Power House the fact of cleaning the smoke box on all boilers, as I have had a good deal of trouble in this way. I sometimes forget this myself, as it keeps me pretty busy keeping my plant running, but in the past three years there has not been a five minute shut-down except on Sundays.

With best wishes for the success of Power House.—JOHN QUINLIN, 276 McPherson Ave., Toronto.

R. J. Hoare, engineer of the Commercial Motor Bodies and Carriage Co., of Guelph, Ont., believes there is need of greater co-operation among the engineers of that city. He, however, is pleased with the progress being made by the local branch of the Federal Union of Stationary and Hoisting Engineers, which was started six weeks ago.

The present system of steam boiler inspection and granting of licenses in the province could be much improved, according to Mr. Hoare.

"I was eleven years in various plants without once having a government boiler inspector call on me. At present when an inspector makes a report the matter ends as far as the engineer is concerned. If anything is wrong, nothing is said. In many plants men are in charge who have no certificates or have lower grade ones than required by law."

* * * *

E. Cunningham, chief engineer of the Taylor-Forbes Co., of Guelph, Ont., says that the water in that city is extremely hard, but by proper use of sal soda he has no difficulty in keeping his boilers clean. For a 150 h.p. boiler he uses a pail of soda twice a week. The soda is dissolved in a pail of hot water and fed to the boiler through the feed water.

Mr. Cunningham in relating some of his experiences, mentioned trouble he had with low water in a horizontal return tubular boiler.

"The water in the boiler was up to the top of the glass, so the feed pump was shut down and the gauge blown down, the water at once rose again to the top of the gauge. After several blowings, the water was still high but as the load at the time was light, low water was not suspected. I happened to be around the condenser and back of the boiler, everything seemed to be unduly warm so I decided to test the water again and to shut down at once if I could not find the water level. On blowing down this time the water did not show in the gauge. When the boiler had cooled down, it was found that the top two rows of tubes were dry. A small piece of dirt had clogged the top connection, which accounted for the water rising out of sight in the glass. The last time when it did not show in the glass the level of the water in the boiler was below the bottom connection."

As it occurred on a Monday morning the explanation given by Mr. Cunningham was that dirt and sediment had been in the boiler and the first fire in the morning had stirred up the sediment and deposited some of it at the valve in the top water connection. The two top rows of tubes apparently acted as a superheater, which accounted for the unusual heat at the back of the boiler and around the condenser.

R. Farrelly, engineer of the Bell Piano and Organ Co., of Guelph, Ont., has been 18 years with the same company. He has no trouble in getting good steam coal at a reasonable price. Mr. Farrelly had trouble once with the packing in a hydraulic elevator. The packing would remain tight for only a few days then would start to waste water. As a last resource packing, made of waste twisted into a rope and well soaked with tallow, was tried. The packing was tightened every day for a week, after that it remained in good condition for years with no further attention. So well did the waste and tallow work, that the elevator had to be packed only twice in ten years.

* * * *

Percy E. Winfield, chief engineer of the Partridge Rubber Co., Guelph, Ont., thinks that for a steady load all day long, no plant can compare with a rubber factory.

"We use a lot of steam, but if the coal is good or only fair, we have little trouble in keeping up the pressure. I believe the proper way to fire is to keep the fires clean at all times, and not allow them to get dirty and do all the cleaning at once. It is easier on the firemen and the coal pile to clean frequently."

* * * *

W. T. Bishop, for the past twenty years engineer of Robert Stewart, Ltd., Guelph, Ont., finds many useful hints and practical ideas in Power House. Proper attention to small details at the right time will save the engineers hours of hard work later on.

"My motto is 'Keep the plant running'," he said.

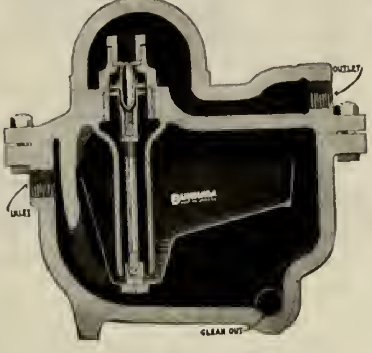
"In the lumber business, refuse is the chief fuel but often a small amount of coal is required. I believe that in the small plant, the use of a feed water heater will save fully 25% of the fuel. I keep the temperature of the feed water around 210 deg. Not only does this save fuel by decreasing the amount of heat required by the water but it removes some of the scale forming compounds before they get to the boiler, keeping the boiler clean and allowing more heat to get to the water."

A maximum voltage rating is usually given on the nameplate which merely indicates the strength of the insulation, and the transformer must not be used on voltages above that rating, but may be used on voltages below it. For instance, a transformer marked 6,900 volts maximum may be used on a 2,300 or 100-volt circuit but not on an 11,000-volt circuit.

Deposits formed in the cooling coils through which the circulating water flows, act as a heat insulator and also tend to reduce the amount of water passing through the coils. Generally such deposits can be removed by passing a solution of muriatic acid and water through the coils.

Dunham High Pressure Bucket Trap—Type No. 80

Quick acting - Powerful - Accessible !



There's nothing "draggy" about the action of this trap. The shape of the Dunham bucket and a short-coupled leverage obtain unusual power and speed. When the bucket is down and the trap is discharging, the inclined bottom stands practically in a horizontal position. As the water is forced out through the discharge tube from the bucket, and the bucket begins to rise from the buoyancy of the water surrounding it, all of the water on the bucket "shelf" is suddenly poured over into the water seal. As a result, the movement of the bucket is greatly accelerated in its closing action.

This is a strong, simply constructed trap for removing condensate from fixtures, steam lines, separators, laundry equipment, heaters, vulcanizers, dry kilns and other industrial apparatus where high pressure steam is used. It is the speediest and most powerful trap of its size and type made. This is due mainly to the shape of the Dunham bucket, as described under illustration.

Another big feature is its accessibility. The cap may be removed without disturbing piping connections. This exposes the double-end valve and reversible valve seat which are made of monel metal. These vital working parts may be quickly reversed or replaced. Compare Type 80 with any other trap for operating efficiency and durability.

Write to us to-day for complete information and price list on Dunham Traps and other heating and industrial specialties.

C. A. DUNHAM CO., Ltd., Toronto, Ont.

Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary,
London, Eng.: 18 St. Thomas St., S.E.I.

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE
(MADE IN CANADA)

HUNTING TROUBLE

(Continued from page 32)

was very dirty, carrying small pieces of scale, etc. The trouble was obviously an obstruction in the 1½ in. feed pipe somewhere.

A Suggestion

Here is a good place to make a suggestion. When covering pipe it is very easy to mark where the unions are with a band of red paint. This will save much time and trouble sometime when it is necessary to disconnect for any reason.

It was finally decided to start with the elbow under the box, where the line turned to go up into the box, cut the covering back about 6 inches from the ell on each side and remove the cork, then cut through the ell with hacksaw (malleable fittings had been used so they could not be broken) unscrew the halves from pipe, and the line would be open for inspection.

The writer happened to notice the flexible coupling between the pump and motor when it started and thought it revolved in the wrong direction. The pump was stopped and it was found to be running backwards. On reversing the motor it gave all the brine wanted and the trouble was cured.

The real cause of the trouble was that an exhaust fan had been put in the kitchen and the motor cut into the lines, supplying the pump motor. The electrician carelessly reversed the pump motor in making the change. The pump was in a rather dark corner and ran just smooth enough, so it was almost impossible to determine the direction of rotation at full speed. The starting box was not located close to the pump and the person who threw in the pump could not observe it.

The trouble did not develop for a few days after the fan was put in, as the boxes held up themselves for a time and no one connected the exhaust fan with the brine trouble.

There is a moral to this. Always have a pressure gauge on discharge of pump. If there had been a pressure gauge on this line it would have shown something wrong with the pump at once, and the trouble would probably have been found easily—JOHN DAVIS, Toronto, Ont.

HIGH VACUUM BENEFITS

(Continued from page 22)

dimensions require to be varied for every different set of working conditions. The introduction of new types of jet and diffuser has made it possible to adjust the dimensions of the jet and the diffuser to suit all conditions, while still maintaining standard parts.

In fact, it is possible to adjust the expansion of the steam in the jet, to give the best possible results under any given working conditions, while the ejector is in operation, a feature hitherto impossible.

Ejector With Diffuser

A two stage ejector constructed on this principle is shown in Fig. 7. Live steam enters through stop valve A^1 connected to first and second stage nozzles B and C. The small valve A^1 is for the purpose of shutting off the first stage at starting until a vacuum of 25 inches is obtained in the second stage.

The steam expands in the nozzles and entrains the air and vapors entering through the suction branch D. The mixture of steam and air passes down through the diffuser E and is discharged through the passages F to the suction chambers G off the second stage, the absolute pressure of the mixture having been raised several inches of mercury.

The remainder of the steam entering at A passes through the second stage nozzle C which is designed to have a constant throat area, with a variable ratio of expansion, thus securing a constant steam supply. The variation of the ratio of expansion is accomplished by the adjustment of the position of the nozzle point H. This adjustment can be made while the ejector is in operation by means of the extension of the point which projects from the casing at K. The steam issuing at J from the nozzle C in the form of an annular sheet, having a very large surface compared with the weight of steam passing, entrains the mixture coming in through the suction chambers G and compresses it in the annular diffuser I to atmospheric pressure.

The whole then passes into the discharge belt M and is exhausted to atmosphere through the opening N.

Progress in New Power Equipment

AN AIR PREHEATER

A costly source of loss in connection with steam boiler operation is the quantity of heat carried away to waste by the flue gases. The days have long passed in which a high exit temperature of the gases was tolerated for the sake of producing natural draught and economizers are fitted in all plants of any importance in order to utilize as far as possible the heat which the boiler itself cannot extract from the gases.

The close regulation of the excess air supply to the fires which is rendered possible by the use of CO_2 recorders has had its natural effect in increasing the temperature of the exit gases, and this again has called attention to the amount of recoverable heat which these gases contain. In addition to extracting a part of this heat by means of economizers, or indeed as an alternative to the use of economizers, it has often been proposed to use the heat of the waste gases to raise the temperature of the air supplied to the fires.

Up to the present, there are two ways by which it has generally been attempted to raise the temperature of air for combustion. In steel works' furnaces, a common practice is to pass the fresh air and the flue gases alternately through regenerating chambers, so that the incoming air picks up heat from high temperature from the passage of the brickwork previously raised to a the flue gases. For boiler furnaces the flue gas temperature is not sufficiently high to make this plan practicable, quite apart from the difficulty of carrying it out. Hence when regeneration has been applied to steam boiler plants it has been customary to transmit the heat from the waste gases to the incoming air, through metallic surfaces separating the air passages from the flues.

Heat transmission under such circumstances is not very effective, as the temperature difference is not great and the surfaces of the heating device are prone to become covered with a layer of soot or tarry matter which acts as a nonconductor.

A third solution has now been evolved in the form of an air preheater, designed by Frederick Ljungstrom of Stockholm, Sweden, whose fertility of mind has been demonstrated by the Ljungstrom Steam Turbine and Turbo-Locomotive.

Fan Supplies Air

Referring to the diagrammatic figure, fresh air is drawn by a fan into the upper portion of the casing, which is divided into two parts by a vertical partition. The air is confined to one side of the partition and passes downwards to a similar semi-circular chamber, through the body of a porous cylindrical drum or rotor.

The flue gases from the boiler traverse the apparatus in the reverse way, entering the lower semi-circular chamber and passing upwards through the rotor to the upper chamber, whence they are exhausted and impelled to the stack by another fan.

The integral fans are carried on a common shaft and the required speed of the rotor—about six revolutions a minute—is obtained by means of suitable gearing connecting the fan shaft with the driving roller.

The rotor is kept in a state of continual slow rotation so that the part heated by the flue gases is continually passing to the other side of the device and gives up its heat to the cold air sweeping through it. Similarly, of course, the cooled part of the rotor is continually returning to be reheated by the flue gases.

Cleaned by Jet

It will be observed that there is no transference of heat through metal in the process. A deposit of soot or tarry matter does not therefore have any very serious effect upon the action of the apparatus, which moreover may be cleaned in a few moments by means of a steam jet.

The rotor is built of thin sheet steel and divided into sections by radial plates, which serve as stiffening spokes. In each section the heating elements are placed concentrically. These consist of specially corrugated plates alternating with plain, thus forming, when assembled, a great number of passages and resembling a honey-comb structure. It will be appreciated that this design allows a very liberal heating surface to be provided in a heater of comparatively small dimensions and with very little obstruction to the passage of the gases and air.

On the outside of the rotor a heavy steel ring is fastened, against which the carrying and guide rollers are working. As the rollers carrying the weight of the rotor are mounted on ball bearings, the amount of power required for driving purposes is insignificant.

Incidentally as friction drive is employed, this precludes the possibility of trouble resulting from contraction or expansion.

It is claimed that as an alternative to an economizer, the Ljungstrom Air Preheater is not only more efficient, but lighter and less expensive in first cost and maintenance.

Figure 1 shows an air preheater designed to deal with the flue gases from a steam plant burning one ton of coal per hour, as compared with an economizer of standard design intended for the same duty. In both cases it has been assumed that the temperature of the flue gases leaving the boiler is 572 degrees Fahr. The air preheater cools the flue gases down to about 212 degrees Fahr., thus absorbing the heat between these limits which, according to tests, results in a saving of fuel of 20.1%. The weight of the heating elements is 7,100 lbs.

The makers of the Ljungstrom Air Preheater are James Howden & Co., of America, Inc., Wellsville, N.Y.

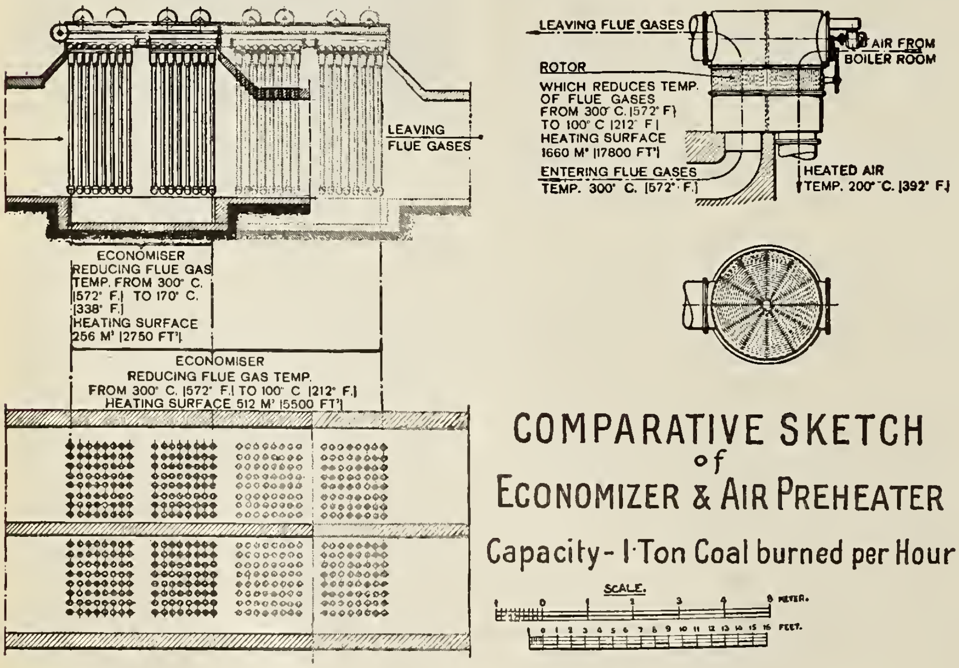

LEAVING FLUE GASES
ECONOMISER REDUCING FLUE GAS TEMP. FROM 300° C. (572° F.) TO 170° C. (338° F.) HEATING SURFACE 256 M² (2750 FT²)
ECONOMISER REDUCING FLUE GAS TEMP. FROM 300° C. (572° F.) TO 100° C (212° F.) HEATING SURFACE 512 M² (5500 FT²)
LEAVING FLUE GASES
AIR FROM BOILER ROOM
ROTOR WHICH REDUCES TEMP. OF FLUE GASES FROM 300° C. (572° F) TO 100° C (212° F) HEATING SURFACE 1660 M² (17800 FT²)
ENTERING FLUE GASES TEMP. 300° C. (572° F.)
HEATED AIR TEMP. 200° C. (392° F.)
COMPARATIVE SKETCH of ECONOMIZER & AIR PREHEATER
Capacity-1 Ton Coal burned per Hour
SCALE.
METER.
FEET.

Fig. 1

HINTS TO BUYERS

Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK

Nature's Water Softener
Copyright 1920—The Refinite Co.

For Boiler Feed Water

Refinite makes scale impossible. It takes out the scale-forming lime and magnesia before the water enters the boilers. You save not only fuel, but the trouble, time and expense of washing boilers and replacing tubes.

A coating of scale even 1-50 in. thickness wastes 100 lbs. from every ton of coal fired.

Write for Information and Catalogue.

Refinite Company of Canada, Limited
305 Continental Life Building, Toronto

ENGINEERS!

Remember to Order
GENUINE
"V." PILOT
PACKING FOR ALL PURPOSES
KIRBY & COMPANY
50 LAKE ST. TORONTO MAIN 4443
SPECIALIZING IN
Engine and Boiler Room Supplies of Every Description.
Adamant Gauge Glasses Ideal Tube Cleaners
Kirbyco Boiler Scale Remover
QUALITY SERVICE

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.
Send for Catalogue
THE GARTH COMPANY
Craig Street-MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - St. Louis, Mo
Eastern Office: 71 Fulton St New York

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T.J. CUNERTY** *Company*
9 Richmond St E. Toronto

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

AIR COMPRESSORS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto, Ont.

AIR FILTERS
Midwest Canada, Ltd., Montreal, P. Q.

AMMETERS
Bristol Co., The, Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., New York, N. Y.
Kirby & Co., Toronto, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md.

ASH CONVEYOR, STEAM JET
Conveyors Corp. of America, Chicago, Ill.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BACK PRESSURE RELIEF VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto. Ont.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAROMETERS
Taylor Instrument Co., Toronto. Ont.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia. Ont.

BELT CEMENT
D. K. McLaren, Limited, Montreal, Que.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELT DRESSING
D. K. McLaren Limited. Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Bolco Supply Ltd., Toronto.

BELT FASTENERS
Bristol Company The, Waterbury, Conn.
D. K. McLaren Limited. Montreal, Que.

BELTING, BALATA
D. K. McLaren, Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto. Ont.
Jeffrey Mfg. Co., Montreal, Que.

BELTING, CONVEYOR
Gutta Percha & Rubber, Co., Limited.

BELT LACING
Bristol Co., The, Waterbury, Conn.
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D K. McLaren, Limited, Montreal, Que.

BELTING, LINK
D K. McLaren, Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren, Limited, Montreal, Que

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto.
Gutta Percha & Rubber, Limited, Toronto.
D. K. McLaren, Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
B. F. Sturtevant Co., Boston, Mass.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Ltd., Windsor, Ont.

BLOWERS, TURBINE
Canadian Sirroco Co., Ltd., Windsor, Ont.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc. Rome, N. Y.
Grant E. Cole, Co., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shel-Bar Bolco Supply Ltd., Toronto.

BOILER FRONTS
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. R., Toronto.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.

BOILER FITTINGS
Crane, ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co., "Copes" Erie, Pa.

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.
Northern Equipment Co., "Copes" Erie, Pa.

BOILER SETTINGS
Beveridge Supply Co., Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Gates Egineering Co., Ltd., Montreal, Que.
Sexton Boiler Setting Co., W. R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
A. E. Rule Co'y., Toronto, Ont.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal.
Can. Fairbanks-Morse, Ltd., Monreal.
Goldie & McCullough Co., Galt
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

BOILER SETTING CEMENT
Beveridge Supply Co., Ltd., Montreal, Que.
Jos. W. Hays Corp., Michigan City, Ind.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Waterous Engine Works Co., Brantford.

BOXES, FUSE AND METER
Mueller Mfg. Co., Ltd., The.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa
Refrigerating Engineers, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Goldie & McCuloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co. Ltd. Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co, Inc., Rome, N.Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Bolco Supply, Ltd., Toronto.

CHAINS FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CLEANERS, BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Monreal.
Jeffrey Mfg Co., Montreal, Que.
Waterous Engine Works Co., Branftord.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg Co., Montreal, Que.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can, Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg Co., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Waterous Eng. Works Co., Brantford, Ont.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL AND ASH HANDLING EQUIPMENT
Conveyors Corp. of America, Chicago, Ill.
Combustion Engineering Corp., Toronto,
Jeffrey Mfg. Co., Montreal, Que.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto
Refrigerating Engineers, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa
Wilson & Sons, J. L., Toronto, Ont.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CENTRIFUGAL AIR
Turbine Equipment Co., Toronto, Ont.

COMPRESSORS, AIR FILTERS
Midwest Canada, Ltd., Montreal, P. Q.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb. Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS. AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDUITS
Canadian Johns-Manville Co., Ltd., Toronto

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONVEYORS AND EQUIPMENT
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

CONVEYORS, STEAM, JET AND ASH
Conveyors Corp. of America, Chicago, Ill.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COOLING AIR FILTERS
Midwest Canada, Ltd., Montreal, P.Q.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COUNTERS. REVOLUTION FOR ENGINES AND PUMPS
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Bristol Company The, Waterbury, Conn.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, P. Q.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

A Reasonable Saving of 5 to 10%

Should You Expect More?

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

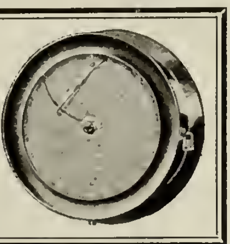
The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee St. PHONE G. 3660 Toronto, Ont.

OIL BURNING SYSTEMS.
INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.
LAURIE ENGINE CO.
(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.

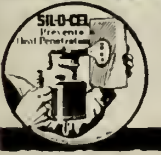
YOU REFRIGERATION ENGINEERS
— REMEMBER —
That "Sundh" (pronounced Sund) Refrigeration Electric Panel Control Equipment is sold by:
DOMINION ENGINEERING AGENCY, Limited
D. M. FRASER, Pres. and Gen. Mgr.
TORONTO 24 ADELAIDE ST. E. MAIN 6926

YORK Ice Making & Refrigerating MACHINERY
For Every Practical Purpose
Consultation on any Refrigerating Problem invited.
CANADIAN ICE MACHINE CO , LIMITED
Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

HE BROWN INSTRUMENT CO.
The Largest Pyrometer Manufacturers in the World
PHILADELPHIA - - PA.
Agents: LaChapelle Eng. Co., 414 St. James St., Montreal, P. Q.
Brown Instrument Co., 1421 Ford Bldg., Detroit, Mich.
Brown Pressure Gauge



SIL-O-CEL INSULATION
SAVES FUEL—Maintains Uniform Temperature. In world wide service on all types of high temperature equipment. Write for Bulletin W-6C
CELITE PRODUCTS LIMITED
New Birks Bldg., MONTREAL, QUE.



I HAVE been treating FEEDWATER for steam boilers for 24 years and am in a position to investigate your feedwater problems.

I WILL give you a formula for your special plant and thus save you 10% to 20% of your fuel.
Send in Your S.O.S. to:—
H. P. STEPHENS
Feedwater Specialist.
June. 5642 2004 Dundas St. W. Toronto

BETSON'S
TRADE MARK
PLASTIC FIRE BRICK

IDEAL for repairing furnace linings and arches or laying up complete linings and arches in one solid seamless piece and for making gas-tight baffles at any angle. No special forms, tools or skill required. Any good workman can do it.

Shipped plastic in barrels ready for use or dry ready to add water, from nearest warehouse.

Send for instructive booklet on furnace linings and baffles.

Betson Plastic Fire Brick Co., Inc.,
P. O. Box 386-6, Rome, N. Y.
Canadian Distributors : International Chemical Co.,
2[illegible]-6 Adelaide St. E., Toronto, Ont., Canada.

AMERICAN
STEAM ASH CONVEYORS

75% of all steam jet ash conveyors in Canada are **American.** Satisfactory and economical performance guaranteed. Ask for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Edmonton, Calgary.
W. A. GOOLD, Winnipeg.
T. M. GRINDLEY Co., Vancouver.

CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

PACKING, AMMONIA, STEAM AND WATER

Beveridge Suppy Co., Montreal.
Canadian Raybestos Co., Ltd., Peterborough, Ont.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Jenkins Bros., Limited, Montreal, Que.
Kirby & Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, OIL

Canadian Raybestos Co., Ltd., Peterborough, Ont.
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PACKING, COMPRESSED ASBESTOS SHEETS

Keasbey & Mattison Co., Toronto, Ont.
Steel Mill Packing Co., Windsor, Ont.
Kirby & Co., Toronto, Ont.

PAINTS

Shell Bar Boico Supply Ltd., Toronto, Ont

PIPE COILS

Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER

Armstrong Cork & Insulation Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronnto

PIPE, BLACK AND GALVANIZED

Crane's Limited, Montreal.

PIPE JOINT COMPOUNDS

Crane's Limited, Montreal.

PIPING AND FITTINGS

Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

PIPING, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUMBING SUPPLIES

Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

POWER HOUSE CONVEYORS

Can. Link-Belt Co., Toronto, Ont.

POWER TRANSMISSION MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

POWER PUMPS (OIL, GASOLINE)

Pratt & Cady, Hartford, Conn.

PRESSURE REGULATORS

C. A. Dunham Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES

C. A. Dunham Co., Toronto, Ont.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC

Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES

C. A. Dunham Co., Ltd., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Jointless Firebrick Co., Chicago, Ill.
Northern Equipment Co., Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS, WOOD AND STEEL

D. K. McLaren, Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH

Can. Link-Belt Co., Toronto, Ont.

PUMPS, AIR

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID

Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Turbine Equipment Co. Ltd., Toronto, Ont. Ont.

PUMPS, CENTRIFUGAL

American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
John T. Hepburn Co., Toronto, Ont.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX

The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Batle Creek.
C. A. Dunham Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Northern Equipment Co., "Copes" Erie, Pa.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HYDRAULIC, PRESSURE

Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek,
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, OIL

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, ROTARY

Albany Pump Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Young Pump Co., of Canada, Hamilton, Ont.

PUMPS, STEAM TURBO

Pratt & Cady Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co. Cincinnati, Ohio.

PUMPS, STEAM

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX

Pratt & Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM (HEATING)

Albany Pump Co., Toronto, Ont.
American Steam Pump Co., Battle Creek.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING

Yarnall-Waring Co., Hamilton.

PUMPS, VERTICAL

Smart Turner Machine Co., Hamilton, Ont.

PYROMETERS

Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS

Crane's, Limited, Montreal.

RADIATOR TRAPS

C. A. Dunham Co., Ltd., Toronto.
Sarco Co., The, New York, N. Y.

RADIATOR AIR VENTS

Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.

RADIATOR VALVES

C. A. Dunham Co., Ltd., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Jenkins Bros., Limited, Montreal, Que.

RAGS

Shell Bar Boico Supply Ltd., Toronto.

REBOILERS

Frick Co., Waynesboro, Franklin Co., Pa.
W. R. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa

RECORDING INSTRUMENTS

Bristol Company, The, Waterbury, Conn.
Canadian Johns-Manville Co., Ltd., Toronto.
Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenburg Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS CO-2

Sarco Company, Inc., New York.

REFRACTORY MATERIALS

Elk Fire Brick Co., Hamilton, Ont.

REFRIGERATING MACHINERY

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
Refrigerating Engineers, Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.
Wilson & Sons, J. L., Toronto, Ont.

REGULATORS, TEMPERATURE

Bristol Co., The, Waterbury, Conn.
Laurie & Lamb, Montreal.
Sarco Co., Inc., New York, N. Y.
Taylor Instrument Co. Toronto, Ont.

REGULATORS, DAMPER

Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Underfeed Stoker Co., Toronto, Ont.

REGULATORS, PRESSURE

Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co, Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS

The Superheater Co., Ltd., Montreal.

REGULATING VALVES

H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Northern Equipment Co., "Copes" Erie, Pa.
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

REVOLVING DOORS FOR HARDENING ROOMS

Jamieson Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING

Can. Link-Belt Co., Toronto, Ont.

RUBBER MILL DRIVES

Can. Link Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER

Beveridge Supply Co., Montreal.

SAFETY STEPS (Irving Life Step)

Irving Iron Works Co., Long Island City, N. Y.

SCREENING MACHINERY

Can. Link Belt Co., Toronto, Ont.

SCALE REMOVERS

Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

SEPARATORS, STEAM

V. D. Anderson, Cleveland, Ohio.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS

W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES, SINGLE, COMPOUND AND TRIPLE

C. A. Dunham. Co.,
Laurie & Lamb, Montreal.

SMOKE BOXES

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

SOOT CLEANERS

Diamond Specialty Co., Windsor, Ont.

SOOT CONVEYOR, STEAM JET

Conveyors Corp. of America, Chicago, Ill.

SPROCKET CHAIN ATTACHMENTS

Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

SPUR WHEELS

Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford

STACKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

STEAM, AIR AND ELECTRIC HOISTS

Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.

STEAM TRAPS

Julian D'Este Co., Boston 14, Mass.
Jenkins Bros., Limited, Montreal, Que.
Sarco Co., New York, N. Y.

STEEL BARRELS

Smart-Turner Machine Co., Hamilton.

STEEL DRUMS

Smart-Turner Machine Co., Hamilton.

STEEL, CONTRACTORS' STRUCTURAL

Can. Fairbanks-Morse Co., Ltd., Montreal

STRAINERS

Babcock & Wilcox, Ltd., Montreal.
The Fisher Governor Co., (Inc.) Marshalltown, Iowa.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Sarco Co., Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd.,

STRUCTURAL STEEL WORK

Babcock & Wilcox, Ltd., Montreal.

SUPERHEATER, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES

Canadian Johns-Manville Co., Ltd., Toronto.

SYPHONS

Jas. Morrison Brass Mfg. Co., Toronto.

TANKS, BLOW-OFF

Waterous Engine Works. Co., Brantford.

TANKS, BRINE

Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, CAST IRON STORAGE

Conveyors Corp. of America, Chicago, Ill.

TANKS, FREEZING, STORAGE AND WATER COOLING

Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
Wilson & Sons, J. L., Toronto, Ont.

TANKS, GASOLINE

Imperial Oil, Ltd., Toronto.

TANKS, OIL

Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co, Brantford.

TANKS, STEEL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works, Brantford

THERMOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury, Conn.
Sarco Co., Inc., New York, N.Y.
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Division, Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Canada

TRANSFORMERS

Can. Fairbanks-Morse Co., Montreal.

TACHOSCOPES

Julian D'Este Co., Boston, 14, Mass.
Grant E. Cole Co., Toronto, Ont.

TRAPS, DUMPING

Grant E. Cole Co., Toronto, Ont.

TACHOMETERS, INDICATING AND RECORDING

Bristol Company, The, Waterbury Conn.,
Schaeffer & Budenburg Mfg. Co., and American Steam Gauge and Valve Co., Brooklyn, N.Y.

TUBE CLEANERS

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pley Packing and Flue Brush Mfg. Co., St. Louis, Mo.
Kirby & Co., Toronto, Ont.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER

Babcock & Wilcox, Ld., Montreal.
Goldie & McCulloch Co., Galt.

TURBINE WATER WHEELS

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.

TURBINES, STEAM

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston
Turbine Equipment Co., Ltd., Toronto, Ont.

VALVES

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Edward Valve & Mfg. Co., East Chicago, Ind.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Lytle Engineering Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Jenkins Bros., Limited, Montreal, Que.
H. Mueller Mfg. Co., Limited, Sarnia, Ont
Reading Steel Casting Co., Hartford, Conn.
Shell Bar Boico Supply, Ld., Toronto.
Valve Engineering Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Underfeed Stoker Co., Toronto, Ont.
Wilson & Sons, J. L., Toronto, Ont.

WALKWAYS, (Irving Subway)

Irving Iron Works Co., Long Island City, N. Y.

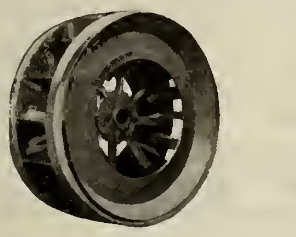
CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer
Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W



Ends Cinder Nuisance

The Sturtevant Cindervane Fan effectually ends the cinder nuisance, at the same time affording excellent induced draft.

Ask for Folder 609.

B. F. Sturtevant Co.
of Canada, Ltd.
Montreal Galt Winnipeg Toronto

The reason the champion is always the favorite is because he's better advertised.

POSITIONS WANTED

FACTORY SUPERINTENDENT—OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

ENGINEER, SECOND CLASS CERTIFICATE for Ontario, wants permanent position. Has had good all-round experience. Apply Box 111, Power House.

FOR SALE

SELF-OILING HIGH SPEED ENGINE, SINGLE cylinder, 17 in. bore x 16 in stroke. Engine develops 200 H.P. when running at 235 R.P.M. with 100 lbs. steam pressure. There are two heavy leather belts 18 in. wide. The engine has two fly-wheels, each 78 in. diameter x 18 in. face. Apply Box 112, Power House.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—with house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

GEO. CALLARD
Builder and Contractor
Furnace and Boiler Work a Specialty
Highest References from All the Leading Engineers of the City.
Phone: Uptown 1590
210 Quesnel Street, Montreal

J. A. BURNETT,
M.E.I.C., P.E.Q.

CONSULTING
& APPRAISAL
ENGINEER

Room 301—205 St. James St.
Telephone Main 6737. Montreal.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers.--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you , 1 monthly until $12 is paid.

Signature ____________________
Occupation ____________________
Employed by ____________________
Residence ____________________
Reference ____________________

B—B—B
BELL'S - BOILERS - BRICKS
TILES—SLABS—ARCH BRICKS—SLABS—SHAPES
For High Temperatures
Kenwood 4335
1347 Dufferin St. Toronto
BELL FIREBRICK COY.

BOILER SETTINGS
SPECIALISTS IN
FIREBRICK AND ARCHWORK
FOR EVERY TYPE OF STEAM BOILER
A. E. RULE COY.
122 Garden Av. TORONTO Lakeside 1274

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you.

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

DISTILLING APPARATUS
Frick Co., Waynesboro, Frenklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaefer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DUST FILTERS
Midwest Canada, Ltd., Montreal, P.Q.

DYNAMOS
Can. Fairhanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Bahcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.

ELEVATING MACHINERY
Can. Fairhanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Wayneshoro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machihe Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Laurie & Lamb, Montreal.
Sturtevant Co., B. F., Toronto and Boston.

ENGINES, STEAM
Canadian Sirocco Co., Ltd.; Windsor, Ont.
Canadian Ingersoll-Rend Co. Ltd., Sherbrooke, P. Q.
Goldie & McCulloch Co., Galt.
Laurie & Lamh, Montreal.
Sturtevant Co., B. F., Toronto and Boston.
Wateroue Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

EXHAUST HEADS
Sturtevant Co., B. F., Toronto and Boston.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

EXPANSION JOINTS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Jeffrey Mfg Co., Montreal, Que.
Sturtevant Co., B, F., Toronto and Boston.

FAN ENGINE REGULATORS
Under-feed. Stoker Co., of Caneda, Ltd., Toronto, Ont.

FEED WATER PURIFIERS
Stephena Chemical & Mfg. Co., Ltd., Toronto, Ont.
Yarnall-Waring Co., Philladephia, Pa.

FEED WATER REGULATORS
Schaeffer & Budenburg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Laurie & Lamh, Montreal.
Northern Equipment Co., "Copee" Erie, Pa

FILTERS
Frick Co., Waynesboro, Franklin Co., Pa.
Schaeffer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N.Y.
York Mfg. Co. York, Pa

FIRE BRICK AND MORTAR
Boston Plastic Fire Brick Co., Inc., Rome. N. Y.
Beveridge Supply Co., Montreal.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.
A. E. Rule Co'y., Toronto, Ont.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS
Crane, Limited, Montreal.

FITTINGS, CAST IRON
Crane, Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinneti, Ohio
Reading Steel Casting Co., Hartford, Conn.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinneti, Ohio.
Reading Steel Casting Co., Hartford, Conn.

FLOOR AND CEILING PLATES
Crane'e Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co., Ltd., Toronto.

FLOORING, METALLIC
Irving Iron Works Co., Long Island City, N. Y.

FLOORING, VENTILATING
Irving Iron Works Co., Long Island City, New York.

FLOW METERS (AIR, GAS, STEAM, WATER)
Yarnall-Waring, Philadelphia, Pa.

FLUE CLEANERS
Shell Bar Bolco Supply Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brueh Mfg. Co. St. Louis, Mo.

FREEZER DOORS
Jemieson Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Boston Plastic Fire Brick Co., Inc., Rome N. Y.
Elk Fire Brick Co., Hamilton, Ont.
Jointless Fire Brick Co., Chicago, Ill

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durahla Mfg. Co., New York, N. Y
Frick Co., Wayneshoro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Limited, Montreal, Que.
Kirhy & Co., Toronto, Ont.

GASKETS, LEAD AND LEATHER
Shell Bar Boico Supply Co., Toronto.
Sarco Inc., New York, N. Y.

GAS PRODUCER PLANTS
Can. Fairhanks-Morse Co., Ltd., Montreal.
Laurie & Lamh, Montreal.

GAUGE COCKS
Can. Fairhanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

GAUGES, DRAFT
Bristol Co., The, Waterhury, Conn.
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Lytle Engineering Co., Montreal, Que.
Schaeffer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y
John Moncreif, Perth, Scotland.
Kirby & Co., Toronto, Ont.
Valve Engineering Co., Toronto, Ont.
W. J. Wall, Montreal.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Ltd., Montreal.
Bristol Company, The, Waterbury, Conn.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Div-Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenhurg Mfg. Co., and American Steam Gauge & Valve Co., Division, Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto. land, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GEARS, REDUCING
Turbine Equipment Co., Ltd., Toronto, Ont.

GENERATORS, STEAM TURBO
Laurie & Lamh, Montreal.

GENERATORS AND CONVERTERS
Can. Fairhanks-Moree Co., Ltd., Montreal.
Dominion Engineering Agency, Toronto, Ont.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Smart-Turner Machine Co., Ltd., Hamilton.

GRAB BUCKETS
Can. Mead-Morrison Co., Ld., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Moutreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
The Boiler Repair and Grate Bar Co., Toronto, Ont.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantord.
W. R. Sexton Boiler Setting Co., Torono, Ont.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont

GREASES
Shell Bar Boico Supply Co., Ltd., Montreal.
W. R. Sexton Boiler Setting Co., Toronto.

GREASE AND OIL EXTRACTORS
Laurie & Lamh, Montreal.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

HEATERS, F.M.
Can. Fairhanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOPPERS, HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Ruhber, Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairhanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Frick Co., Wayneshoro, Franklin, Co., Pa

ICE AND REFRIGERATION EQUIPMENT
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, P. Q.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Wilson & Sous, J. L., Toronto, Ont.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadiau Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Torono, Ont.
Celite Products Limited, Montreal, P.Q.

IRON FILLER
Can. Johns-Manville Co., Ltd., Toronto.

LAMPS, ARC
Can. Fairbanke-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
J. H. Williams & Co., Limited, Brooklyn, N. Y.

LAMPS, INCANDESCENT
Can. Fairhanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

LEATHER FILLET
D. K. MacLaren Ltd., Montreal, Que.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
The Underfeed Stoker Co. of Caneda, Toronto, Ont.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
MacLean Underfeed Stoker Co., Toronto.
Combustion Engineering Co., Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Bundenherg Mfg. Co., American Steam Gauge & Valve Co. Division, Brooklyn, N. Y.
Taylor Inetrument Co., Toronto, Ont.

MIXING VALVES
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Dominion Engineering Agency, Toronto, Ont.

OILS
Imperial Oil, Ltd., Toronto.

OILS, ENGINE
Canadian Ingersoll-Rand Co., Ltd., Sherhrooke, P. Q.
Imperial Oil, Ltd., Torono.

OIL PURIFIERS
Turhine Equipment Co., Ltd., Toronto, Ont.

OIL AND GREASE CUPS
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.

TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and draft in last pass.

It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

Write for Bulletin CF-131.

THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

FOXBORO
REG. U.S. PAT. OFF.
THE COMPASS OF INDUSTRY

5323

GARLOCK

Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS

THE GARLOCK PACKING COMPANY

Dust-Destroyer and Thief!

The Trumbull Cliffs Furnace Company, of Warren, Ohio, U.S.A., pay no tribute to dust! Their turbo generator cooling air is filtered in this 25,000 cu. ft. per minute Midwest Installation.

Dust in the cooling air for your generators, motors and transformers, not only threatens you with short circuits, fires, and serious damage, but as it accumulates in the air passages and windings, it robs you of machine capacity. Don't pay tribute to dust! Keep cooling air absolutely clean with Midwest Air Filters. They have no moving parts—no sprays—nothing to get out of order. And maintenance costs are practically nil!

WRITE DEPT. F-15 FOR OUR NEW DATA BOOK.

MIDWEST AIR FILTERS

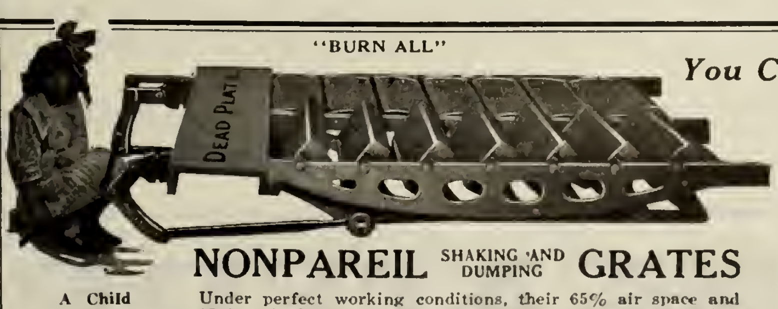
MIDWEST CANADA LIMITED
83 Craig St. W., Montreal, Que.

DOMINION BELTING CO. LIMITED
HAMILTON - CANADA
Quebec Branch, 51 Duluth Bldg., Montreal

Sole Manufacturers:

"Maple Leaf" Brand Stitched Cotton
Duck Belting, Belt and Dressing

The demand for our products has steadily increased because the standard of quality has been strictly maintained. We make only one grade, the best that can be produced. Write for prices and further information.



NONPAREIL SHAKING AND DUMPING GRATES

A Child Can Operate It.

Under perfect working conditions, their 65% air space and 95% underdraft is cutting fuel bills by 10%. SEXTON has installed them in a number of leading Canadian plants. Get a line on them today and be convinced.

You Can See

SEXTON'S
FIREBRICK WORK

In many of the largest plants in Canada. Using only the best High Tension Fire Cement, he handles the work RIGHT—and without waste of time. That's why it lasts longer and gives 100% satisfaction.

Whether it's building-in boilers, general repair work (renewals and repairs for all kinds of shaking and dumping grates)—see SEXTON first.

THE W. R. SEXTON BOILER SETTING CO.
Established 1900 114 Grenadier Road, Toronto *Phone: Junc. 2765W*

Established 1907 **POWER HOUSE** Member A.B.C.

B. G. NEWTON, Manager
CANADA—**Toronto** (head office): 153 University Ave., Tel. Ad. 5740. **Montreal**: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. **Winnipeg**: 810 Confederation Life Bldg., Tel. Main 3449.

S. S. MOORE, Advertising Manager
UNITED STATES—**New York**: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. **Chicago**: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. **Boston**: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—**London**: The MacLean Company of Great Britain Limited. 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A
Audel, Theo. 45
Allen Feed Water Purifier Co... 16

B
Babcock & Wilcox, Ltd.......... 37
Betson Plastic Fire Brick Co., Inc. 43
Brown Instrument Co. 43
Bristol Co. 6
Buyers' Directory 42, 44, 46
Bird Archer Co. 8
Burnett, J. A. 45
Bell Fire Brick Co. 45

C
Callard, Geo. 45
Canadian Fairbanks-Morse Co., Ltd. 2
Conveyors Corp. of America... 43
Cory & Sons, Inc., Chas........ 6
Combustion Engineering Co.... 13
Cunerty Co., T. J. 41
Can. Allis Chalmers Co. 3
Can. Steam Boiler & Equipment Co. 43
Celite Products 43

D
Dart Union Co. 4
D'Este Co., Julian 11
De Laval Steam Turbine Co.... 4
Detroit Stoker Co. 7
Dominion Belting Co. 47
Dominion Engineering Agency.. 43
Dunham Co., C. A. 37
Durabla Mfg. Co. 2

E
Engineering and Mach. Works of Canada 8
Edward Valve & Mfg. Co. 16

F
Fisher Governor Co. 9
Foxboro Co. Inc. 47
Flexible Steel Lacing Co........ 12
Flexible Metallic Packing Co... 14

G
Garlock Packing Co. 47
Garth Co., The 41
Gates Engineering Co. 14
Goldie & McCulloch 18
Gutta Percha & Rubber Co..... 5

H
Hays Corp., Jos. W.......... 16

I
Irving Iron Works.......... 12

J
Jeffrey Mfg. Co. ....Inside Back Cover
Jamieson Cold Storage Door Co. Inside Front Cover
Jenkins Bros. ....Front Cover
Jointless Fire Brick Co. 17

K
Kirby & Co. 41

L
Laurie Engine Co. 43
Leitch, Arthur S. 15

M
Magnolia Metal Co. 17
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncrieff, Ltd. 43
Midwest Canada, Ltd. 47
MacLean Underfeed Stoker Co.. 17

P
Pilley Packing & Flue Brush Mfg. Co. 41

R
Refinite Co. of Canada 41
Rule, A. E. 45

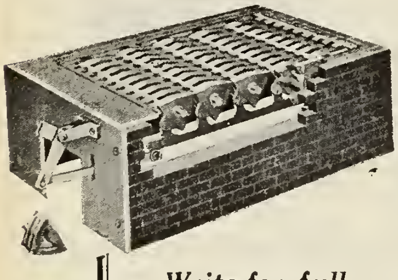
S
Superheater Co., Ltd.......... 48
Sterne & Sons, G. F.......... 14
Sarco Co.. Inc. 9
Sanford Riley Stoker Co...... 10
Shell Bar Boico Supply Co...... 48
Sterling Engine Co. 11
Sturtevant Co. 45
Stephen Chemical & Mfg. Co., Limited 45
Stephens, H. P. 43
Smart-Turner Machine Co., Ltd. 11
Sexton Boiler Setting Co., W. R. 47

T
Taylor Instrument Co.. The.... 12
Thomson-Gordon, Ltd. 41

U
Underfeed Stoker Co. of Canada 10

W
Wall, W. J. 43
Waterous Engine Works Co.... 1
Watson & McDaniel Co.......... 41
Watson, M. Barry, M.E.......... 45

Y
York Mfg. Co. 43
Young Pump Co. of Canada.... 15



Anti-Clinker
SHELL-BAR GRATE BARS

Designed and built by men with practical experience, the Shell-Bar Anti-Clinker Grate Bars are built to

Get the last bit of heat out of the last bit of fuel

Maximum air space permits perfect combustion even of low-grade fuel. Nothing is burnt to waste—nothing is wasted in clinkers. Wherever they are used they are giving more heat with less fuel.

Write for full particulars

SHELL-BAR BOICO SUPPLY, Limited 1-15 Saunders Ave. **TORONTO**

SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

SUPERHEATERS
ELESCO
DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES
FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA
THE SUPERHEATER CO., LIMITED, Transportation Bldg., Montreal
WORKS AT SHERBROOKE, QUE.

Some of the Advantages of the Jeffrey Standard Scraper Conveyor

Simplicity—It does not consist of much machinery and does not require much wood or steel for support.

With timber supports it may be quickly installed as a temporary or permanent equipment in power house extensions.

Can be readily inspected. Consists of no complicated parts either in steel chains or its Scrapers.

Wide range of Service from one conveyor. May be installed on the horizontal, on an incline, or as a combination in one conveyor of both horizontal and incline or two inclines, with the joining connection between the horizontal and incline or the two inclines being made in a curve of large radius.

Low upkeep and ease of repair.

Write for Catalog No. 257 on Jeffrey Standard Scraper Conveyors.

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms, Montreal

JEFFREY
MATERIAL HANDLING MACHINERY

MORRISON'S

STEAM GOODS

The J. M. T. Reducing Valve

"Every installation is a demonstration of merit"

Since the introduction of this J.M.T. Valve there has been no "problem" of pressure reduction of air and steam. A sudden change in the low pressure demand, or variations in flow and pressure on the high pressure side, have no effect on the constant low pressure maintenance.

The Morrison catalogues give full particulars of this and the other Morrison Steam Goods. Have you a copy?

The James Morrison Brass Mfg. Co., Limited
93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Fostering Economy in the Development of Power for All Industries

Vol XVI—No. 19

Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.

October 5, 1923

CELITE PRODUCTS LIMITED.
New Birks Bldg., Montreal, Canada

CELITE PRODUCTS
BARRIERS
TO INDUSTRIAL WASTE
SIL-O-CEL
HEAT INSULATION
FILTER-CEL
FOR FILTRATION
CELCOTE
BOILER WALL COATING
FRAXITE
HIGH TEMPERATURE CEMENTS

YOU HAVE TO DECIDE
Between Long Service and Low First Cost When You Buy a Rod Packing.

Reason will tell you that a packing that will stand up and give long service under high pressure, superheated steam, and compressed air, must be made of materials that are not cheap.

To meet the exacting conditions a rod packing must be made of the best materials obtainable.

YOU CANNOT AFFORD TO TAKE CHANCES.

IT IS A WELL KNOWN FACT THAT

TRADE MARK

"PALMETTO" PACKING

will outlast other packings because it is made of materials usually considered too good for packing. It is thoroughly lubricated in each single strand before braiding, and not superficially lubricated like other packings.

If you don't know that "Palmetto" gives longer service than other packings then let us send you at our expense working samples to test under your own conditions.

GREENE, TWEED CO.

Sole Manufacturers

109 DUANE ST., NEW YORK

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

WATEROUS STEEL PLATE **TANKS**

We have made a success of building steel tanks and plate work by specializing in it and our thirty years' experience has shown us how to turn this work out right.

If you are in need of a tank of any shape or size, either welded or rivetted, let us have your specifications.

We have had many years' experience in welding tanks and plate work and our method of welding makes it impossible for our tanks to leak.

Let us quote on
Steel Tanks,
Troughing,
Steel Chutes,
Conveyors,
Steel Pipes,
Steel Stacks.

On your next tank or plate order get our prices.

Waterous

BRANTFORD, ONTARIO, CANADA

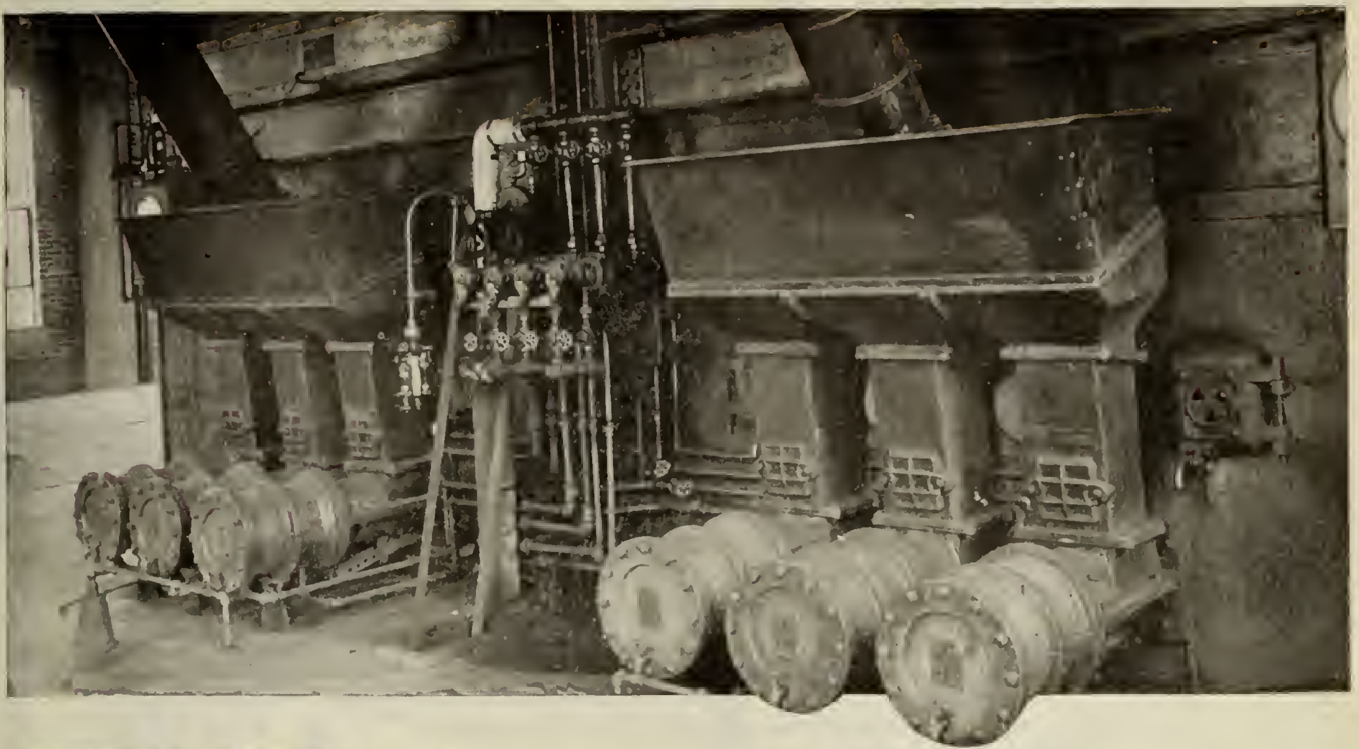
GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO • CANADA
Sales Offices - - Coast to Coast



Which Stoker?

-You Make this Decision Once-It Must be Right

EXPERIMENT with any equipment is costly — but experiment with mechanical stokers is out of the question. The investment is large; it is made once in a lifetime; snap judgment won't do—*which stoker?*

Canadian plants want greater boiler capacity—continuous power day and night when necessary—they want this accompanied by greater economy in burning Canadian coals and by lower labor costs.

This means *high-duty stoker firing*, best exemplified by the "Jones A-C" (Automatic-Cleaning) Stoker.

Regardless of the size of the plant, the grade of coal burned or the local conditions to be met, the logical, safe answer to "*which stoker?*" is "Jones A-C."

The new "A-C" catalog goes into detail. "Jones" engineers, with unmatched experience in this specialized field, will gladly make a survey of your plant and give you the full benefit of the best they have learned in installing stokers in many prominent power houses. Investigation implies no obligation.

"Jones" and "Riley" Stokers

"Murphy" Furnaces

RILEY JONES
The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
MURPHY

The Under-Feed Stoker Co. of Canada, Ltd.
146 King St. West, Toronto

Alberta and Saskatchewan:
Mr. J. Twomey, Camrose, Alberta.
Manitoba:
W. W. Hicks & Co.,
567 Banning St., Winnipeg.

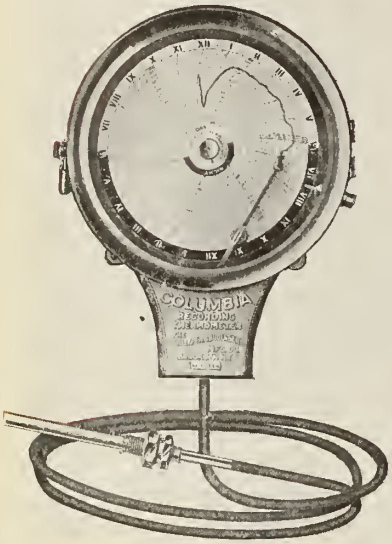
British Columbia:
E. A. Earle, Limited,
729 Hastings St. W.,
Vancouver, B. C.

Quebec:
The Cleaton Co., (Canada), Ltd.,
403 Southam Bldg.,
Montreal, Que.

JONES "A-C" STOKERS

The Recording Thermometer

PLUS!

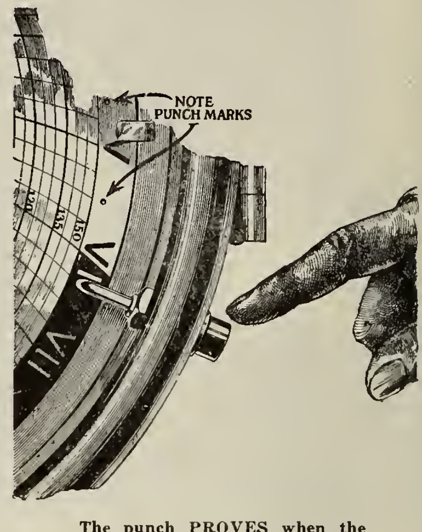


COLUMBIA
Recording Thermometer

insures **not only** correct records **but also** that the records are **read** and **read** at **regular intervals.**

The tremendous importance of this exclusive patented device is readily understood. No other thermometer can use it.

It will pay you well to write for detailed description.



The punch PROVES when the thermometer was read.

Exclusive agents for Canada.

The Canadian FAIRBANKS-MORSE Company, Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver, Victoria.

99

Tight Joints

On Steam, Water, Air, Oil, Ammonia and Acids at All Temperatures

Place Durabla Packing in the next joints you make and be insured against costly shutdown.

Durabla Compressed Asbestos Fibre Gasket material is not affected by vibration or condensation. It will not burn out, blow out, or pulp at the joints.

Made in Canada in stock sizes 36 in. wide by 150 in. long in thicknesses of 1/64, 1/32, 1/16 and 1/8 in.

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

GARLOCK Oilblack Sheet Style No. 353 is a new product. It is a strong, durable general service rubber sheet packing with pronounced oil resisting qualities. This sheet is designed for use on water, oil, low and medium pressure steam, and for general power plant use.

A sample for trial in your plant will be furnished upon application.

THE GARLOCK PACKING COMPANY

HAMILTON, ONTARIO

BRANCHES:

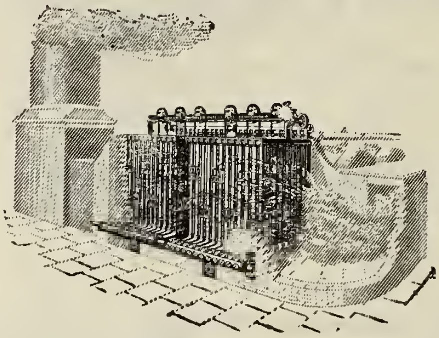
MONTREAL, QUE.
CALGARY, ALTA.
TORONTO, ONT.
ST. JOHN, N.B.
WINNIPEG, MAN.
VANCOUVER, B. C.

More Steam -- Less Coal

Up-to-date Boiler plants are saving thousands of tons of coal annually by the installation in the main flue between the boilers and the chimney stack of a

Green's Fuel Economiser

which by utilising high temperature flue gases



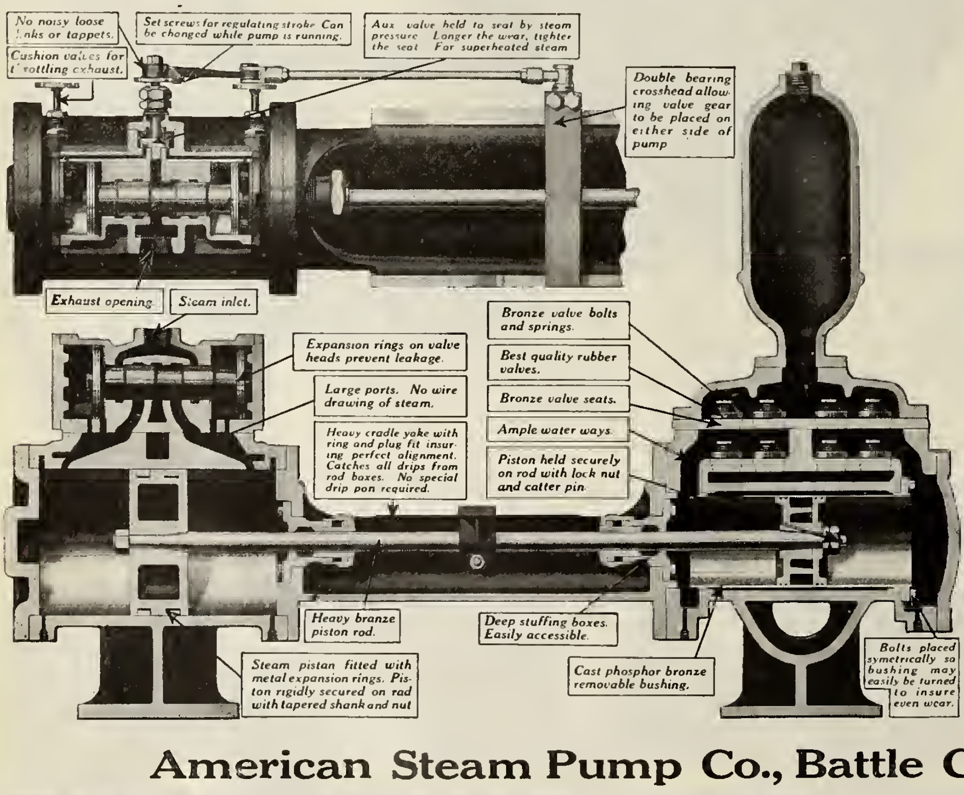
SAVES 15-20% OF COAL

Write for illustrated and descriptive Catalogue D.J. to—

E. GREEN & SON, Ltd., Wakefield, England

Codes: A.B.C., 5th Edition; Bentley's Phrase; A1; Lieber's; Engineering; Western Union.

AMERICAN--MARSH PUMPS


No noisy loose links or tappets.
Set screws for regulating stroke Can be changed while pump is running.
Aux valve held to seat by steam pressure Longer the wear, tighter the seat For superheated steam
Cushion valves for throttling exhaust.
Double bearing crosshead allowing valve gear to be placed on either side of pump
Exhaust opening.
Steam inlet.
Bronze valve bolts and springs.
Expansion rings on valve heads prevent leakage.
Best quality rubber valves.
Large ports. No wire drawing of steam.
Bronze valve seats.
Heavy cradle yoke with ring and plug fit insuring perfect alignment. Catches all drips from rod boxes. No special drip pan required.
Ample water ways.
Piston held securely on rod with lock nut and cotter pin.
Heavy bronze piston rod.
Deep stuffing boxes. Easily accessible.
Steam piston fitted with metal expansion rings. Piston rigidly secured on rod with tapered shank and nut
Cast phosphor bronze removable bushing.
Bolts placed symetrically so bushing may easily be turned to insure even wear.

THE illustration tells its own story. Why the American-Marsh are the most reliable, trouble-proof and efficient pumps on the market.

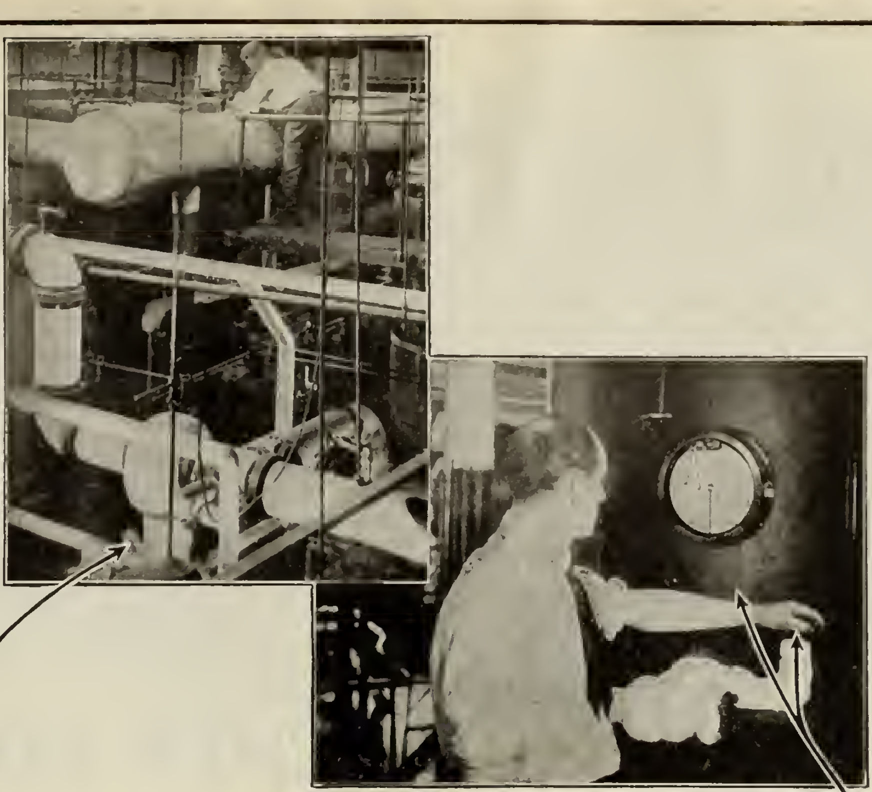
Less than one-half the wearing parts found in the duplex type while a saving of 25% in steam consumption is guaranteed.

Over 160,000 in successful operation.

Ask for catalog.

Canadian Agents: A. R. Williams Machinery Co., Ltd., Toronto and Winnipeg; Williams & Wilson, Ltd., Montreal. Bissett Pinder & Co., Edmonton. Stephens & Boyle, Vancouver. London Engine Supplies Co., London.

American Steam Pump Co., Battle Creek, Mich.



This hand tells the story

To regulate this brine cooler. they had to journey from the control valve (shown by the arrows) to a thermometer behind some pipes at the back of the cooler, then up a ladder at the far end of the room to the thermometer atop the cooler and from there back to the valve—and after setting the valve the only way to tell whether it was right was to make the trip again.

Some job!—and, naturally, the operators preferred guesswork to footwork and control was far from perfect.

With a Foxboro Long Distance Two-Pen Recording Thermometer installed, accurate control becomes at once a matter of course.

From 40 to 90 minutes a day are saved by using the one recorder. The time saved plus the improvement in cooler operation pays for the installation many times over.

The operator has an accurate, continuous record of both incoming and outgoing brine temperatures. He can determine cooling effect at a glance and adjust the valve accordingly. The superintendent has a permanent record of cooler operation.

The bulbs of the Foxboro Recording Thermometer can be placed 500 feet from the recorder case.

Check up the places in your plant where you can improve conditions and save money by installing the Foxboro Long Distance Recording Thermometer.

For places where you need a single temperature indication, without a record, the Foxboro Long Distance Dial Type Thermometer is accurate and easy to read—therefore often read.

Write for Bulletin CF-104-1.

THE FOXBORO CO., Inc.

Foxboro, Mass. U.S.A.

New York Chicago Boston Philadelphia Pittsburgh Cleveland
Rochester Birmingham Tulsa Los Angeles San Francisco
Portland, Ore.

PEACOCK BROTHERS, LIMITED, 179 Delorimier Avenue, MONTREAL, CANADA.

FOXBORO
TRADE MARK
THE COMPASS OF INDUSTRY

BOILER CHEMICALS

Made in Canada for You

Do it Now

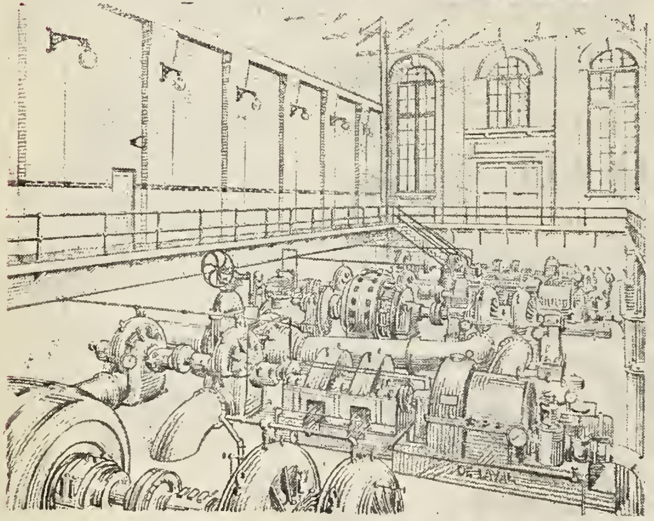
Not a hit-and-miss ready-made compound, but made for you on scientific principles.

Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal Factory: Cobourg

De Laval Pumping Equipment in Canada



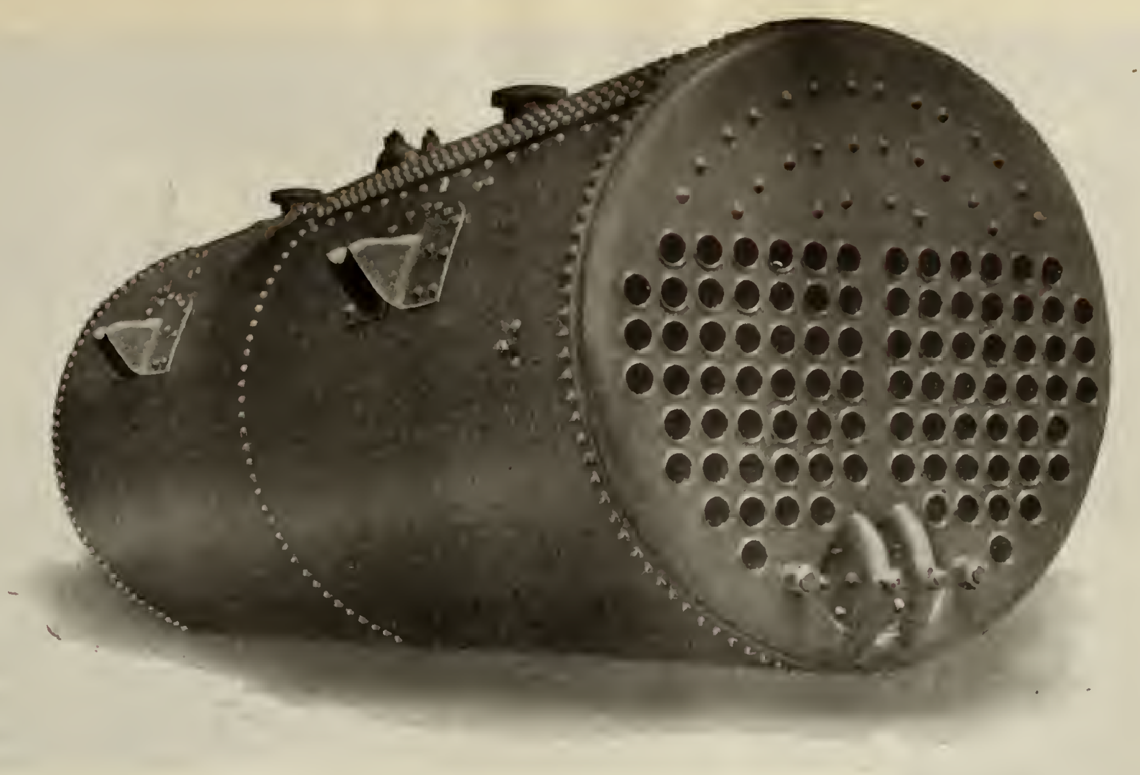
THE John Street Station of Toronto, here shown, has twice made new records for duty with its De Laval geared steam turbine driven centrifugal pumps. The remarkably high percentage of De Laval Centrifugal Pumps in installations using electric power throughout Canada, as at Toronto, Hamilton, Burlington, Montreal, Lindsay, Brockville, etc., is also evidence of the practical value which engineers attach to simplicity, durability, low power consumption, the power limiting characteristic and the low starting torque inherent in De Laval pumping units.

State your pumping conditions and ask for Special Publication W-100.

De Laval Steam Turbine Company

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto
THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

322



When you need a new Boiler, let this plant show you what it can do

With our 35 years' experience, we are able to turn out Boilers of all types at low first cost, of high efficiency and long service records, and with minimum stoppages for repairs.

The construction is carried out with scrupulous care at every step. All rivet holes are accurately laid out—no drift pins being used. Caulking edges are neatly bevelled and all seams thoroughly caulked. Tube holes in heads are accurately machine-cut and edges carefully chamfered. All tubes are expanded and beaded over at both ends. On completion all boilers are tested to at least one and a half times their working pressure before leaving our works.

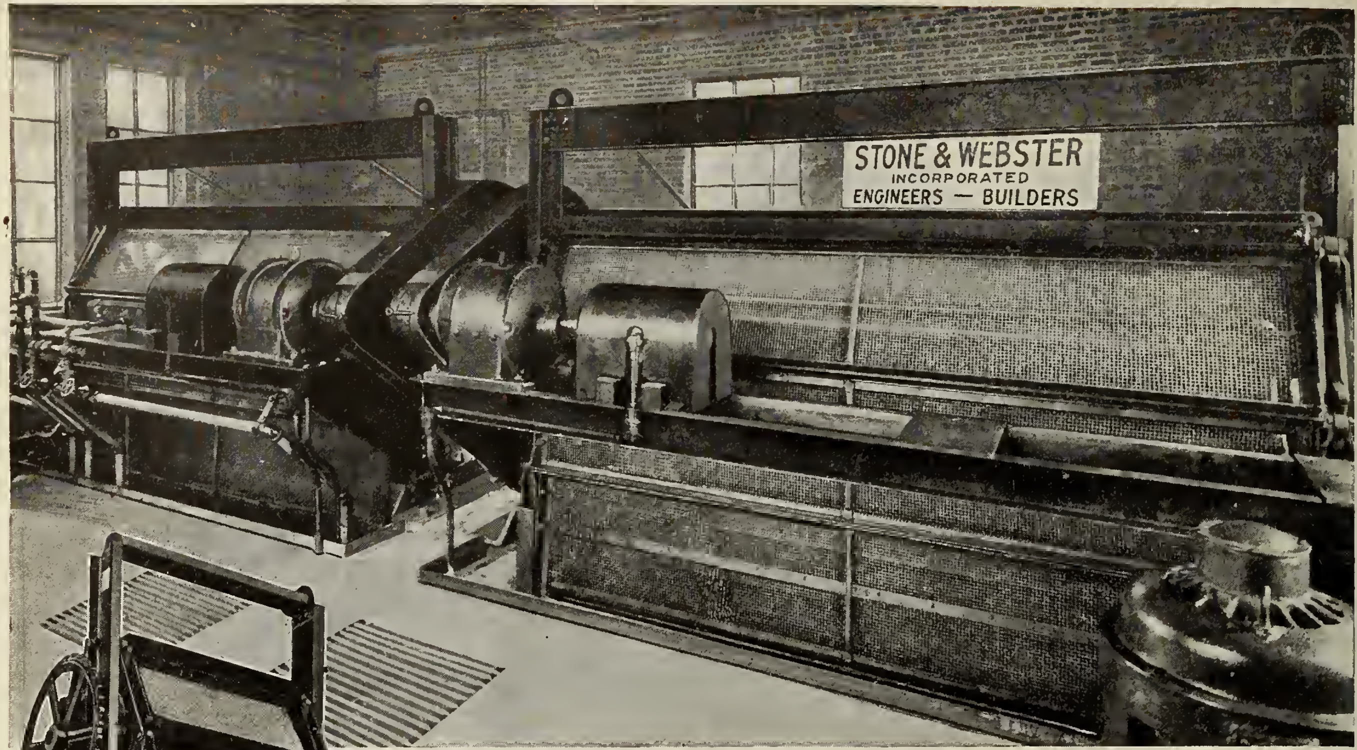
We build to suit the Interprovincial Boiler Code and we can ship economically by rail or water. Let us show you what we can do for you.

We build Horizontal Return Tubular, Vertical Tubular, Locomotive Type and Marine Boilers. We construct Tanks, Penstocks and Steel Plate work of all kinds. We furnish gray iron and brass castings of any size in the rough or machined to order.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Building, Montreal



Traveling Water Screens

THE function of the Link-Belt Traveling Water Screen is to automatically remove all debris and rubbish from the water which passes through them. A steady supply of clean water to the condensers is thus assured at all times. They are self-cleaning and require little attention. Let us tell you more about them.

Link-Belt traveling water screens, as illustrated, were selected by Stone & Webster, Inc., Engineers and Builders of the new Hartford Electric Light Co. power plant, at Hartford, Conn.

The Link-Belt line includes complete coal and ashes handling equipment; elevators and conveyors, the Peck Carrier, locomotive and crawler cranes, electric hoists, portable loaders, skip hoists, drag scrapers, crushers, chutes, gates, weigh larries, coal bunkers, track hoppers, etc. Let our experienced engineers suggest better ways and means for handling your coal and ashes. Send for catalogs.

LINK-BELT LIMITED
(FORMERLY CANADIAN LINK-BELT LIMITED)
TORONTO—Wellington and Peter Sts. MONTREAL—10 Gauvin Lane

LINK-BELT

Automatic Valved Soot Blowers

Diamond "Valv-In-Head"

Soot blowers having automatically operated valves were originated and developed by us, and are covered by patents issued and pending. Infringements of these patents will be prosecuted.

Diamond Specialty Limited, Windsor, Ont.

Yarway Blow-Off Valves have Given Willys-Overland Co. Excellent Service for 13 Years

In 1910 the Willys-Overland Company installed their first Yarway Seatless Blow-Off Valve, in the plant at Toledo, Ohio. They have sent in a number of repeat orders, the last one a few months ago. From the last report, these valves have given excellent results.

The Yarway Seatless Blow-Off Valve is built especially to withstand the destructive action of mud, grit and sediment under high pressure. It has no-seat-to-leak; therefore, it stays tight, keeps the water and steam where they belong, and saves fuel.

The Yarway Seatless and the Yarway Double-Tightening Valves in tandem, form the ideal combination for blow-off service, complying with boiler laws of every state.

We shall be glad to send you a copy of our Booklet B-410, in which both valves are fully described—write for it.

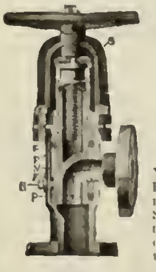
Some of the Yarway Seatless Blow-Off Valves in service at the plant of Willys-Overland Company, Toledo Ohio.

YARNALL-WARING CO.

Mermaid Lane & Ardleigh St., Philadelphia

207 St. James St., MONTREAL

400 Penobscott Bldg., DETROIT.

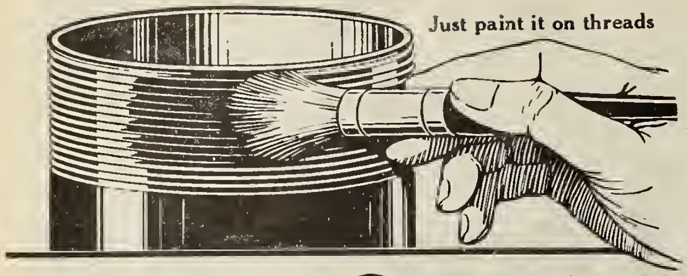


Yarway Seatless Blow-Off Valve (formerly the Simplex) Send for celluloid model illustrating operation of this unique valve.

YARWAY

POWER PLANT DEVICES *to save fuel*

YARWAY BLOW-OFF VALVES—YARWAY SPRAY NOZZLES—YARWAY-LEA V-NOTCH METERS


Just paint it on threads

Perfect Screw-Thread Joints

HOW TO MAKE THEM: Apply Smooth-On No. 3 to the threads with a brush like paint, screw the pipe or fitting into place, and forget it forever.

Smooth-On No. 3 will stand extremely high pressure and temperatures of water, oil, air, steam, or super-heated steam, and is not affected by vibration or violent changes of temperature, because its metallic body can never shrink, shrivel, crack or dry out.

Write for a free sample can and then buy your additional supply in 1-lb., 5-lb. or 10-lb. gray-labeled tins, from any hardware or supply dealer.

The Canadian Asbestos Co.

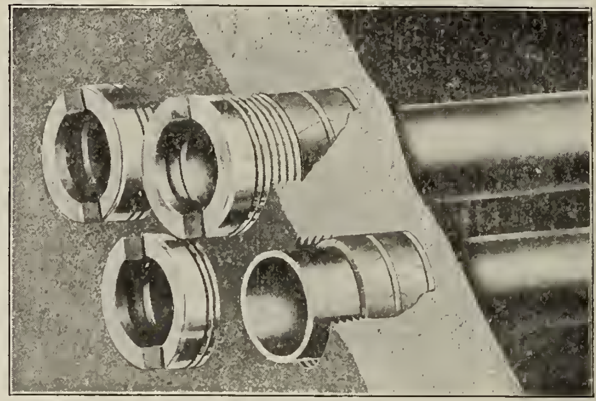
Dept. 52 Montreal, Que.

Do it with **SMOOTH-ON**

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING



Scientifically Correct

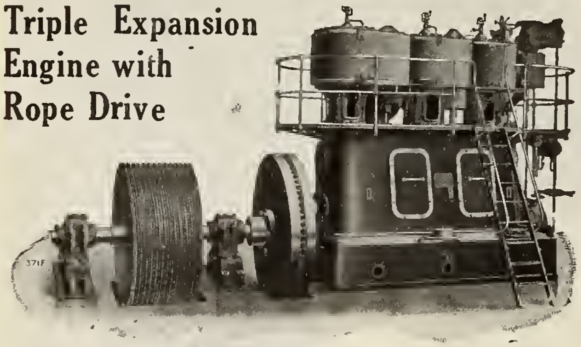
Condenser Packing

Disintegration of tube ends is due largely to electrolytic action. "JOHN CRANE" Metallic Packing (patented) for condenser tubes, overcomes this action. It offers a path of low resistance between tube and sheet. Further, it does not crush or deform tubes either at time of installation or through later expansion. Quick and easy to apply with latest installation tools. In wide use by manufacturers and operators of condensers.

INVESTIGATE! Interesting text book upon request.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
Beldam's Asbestos Packing & General Mfg. Co., Ltd.,
Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B. C.
"MADE IN CANADA."

Triple Expansion Engine with Rope Drive



Belliss & Morcom Ltd.
Birmingham, England

Builders of:

STEAM ENGINES
AIR COMPRESSORS
STEAM TURBINES
CONDENSERS
CRUDE OIL ENGINES

Packing for Centrifugal Pump Spindles will not cut

Maxim Silencers

for Air Compressor Suction, Gas Engine Exhausts, etc.

Welldeck Steam Traps

do not get out of order

AGENTS:

LAURIE & LAMB, Board of Trade Bldg., **MONTREAL**

A Jenkins Disc is quickly renewed

without removing the valve from the line

A JENKINS Disc in a Jenkins Valve is the right combination—a tight-closing valve is assured. The disc has very long life, and, when necessary, it can be quickly renewed with the valve left in the line.

The compositions of the various Jenkins Discs are the result of constant study and 58 years' experience in disc manufacture. Each is exactly suited to the particular service for which it is intended. The schedule at the right gives the principal discs and their use.

Use the disc ONLY in the particular service for which it is recommended. If in doubt as to the kind of disc you need, let us know what work it is expected to do and, we will recommend the right one or prepare a special composition to suit your requirements.

A JENKINS VALVE fitted with a JENKINS DISC—
assurance of perfect valve performance.

Schedule of Principal Compounds and Service for Which Jenkins Discs are Guaranteed

NO. 119—This is the disc which is regularly used in all Jenkins Standard Globe, Angle, Cross, Y or Blow-off, Safety and Radiator Valves when intended for steam service. It is dark red in color. The composition is tough and flexible in service when under steam pressure. It shows remarkable freedom from cracking and flaking and unrivalled durability in working steam pressures up to 150 pounds.

No. 80—A disc of dark gray composition for steam service. It is extremely hard although sufficiently elastic under pressure to insure perfect tightness.

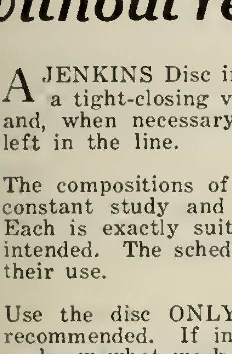
No. 110—A tough, semi-hard disc especially recommended for hot water service. This is the composition regularly used in Jenkins Check Valves, both standard and extra heavy, horizontal and swing patterns, when intended for boiler feed lines and returns.

No. 93—Rubber disc made expressly for cold water, gas or air service, and regularly supplied in all Jenkins Globe, Angle or Check Valves when intended for such service. This is a tough, pliable composition suitable for hydraulic pressures up to 350 pounds.

No. 94—A soft, tough, elastic disc for low pressures of water, gas or air. Suitable for use in valves or other devices where a tight closure is desired with a minimum amount of pressure applied to disc.

JENKINS BROS. LIMITED

HEAD OFFICE AND WORKS: 103 St. Remi St., Montreal.
SALES OFFICES: Toronto, Vancouver.
EUROPEAN BRANCH: London, W.C. 2, England.
FACTORIES: Montreal, Bridgeport, Elizabeth.



Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

LINDE

Made in Canada since 1896

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Making Plants Large and Small

Vertical Enclosed Type Machines made for capacities from one to fifty tons.

Horizontal Frame Heavy Duty Type Machines made for plants up to 300 tons capacity.

LINDE Machines embody every improvement that adds efficiency and durability, and are the ultimate development of specialized engineering and manufacturing experience during fifty years.

All present-day Linde Machines are fitted with our patent silent valves, giving increased efficiency and guaranteed to be mechanically silent in operation.

Linde Machines will do the most work for the least money.

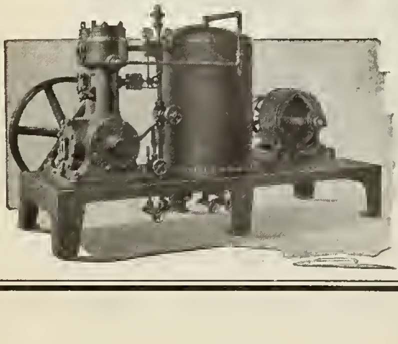
The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

VILTER

ICE MAKING AND REFRIGERATING MACHINERY



A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY

Established 1867

242 BEECHER ST., MILWAUKEE, WIS.

Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada

Nonpareil Cork Covering on brine lines at the City Hospital, Cleveland, Ohio

Put On In Sections

NONPAREIL Cork Covering comes to you ready to apply—36-inch split sections for pipes and molded jackets for fittings. Cement the joints, wire in place and paint. Simple, neat, and permanent. No troweling or wrapping. No messy waterproofing. Nonpareil Cork Covering is finished at the factory with moisture-proof mineral rubber.

Like Nonpareil Corkboard, Nonpareil Cork Covering is made of clean, dry granules of pure cork, compressed in molds and cemented with its natural gum—the most efficient low-temperature insulation known. Nonpareil Cork Covering prevents at least 80 per cent. of the refrigeration loss from uninsulated lines and the saving is usually enough to pay for the insulation in much less than a year.

And, best of all, it is permanent. Apply it properly in the first place, keep the wires tight, and paint it once a year, and Nonpareil Covering will last as long as the pipes.

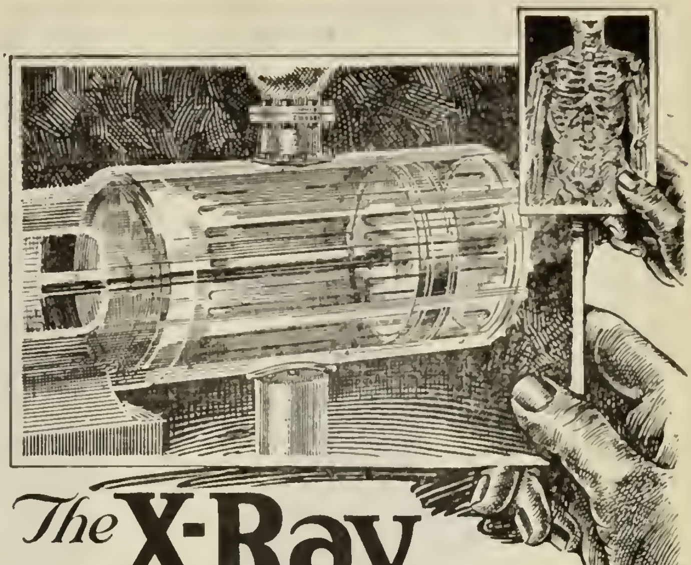
Have you had the new booklet, "Permanent Covering for Refrigerated Lines and Tanks?" Write for a copy; it is sent free.

Armstrong Cork & Insulation Company, Ltd.
902 McGill Bldg., Montreal Que.
11 Brant St., Toronto, Ont., Can.

Also manufacturers of Nonpareil Corkboard Insulation for cold storage and ice storage Rooms; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Cork Covering

For All Cold Lines



The X-Ray of the Engine Room

How often you have said to yourself—"If I could only see what is going on inside of that engine I would find out in an instant what is wrong!"

But when you said this you didn't stop to think of the possibility of doing this very thing by using an

AMERICAN
THOMPSON
IMPROVED INDICATOR

By means of this sensitive instrument you can virtually look into your engine and locate internal troubles, just as the surgeon looks into the human body and ascertains the cause of certain disorders with the X-Ray. **The American Indicator is the X-Ray of the engine room.**

If a valve is leaking or improperly set, causing too much lead, late admission, too much compression, too early cut-off, late release, unequal cut-off, etc.—if your eccentric has slipped back or is too far ahead—if there is loss of steam pressure due to improper piping—the American Indicator shows it.

It gives the exact horsepower developed at every point of the stroke. A score or more of engine troubles are as clearly put before you by the American Indicator as though the internal workings of your engine were plainly visible.

Many features and refinements not found in other indicators render the American most accurate, durable and easy to use.

Our Catalog T-33 explains these features in detail. Write for a copy to-day.

American Schaeffer & Budenberg Corporation
SUCCESSORS TO
Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO. DIVISION
BROOKLYN, N.Y.

Peacock Bros., Limited
Montreal

KERR

"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville Ontario

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE MEANS ECONOMY

Let us know your requirements. We will solve the problem.

Write us Today

Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.

REFRIGERATION SUPPLIES
REPAIRS - FITTINGS
AGENT FOR FRICK REFRIGERATING EQUIPMENT
REFRIGERATING ENGINEERS
LIMITED
457 King W. TORONTO Adel. 7753

REFRIGERATING MACHINERY
Expansion Pipe Ammonia Fittings. Calcium Chloride.
Ammonia. Ice Machines.
Agents for "TRIUMPH" Ice Machines.
J. L. WILSON & SONS
REFRIGERATING ENGINEERS.
3 SILVER AVE. TORONTO

Tycos *and* Steam Pressure

Standardize the operations in your plant by keeping and studying *Tycos* Records of steam temperature and pressure.
There is a *Tycos* Pressure Recorder showing steam line pressures continuously day and night on one chart. There is a Bi-Record Recording Thermometer and Pressure Gauge for giving both temperature and pressure records on the same chart. *Tycos* Temperature and Pressure Recorders are rugged and reliable, characteristics desired by all power plant operators.
Tycos Engineers are at your service. Send details of your problems for co-operative advice.

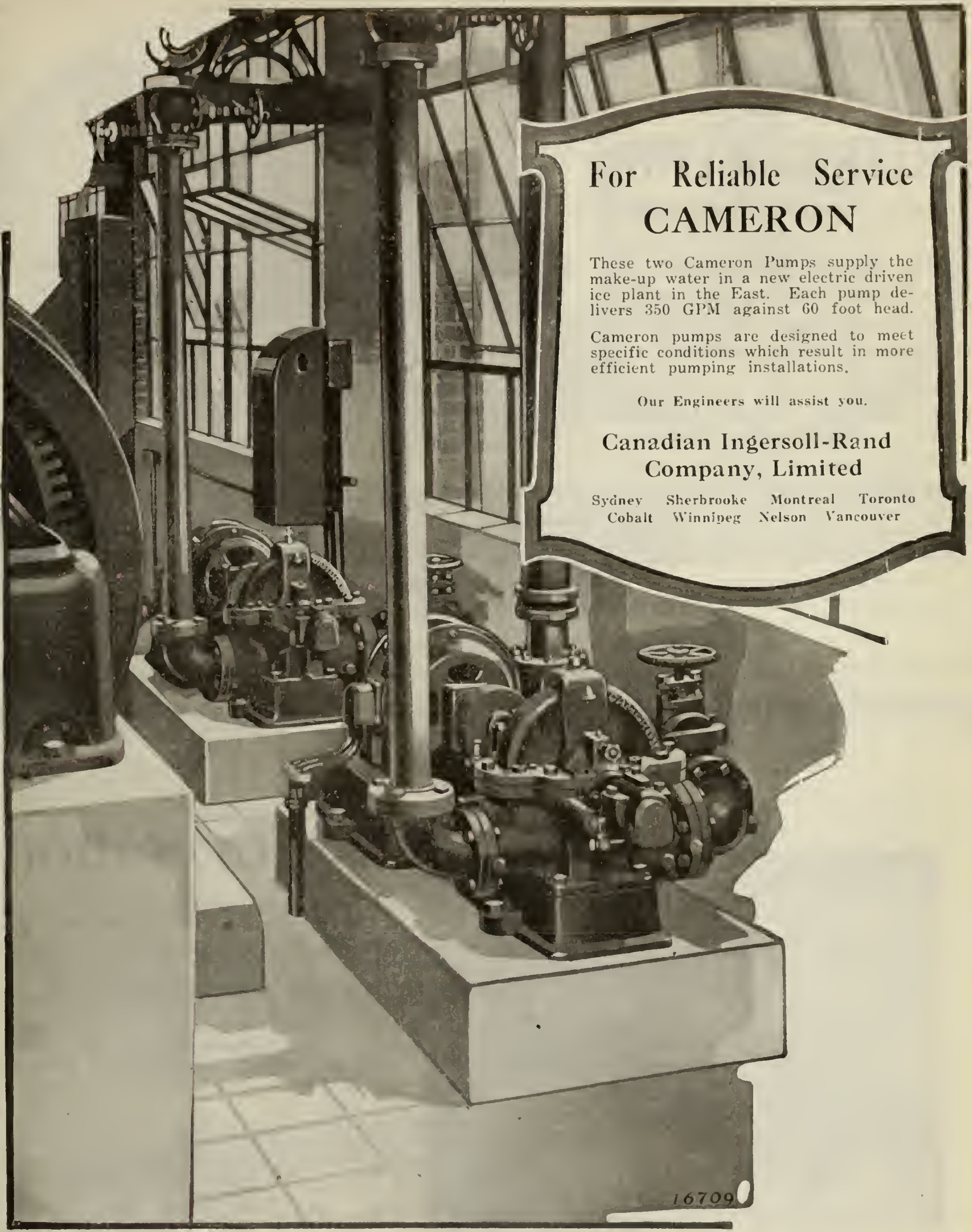
Write to-day for our General Industrial Catalog.

Taylor Instrument Companies
110-112 Church St.,
Tycos Bldg., Toronto

There is a *Tycos* or *Taylor* Temperature Instrument for Every Purpose.

Indicating
Recording
Controlling

877



For Reliable Service CAMERON

These two Cameron Pumps supply the make-up water in a new electric driven ice plant in the East. Each pump delivers 350 GPM against 60 foot head.

Cameron pumps are designed to meet specific conditions which result in more efficient pumping installations.

Our Engineers will assist you.

Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto
Cobalt Winnipeg Nelson Vancouver

16709

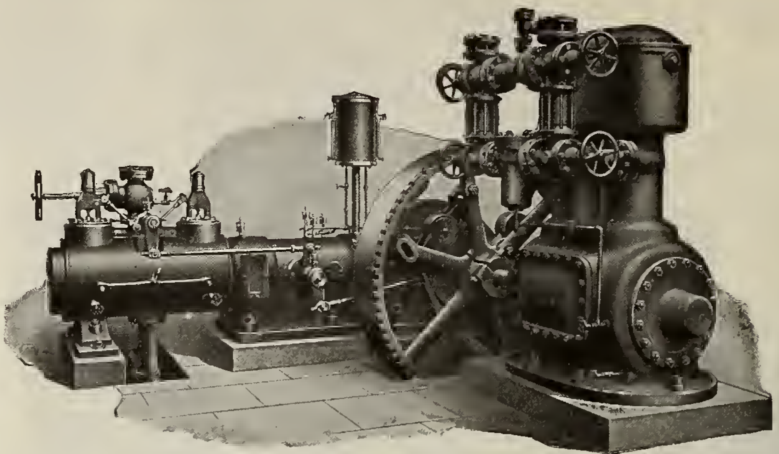
Ingersoll-Rand

Air, Gas and Ammonia Compressors, Vacuum Pumps

FRICK COMPANY, INC.
TRADE FRICK MARK
WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical



Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

---

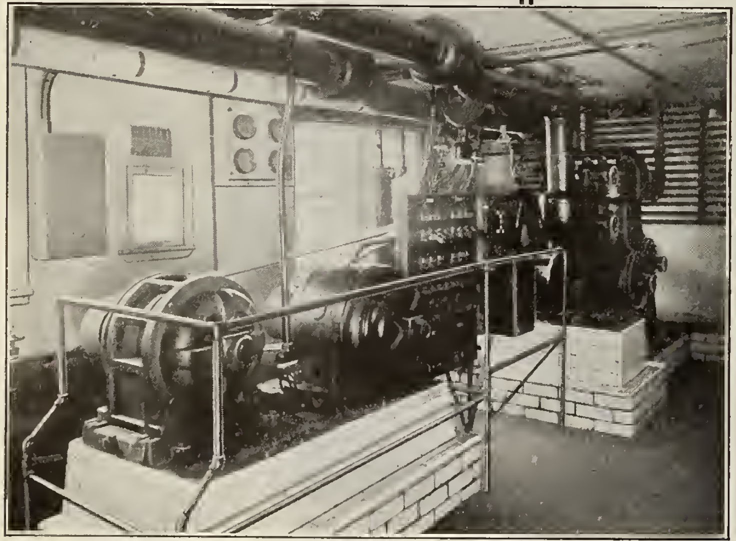
Mechanical Refrigeration

—is an important adjunct to many lines of industry and commerce. In moderate size installations the best results can be obtained by using the—

YORK Enclosed Machine

These machines can be driven by any available power. Their simplicity of construction permits them to be operated successfully by employes, who have had no previous experience in operating one.

They are carried in stock in all our warehouses for prompt delivery. Write our nearest office and give our engineers the opportunity to assist you in solving your Refrigerating Problems.

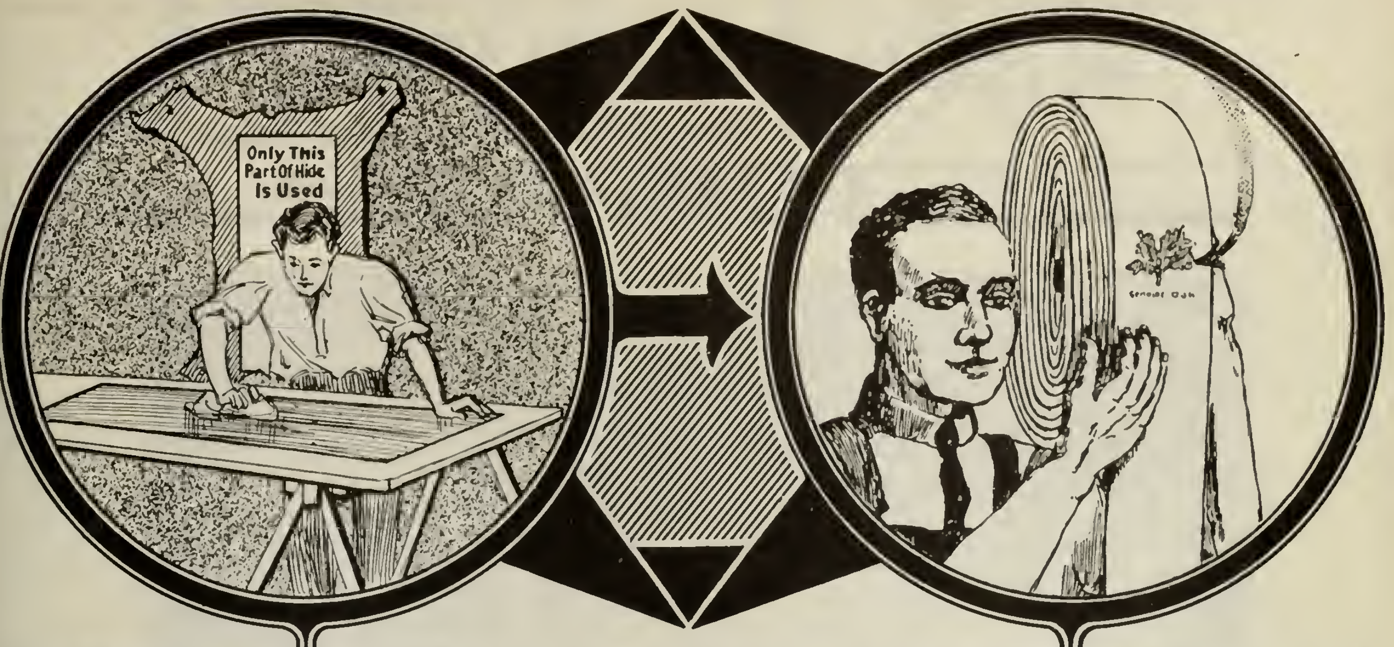


An installation of York Enclosed Refrigerating Machines in a Candy Factory.

Canadian Ice Machine Co.,
Limited

TORONTO	Villiers & Munition Sts., Eastern Harbor Terminal
MONTREAL	324 Craig Street West
WINNIPEG	1415 Whyte Avenue
VANCOUVER	1158 Homer Street

Representing
YORK MANUFACTURING COMPANY
York, Penna., U.S.A.


Only This Part Of Hide Is Used
Genuine Oak

From Currying to the Finished Belt

nothing is spared to maintain
the high quality that has made

D. K. McLaren's GENUINE BRITISH OAK TANNED Leather Belting

So popular with engineers in many of the leading Canadian plants

IN THE face of increased production costs we have continued to use only the **Genuine British Oak Tanning Process.** A process unequalled where strength and flexibility is desired. Likewise, nothing but the back portion of every hide is used, and that only after the hide has been passed by an expert after close inspection.

This policy is appreciated by regular users of D. K. McLaren's Belting who know they can depend absolutely upon getting the same high quality belting at all times and under all conditions.

The Oak Leaf on every length of D. K. McLaren's Belting is a Real Guarantee of Dependability

D. K. McLaren
LIMITED

Head Office and Factory:
351 St. James Street, Montreal, P.Q.

BRANCHES:
Toronto, Ont., 194 King St. W.
St. John, N.B., 90 Germain St.

STOCK DEPOTS: Calgary, Alta., Gorman's Limited; Edmonton, Alta., Gorman's, Limited; Vancouver, B.C., T. M. Grindley Company, 1158 Homer St.

REES RoTURBo

Self Regulating

PUMPS

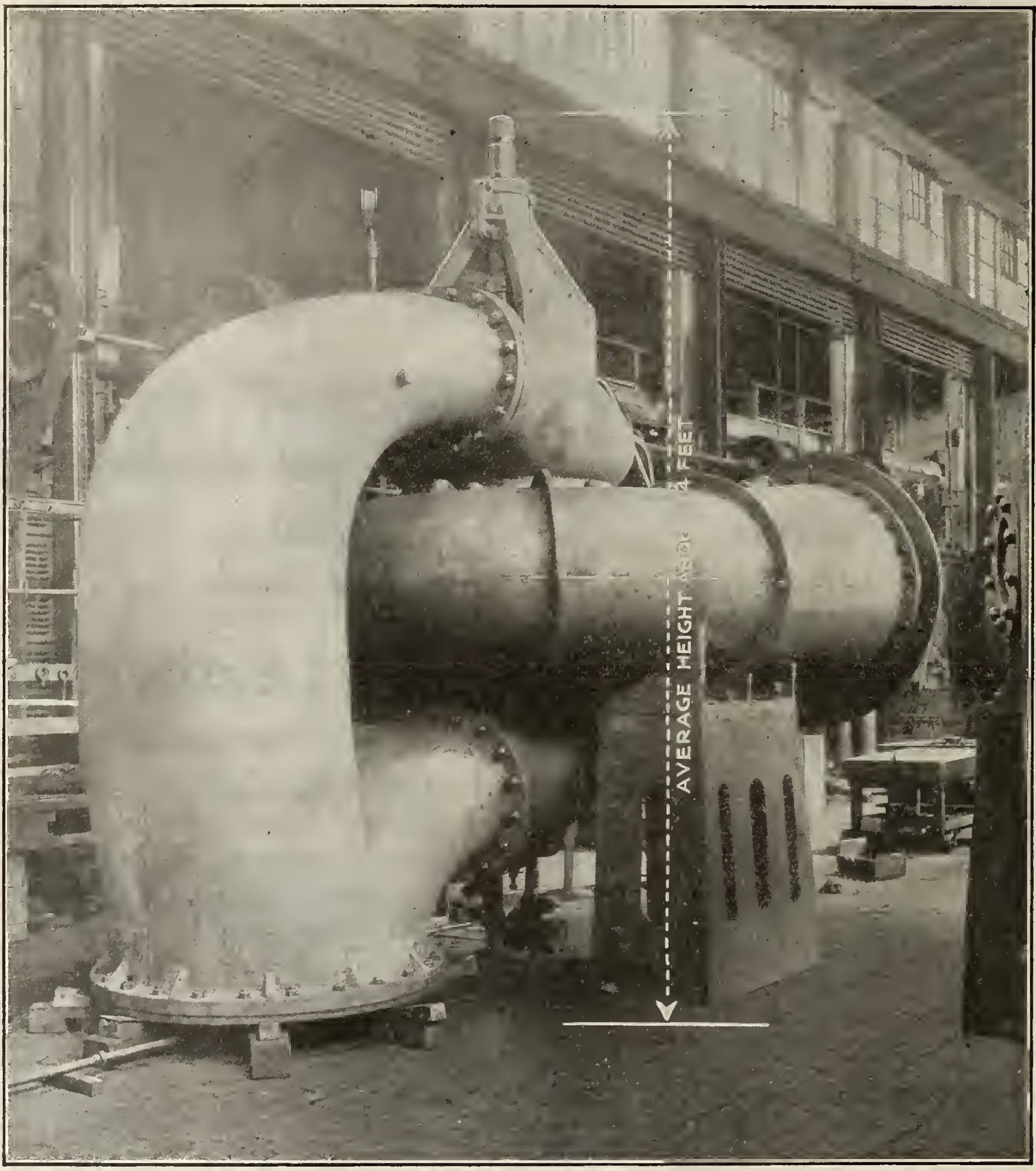


Illustration shows one of TEN REES RoTURBo PUMPS installed or on order for The St. John Drydock & Shipbuilding Co.

The three main pumps, "one of which is shown above" have an average capacity of over 250,000,000 imperial gallons per 24 hours and a maximum capacity of over 300,000,000 imperial gallons per 24 hours.

Ask for the REES Catalogue and any desired information.

THE GOLDIE & McCULLOCH CO., LIMITED

Head Office and Works, GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bldg.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig,
400 St. James St.,
Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B. C.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

N. C. SHATFORD
News Editor

The Reign of Electricity

WHEN men learned to liberate the energies of coal and use the power of steam as a motive force, the old world order passed away and the so-called "industrial revolution," a hundred years ago, ushered in the formative period of modern industry. The use of steam power opened the coal fields and later the oil wells, creating and developing transportation and industry as they are to-day.

Yet, although the possible expansion of industry is unlimited, the existing means of bringing to it energy, in the material form of coal, is daily becoming so difficult and costly that Central Canada at least must soon face once and for all, the problem of obtaining fuel within the borders of the Dominion, instead of depending upon the whims of American coal miners and operators.

It is certain that ever increasing costs and threatened shortages indicate that means must speedily be found of displacing the fuel imported from the United States at $16.50 a ton, whether the solution be in cutting the cost of transportation of coal mined in Alberta at $2 a ton; adequate facilities for coal storage or the reduction of coal to coke in the Maritime provinces at prices which will permit of effective competition in Ontario and Quebec markets.

In any event it is apparent that a fuller and more complete utilization of coal is imperative otherwise the coming decade will surely signal the end of the formative period of industry, and the untrammeled reign of the new motive force, electricity.

This force, virtually energy itself, has the capacity to to work freed from substantial form, devoid of bulk, practically abolishing time in its transmission and to a great extent distance, capable of subdivision and distribution, easy of application and adaptable to a vast range of utilization.

As a motive power, electricity was first applied to portable machinery and the locomotive, but now it has become the driver of numberless devices; in mines for pumps, ventilators, coal-cutters, drills, crushers and hoisting machines; in the iron and steel industry for refining steel and iron, making steel directly from the ore, welding, cutting metals, the electric motor replacing more and more the rolling engine; in textile, pulp and paper mills and mills of every description electricity is gradually replacing steam because of ease of handling; on the farm not only for machinery and irrigation, but even as a stimulant for increasing crops; in electro-chemistry it has limitless potentialities; in communication and in transportation its use is magical—in short although electricity, within the brief period since its advent as a practical factor has been put to such varied and extended usages, the incalculable realm and scope of its application are but beginning to be grasped.

* * * *

Watching an Idea Grow

IT'S as good as a game of golf to watch an idea grow. You know how it is. You take something which seems to be almost nothing. You pass this something to a man who adds something else. Then he passes it to another, and after a while you have something that is a real, great big something.

Well, that's just what happened and the result of it will be spread before you in the October 20 issue of Power House. And some of the ablest men in the power plant field are sure this issue will make every engineer in Canada sit up and think!

* * * *

Controlling Air Supply

SEVERAL prominent engineers have voiced the opinion recently that maximum boiler efficiency will never be obtained until boiler rooms are enclosed in air-tight compartments and the air supply controlled just as rigorously as the quantities of water and fuel.

Until comparatively recently little thought was given to the air supply in the power plant, though it has long been recognized that this is a factor of great importance in gas producer practice, in which latter case, especially in pressure plants, fairly accurate control is actually maintained in daily operation.

Excess air is a very general cause of loss in boiler plants, sometimes amounting to 500 per cent. or more; it results not only in lowering furnace temperatures, thus decreasing radiant heat transmission, but also in carrying away vast quantities of heat in the chimney gases.

Even if the temperature of the latter be as low as 300 deg. Fahr. it is obvious that every pound of excess air sent out of the stack at that temperature has had to be heated uselessly from around 60 deg. Fahr. to that figure, a rise of 240 deg. Fahr.; this represents sheer loss except in so far as the greater volume of gas may enable the chimney to show a better efficiency. Unfortunately most stacks are none too large for their legitimate duty and the increased volume is doubly desirable.

Too little air results in poor furnace efficiency through incomplete combustion and heavy losses are possible with a comparatively small deficiency. There is, therefore, just one point at which maximum efficiency results and draught gauges, recorders and other apparatus are intended to assist the operator to find that point and keep close to it in continuous working. The exact amount of air required in excess of the theoretical quantity to oxidize the fuel depends upon various factors, amongst which the type of fuel and the form of the combustion chamber are two of the most important.

Modern practice leans heavily toward the use of preheated air and early fears that mechanical stokers could not stand the temperatures involved have proved groundless, there being numerous examples where air at 300 deg. Fahr. is being handled with no sign of trouble.

The air is heated by the flue gases either in conjunction with the use of water economizers, or instead of this method, it is possible by the combination of both means to reduce the chimney gases to about 300 deg. Fahr. in some cases when using fan draught, and not only is this heat conserved but the furnace conditions are materially improved, a larger proportion of radiant heat being available, with a higher initial furnace temperature.

Properties of Carbon Dioxide As a Refrigerant

By J. H. PRATT*

An Interesting Review of the Sources, Manufacture and Uses of This Odorless Gas in a Refrigerating Plant—Its Cost and the Operating Pressures Necessary

CARBON DIOXIDE is a colorless, odorless, tasteless gas, approximately one and one-half times heavier than air. It has the following characteristics:

Critical temperature.............88.6 F.
Critical pressure......1,078 lbs. per sq. in.
Boiling point at atmospheric pressure 110F.
Latent heat of vaporization at O F. 117.5 B.t.u.

This gas exists to a slight extent in the atmosphere; in country air, 0.3%, and in city air often as high as 0.6%. It is non-poisonous, but does not support respiration or fire, due to the exclusion of oxygen. Ordinary flame is extinguished by from 10% to 15% carbon dioxide, "but even 20% is not dangerous in an hour to animals, and probably not to man." The "pathological" effect of a small percentage of carbon dioxide is used by professors in establishing a new method of artificial respiration in gas poisoning cases.

Produced by Nature

Carbon dioxide is produced by nature, through all types of combustion, decay and fermentation, and is given off in large quantities by certain active volcanoes. Natural gas wells are found in Europe, and three have been found on the American continent.

The constant tendency to increase the percentage of carbon dioxide in the atmosphere through breathing, combustion, etc., is overcome by the chemical action of the chlorophyll, or green coloring matter of plant leaves, which absorb the carbon dioxide, releasing oxygen, and turning the carbon into plant structure. This property of carbon dioxide has been used in Germany, and is just being developed in America to increase the growth of plant life in green houses by the increase of carbon dioxide percentage in the atmosphere.

Scientists claim that the small percentage of carbon dioxide in the earth's atmosphere controls the temperature of the world, acting as the glass of a greenhouse, holding in the heat waves. They claim that, in prehistoric times, the carbon dioxide percentage was twice as high as at present, and that this caused the heavy plant growth which produced the coal beds of to-day. They also state that halving the carbon dioxide percentage would reduce the temperature of the earth to that of the moon, with the consequent death of all vegetable and animal life.

Artificial Production

The artificial production of carbon dioxide amounts to between fifty and sixty million pounds annually. Part of this is recovered from natural mineral springs. Small quantities are made by breaking down magnesite ore, with a resulting by-product of Epsom salts. Other comparatively small quantities are reclaimed from the fermentation of molasses in industrial alcohol plants.

It is a pity that we cannot have, in every Canadian power plant, a prototype of the classic Dutch boy who stuffed his finger in the hole in the dyke and thus saved his country from inundation.

High cost of fuel and labor are sufficient handicaps to the economical production of power. But the other factors—the leaks through which steam escapes or through which valuable heat units are dissipated—these are things that any wide-awake engineer can prevent.

At least 90% of the carbon dioxide made to-day is manufactured by the so-called coke process. This consists of burning high-grade coke under specially constructed boilers, with carefully regulated draft, producing flue gases with 17% to 19% carbon dioxide. These gases are scrubbed free of mechanical dirt and sulphur compounds, and are then passed into large coke-filled absorbing towers where they meet a counter-current flow of lye solution, made up of sodium or potassium carbonates, dissolved in water.

The lye solution dissolves the carbon dioxide from the flue gases, is then circulated through a series of heaters, and finally pumped into an expeller or still, where it is boiled out by the condensation of the exhaust steam used by the engine which operates the plant.

Release Gas at Still

The gas released at the still or expeller contains a large quantity of steam which is removed in an atmospheric cooler. It then passes through a series of traps and separators, and is delivered direct to the low pressure suction of the liquefying compressor.

This compressor, operating against pressure ranging from 950 to 1,250 lbs., is built with three stages. In modern plants it is direct-connected to a specially designed steam engine, which also drives the circulating and cooling water pumps. Well designed plants are balanced so that there is just enough steam produced from the combustion of the coke to operate the machinery and compress the carbon dioxide from the flue gases.

Liquid Containers

Carbon dioxide is sold and shipped in two standard sizes of cylinders. The small one, containing 20 lbs. is 5 inches by 51 inches high, and the larger one, containing 50 lbs., is 8½ inches by 51 inches high. These cylinders have a wall approximately three-eighths of an inch thick to withstand the pressures which may run up to 1,300 to 1,400 lbs. per square inch, when exposed to the summer sun. These cylinders must be tested at least once in five years by a 3,000 pound hydraulic test.

Turnover on carbon dioxide drums is very slow, particularly in the refrigeration field, where they are often held by customers for many months. This low turnover is one of the biggest cost factors in the industry, as the drum investment is high; consequently, interest charges, depreciation and maintenance total as much as the actual manufacturing costs.

Uses of Carbon Dioxide

Approximately 90% of the carbon dioxide produced is used in the soft drink trade, either by the bottler of carbonated beverages, or direct by the soda fountain. Other food products uses consist in the leavening of bread, as a preservative for apples, grapes, grain and cereal products. Its use in place of air in the manufacture of ice cream, butter and other dairy products, is becoming prevalent, as it is sterile, reduces the destruction of vitamins through oxidation, and has other mechanical advantages.

The refrigeration industry to-day uses from one to one and a half million pounds annually, or approximately 2% of the entire production.

Carbon dioxide is generally used as a fire extinguisher for ships, electrical fires, telephone switchboards, and was recently used for extinguishing a very bad mine fire, nearly a quarter of a million pounds being consumed in this particular instance.

Has Varied Uses

It is used in the chemical industry as a base for the manufacture of salicylic acid and aspirin, and a a non-oxidizing agent in the rubber industry.

Physicians and beauty doctors use it as a local anaesthetic, and one large city uses it as a substitute for illuminating gas in the humane killing of animals.

Ordinary coke process carbon dioxide will analyze 99.5 to 99.8 pure, the impurities consisting of less than 1-10 of 1% water, and the balance air. In ordering carbon dioxide for refrigeration purposes the manufacturer should be advised, as cylinders returned from bottling shops contain varying quantities of water which are not always entirely removed for the ordinary trade. Refrigeration drums are carefully drained and dried, and the carbon dioxide can then be guaranteed to be practically anhydrous.

---

*Extracts from a paper presented by the author at a meeting of the Chicago section of the American Society of Refrigerating Engineers.

The refrigerating engineer, on receiving cylinders, can invert them for a few hours and blow off small amounts of water which may still be there. If he then wants to test the purity of the gas for air, it can be done very simply by absorbing the carbon dioxide in caustic by means of a simple apparatus which can be supplied at a small cost by most carbon dioxide manufacturers.

As a Refrigerating Agent

Carbon dioxide has been generally used as the common refrigerant in European countries for many years, and refrigerating units are now built by several American manufacturers in sizes ranging from one half ton to 250 tons capacity.

Due to the fact that carbon dioxide, in fairly large quantities, is not dangerous to plant or animal life, these systems are generally used in connection with hospitals, department stores, hotels and theatres, where slight traces of other refrigerants would be dangerous or disagreeable.

The entire charge of carbon dioxide from the ordinary refrigerating plant can be emptied into the engine room without danger, as the amount can run up as high as 10% to 15%, while ½% of other refrigerants in the air may be fatal. The fact that it is heavier than air keeps it in the engine room, where it is not obnoxious, whereas other lighter than air refrigerants escape through the upper stories of buildings.

Special safety devices, including outside vent pipes, are not required by city ordinance, as is true of other refrigerants. Besides its general use for purposes already mentioned, it is now becoming popular in connection with fur storage vaults, markets, delicatessen stores, and florists, where the escape of other rerigerants might injure merchandise.

Gas Chemically Inert

Carbon dioxide gas is absolutely inert and stable under all conditions. It never forms non-condensable gases which have to be vented from the system; nor can it form explosive mixtures, either inside the refrigerating system, or around it. This inert quality allows the use of babbitt, bronze, and in fact any metal for bearings or structural purposes throughout the plant. The use of copper coils in shell type condensers is an advantage, as the amount of cooling surface is reduced, as well as the space needed for the apparatus.

Any good grade of low "cold test" oil may be used in connection with carbon dioxide refrigerating plants, as it has no chemical or emulsifying effects on oils, the life of this oil being practically indefinite, except as it picks up dirt and foreign matter in the course of operation.

Cost and Supply

Carbon dioxide at the present time is sold for refrigerating purposes at costs varying from 8c to 12c in different parts of the country. It can be purchased in reasonable quantities in practically every fair-sized city in Canada, as every soft drink bottler is a jobber of carbon dioxide.

Many new industries, such as the manufacture of helium; chlorine; oxygen and nitrogen as manufactured from liquid air, require extremely low temperatures, and have to turn to carbon dioxide as the agent.

A much smaller volume of carbon dioxide is handled per unit of refrigeration than required by any other ordinary medium.

COMPARISON OF REFRIGERANTS

	Refrig'n. (net) per lb. at 0° F. boiling temp.	Specific vol. of dry saturated vapor at 0° F.	Theoret vol. of piston disp't. for 100,000 B.t.u. refrig n.	Column three taking CO_2 as unity.	Suc. pres. lbs. per sq in. gage.	Condenser pres. lbs. per sq. in. gage.
Ethyl chloride	160.6	19.0	11,900	32.50	—10	8.2
Sulphur dioxide	149.34	7.49	5,020	13.72	— 4.35	45
Ammonia	491.1	9.114	1,855	5.07	15.7	126
Carbon dioxide	77.0	0.282	366.0	1	288	891

Note:—Refrigeration is a 0° F. Temperature at expansion valve 70° F.

From the table it is seen that the equivalent volumes for other refrigerants are six times greater for ammonia, fourteen times for sulphur dioxide, and thirty times for ethyl chloride. Unfortunately this is not quite as great an advantage as it first seems, as it is considered good practice to use long stroke compressors for handling carbon dioxide; consequently, the frame, fly wheels and other principal parts are ordinarily about the same size as used for ammonia.

Operating Pressures

The main argument used against carbon dioxide has been the comparatively high operating pressures. These ordinarily range from 250 lbs. suction to 900 lbs. condenser pressures. While these are high as compared to ordinary steam work, they are not excessive as compared to Diesel engine and liquid air practice.

With present-day construction methods, there is no real difficulty in handling these pressures. The elimination of fittings by the use of welded joints and bent pipe overcomes most of the trouble, although satisfactory flanged joints are easily made by experienced engineers. It is, however, considered good practice to cut down the amount of direct expansion piping as far as possible, in order to avoid joints.

Stuffing box leakage at these high pressures is often considered serious, but the writer personally investigated several five-ton machines recently that had operated with a loss of less than 50 lbs. of carbon dioxide per year.

In connection with the high pressures, it is not often understood that the pressure ratio, i.e., condenser pressure, divided by suction pressure, is much less for carbon dioxide than for ordinary air compressors, or other refrigerating systems. For carbon dioxide the range is from two to three, as compared to six to ten for ammonia. This low ratio gives maximum compressor economy, due to the small amount of clearance, re-expansion, smaller superheating losses, and much less piston leakage and valve wire drawing.

The critical temperature of carbon dioxide being 88.4 degrees F., it is a common fallacy that there is practically no refrigerating effect with condenser temperatures above this. The fact is, that carbon dioxide is not a perfect gas around the critical point, and there is no sudden change in properties in passing from 88 degrees to 89 degrees F.

Authorities do not agree whether the refrigerating effect is due to the liquefying of part of the gas through the expansion of the balance, or entirely to the effect of the high specific heat of the gas at this point. The fact is that the efficiency and capacity of the system are considerably higher than for a dense air machine under similar conditions.

Practically all British ships, and United States navy vessels operate such systems satisfactorily in equatorial waters, although the capacity of their plants is reduced as much as 50%, as compared to the usual 70 degrees F. condenser temperatures.

Simplicity of Operation

Due to the fact that cylinders, stuffing boxes and other compressor details must be well designed and built, and that high pressure piping must be heavier than for other refrigerants, the first cost of the ordinary carbon dioxide refrigerating plant is somewhat higher than others.

There is one exception to this in connection with the air cooling of theatres, where, due to the safety feature of carbon dioxide, it is possible to cool the air with direct-expansion coils, instead of using brine piping, as required by other refrigerants, where a slight leakage would render the entire ventilating system obnoxious. This saving in brine piping somewhat more than offsets the additional cost of the balance of the system.

Efficiency Tests

Unfortunately there are no good tests on record for larger carbon dioxide refrigerating plants, although it is understood that some are now being made, and that preliminary results show the general efficiency of carbon dioxide systems to be exactly as good as others.

Macintire states that "contrary to the expectation of most engineers the power required by the different refrigerating machines per unit of refrigeration is about the same. In fact, ammonia leads slightly in this respect, but the net result is so close that the matter of the horsepower per ton of refrigeration for usual operating conditions need not be considered when deciding on one or the other refrigerant."

Saving Energy With Electrically Heated Boilers

By F. JOHNSTONE TAYLOR

English Engineer Believes Future Developments Will Prove System Economical When Cheap Power Can be Purchased From Hydro Electric Plants

WHEN a plant depends upon electric power from an outside source the question of steam and hot water required for various purposes arises and this demand has usually to be met by an independent boiler.

Small coal-fired boilers are not, as a rule, economical, although in large industrial areas the gas-fired boiler may prove a satisfactory alternative if gas is obtainable at a favorable rate. Moreover, such boilers may be fired with producer-gas when this is available and, for that matter, blast furnace gas.

In districts, dependent upon electric power at low rates from hydro electric stations, there is the possibility of utilizing the current for generating the steam or heating the water required at a cost comparable with coal, gas, or oil, especially if these are costly, or difficult to obtain.

Electrically heated boilers are of late years quite an attractive proposition to the factory owner. High tension alternating current is essential with the modern types, because, except in the case of quite small units, resistances of the ordinary type are quite out of the question. Also the system of heating by induction is impracticable on account of the high cost of the apparatus.

The modern method is to fit the boilers with electrodes immersed in the water, which thus becomes the resistance for the current just in the same way as it is utilized when testing a generator. Voltages up to 8,000 have been successfully used and it is expected that much higher ones will prove practicable in the near future.

A Standard Type

A standard type of boiler is shown in Figure 1. Current is led from terminal A to electrode B, surrounded by tubes C, known as vaporizing tubes whose purpose is to increase the circulation along the electrodes. This is necessary to prevent steam bubbles accumulating on the electrodes and disturbing the whole resistance of the circuit. Moreover, the current flows from the electrodes through the upper and lower openings to the neutral point, that is the metal support on the end of the vaporizing tubes. By raising and lowering the tubes the path through the water from the electrodes to the neutral can be shortened or lengthened as required.

The conductivity is therefore increased or diminished and the heating effect controlled over a wide range.

Directing the current in the required direction prevents the liability of its passing direct from one electrode to the other. The tubes may be arranged for either hand adjustment or automatic.

Thus the current and the heating effect are kept constant, despite the change of temperature of the water. This of course entails a regulating device on account of the changing conductivity of the water with change in its temperature. The heating effect also rises as the temperature of the water rises, falling again when steam begins to form.

A horizontal boiler is shown in Figure 2, from which it will be seen that extension tubes A are fitted to the vaporizing tubes so as to render the water circulation effective in the lower part of the boiler. These tubes which are made of metal form the neutral point.

Factors in Success

Electric heating is specially suitable for making use of electric current which could not otherwise be employed and for using it during the night when obtainable at a cheap rate, but the correct method of applying the current and the best method of storing the heat energy are important factors in the success of an installation.

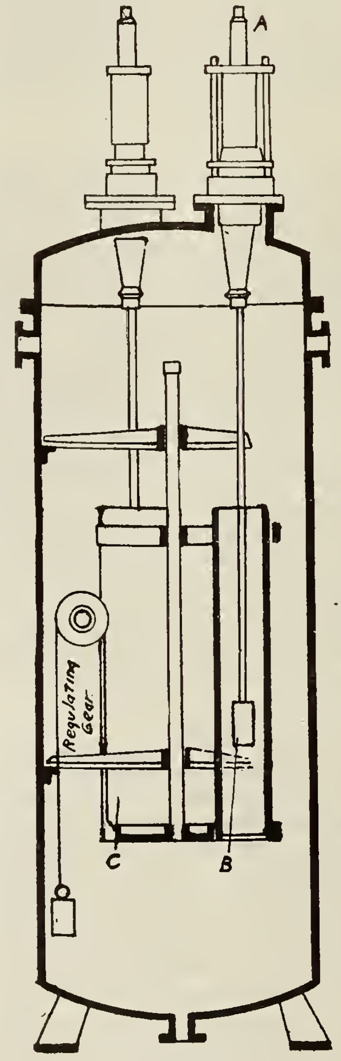


Fig. 1—Vertical boiler high voltage.

Countries with large hydro electric stations for instance have an excess of power at certain periods of the year and often a shortage at others. In consequence it may be good policy to use electric power for heating at one time and coal at another, and the expense of the dual installation may be warranted.

The heat accumulator may be constructed as a high pressure steam boiler and the steam drawn off from it for both heating and manufacturing processes. A boiler of this class could be heated up at a cheap rate during the night to a pressure of about 170 lbs. per square inch, the steam being drawn off during the day, although of course at a continuously decreasing pressure.

For manufacturing purposes, however, steam can be usefully employed at pressures down to about 28 lbs. per square inch.

The boiler must, therefore, be so designed that when it is at full pressure in the morning it can work till evening without the pressure falling lower than desired. Six to seven and a half lbs. of steam can be stored per cubic foot of hot water at the usual pressures and one k.w. hour gives about 2.7 lbs. of steam.

Presuming for a small plant there is some 80 k.w. available for ten hours during the night, the accumulator must be capable of storing 800 k.w. hours or approximately 2,200 lbs. of steam, corresponding to a capacity of about 350 cubic feet.

This is entirely dependent upon the cost of current, provided properly designed apparatus is installed, and the question as to whether it will prove cheaper than coal depends upon the cost of coal in the locality. It must always be remembered, however, that this system of electric heating is extremely convenient, demanding the minimum of attention and cutting out coal and ash handling. To bear a little extra cost for it may often be good policy, and if electric power is really cheap its use for this purpose is worth looking into.

Under working conditions experts claim that the same heating effect as 2.2 lbs. of coal are obtainable in small boilers with 3 k.w. hours; in large central heating boilers with 4 k.w. hours; in high pressure steam boilers with 5 k.w. hours.

A good example of this type of electric heating system is the installation at Spoerrie's spinning mills at Flums, Switzerland, of a boiler 51 feet 8 inches long by 6½ feet in diameter.

Water power drives the mills but conditions demand some of the water being let off at times when the mills are not working for the benefit of users lower down stream. This waste of energy is at times of low water utilized in an electrically heated storage boiler working from 55 lbs. in the morning to 15 lbs. in the evening. The load varies from 700 k.w. to 100 k.w., its average being 500 k.w. The current is three phase generated at 5,000 volts, 50 cycles. The boiler has a maximum water capacity of 10,000 gallons and a maximum pressure of 170 lbs. per square inch. Its storage capacity when discharging steam at 28 lbs. is 10,000 lbs. of steam. Owing to the short time it works with electric current the boiler has been highly rated.

There are in addition coal-fired boilers which bring the total storage capacity to 13,500 lbs. of steam. An auto bye-pass valve is fitted between the electric and the coal-fired boilers, which allows steam to pass from the former to the latter before the safety valve of the electric boiler comes into operation. The control apparatus between the two boilers consists of a switchboard with the necesrary instruments, servomotor control valves for the hydraulic regulator to regulate the current supplied to the electric boiler, control valves for the auto stop valves in the piping between the boilers, boiler feed pump and steam pressure reducing and distributing valves.

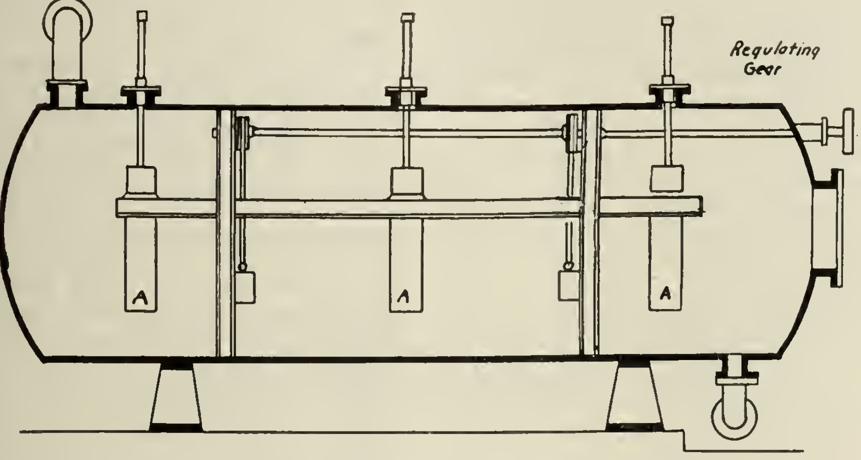


Fig 2—Horizontal electric boiler.

It is stated that the plant is in every way successful and that the combined arrangement, under the conditions prevailing is economical in working.

In fact there is no doubt that with the extended distribution of cheap electricity and a fuller appreciation of the necessity for the conservation of energy this system will receive more attention in the future.

Storage batteries cannot be charged from an alternating-current circuit without the use of a rectifier, of which there are a number of forms, such as mercury vapor, tungar, vibrating types, electrolytic, motor-generator sets (induction motor driving a direct-current generator), rotary converters, etc.

Inspire Exhibitors at Power Exposition

Directors to Award Certificates of Merit to Manufacturers With Attractive Booths at New York Show, December 3

THE importance of effective exhibits at the coming Exposition of Power and Mechanical Engineering in the United States is recognized by the management who plan to award certificates of merit to exhibitors who arrange their exhibits effectively.

The success or failure of an exhibitor may depend in great measure upon the arrangement of his exhibit. Obviously, excellent products may be shown to poor advantage and mediocre devices may be exhibited so that visitors will be attracted, will receive valuable information and may be moved to purchase. To inspire the arrangement of good exhibits the management offers these merit certificates.

December 3 to 8, 1923, are the dates set for the exposition and the place will be the Grand Central Palace, New York City. Contracts already signed give assurance that the event will exceed last year's, which was the first exposition of the kind in the United States, both in size and diversity. In addition to exhibits of devices for the generation of all kinds of power, space has been set aside for equipment used in the transmission of power. This will add greatly to the interest of the exposition.

Appeal to Engineers

The appeal of this exposition is to engineers not only in the power and mechanical fields but in all fields. Notable advances in the art and science of power generation will be packed in the Grand Central Palace and even the technical man, only casually interested in power, will find novelties to interest him for several hours.

The power man will delight in comparing competitive devices and in talking with the representatives of the exhibitors. He will become thoroughly acquainted with the entire field and will store information against the day when he has a troublesome problem requiring immediate solution when he will utilize the lore accumulated at the exposition.

The co-operation which the American Society of Mechanical Engineers is extending is an indication of the importance of the exposition. The A.S.M.E. annual meeting parallels the first four days of it, and to permit the mechanical engineers to reap the benefits of both meeting and exposition, the power and mechanical sessions at the meeting are to be assigned to the morning.

As the exposition does not open until noon each day there is no conflict and members can have ample time to give careful study to the exposition. The American Society of Refrigerating Engineers' meeting also parallels the first days of the exposition and members of that organization, as well as mechanical engineers, will be admitted on display of their badge.

Rising Fuel Costs

Rising fuel costs challenge the attention of all manufacturing executives and production engineers even though the power cost may be but a small percent. of the cost of finished product. Under present manufacturing conditions, the coal pile is an excellent place to start economy and the devices to be shown at the exposition are designed to effect that very thing. Furthermore, power is being used at a rapidly increasing rate and with the work of the world to be done mechanically, fuel must be consumed at a corresponding rate. So that not only is fuel economy made imperative by the demand for more economical use of fuel and heat but by a sense of duty to conserve fuel resources for future generations.

The managers of the exposition are Fred W. Payne and Charles F. Roth. They extend a hearty invitation to all Canadian manufacturers and engineers.

Recent Type H. boiler installations, made by the Goldie & McCulloch Co. Ltd., of Galt, Ont., include the Y. M. C. A., Kitchener, Ont.; Y. M. C. A., Galt, Ont.; Ottawa Collegiate Institute; Citizen Building, Ottawa; Rockcliffe School, Ottawa; La Corona Hotel, Montreal; Kitchener-Waterloo Collegiate; E. T. Coldrey, for Carleton County Court House, Ottawa; W. G. Edge, Limited, for Guelph Collegiate; G. Ruppel & Co., Kitchener; Dominion Shirt Co., Kitchener; The Hurlbut Co., Preston; Drake Avery Co., for G. C. I.; Wm. Knell & Co., for Waterloo School; Ottawa Auditorium; St. Andrew's Presbyterian Church, Ottawa; Garth Co., for Arnprior School and Ashbury College, Ottawa; Waterloo Lutheran Seminary; Newmarket High School; Ottawa Isolation Hospital; Tilsonburg Shoe Co., Limited; and L. N. Poulin, Ltd., Ottawa.

Operating a Vacuum System With a Steam Pump

By JAMES MACKAY

Power Used From High Pressure Boiler is Trifling, and the Pump, as a Matter of Fact, Acts as a Reducing Valve—Suction Eliminates Air From Radiators and Pipes

WHERE the boiler carries a pressure of more than twenty pounds, it is desirable, in the interest of economy, to operate a steam actuated pump for inducing a vacuum on the heating job. Where this is done, the power used by the pump is but trifling, and the pump, as a matter of fact, acts as a reducing valve, all of the steam being sent into the low-pressure side from the pump exhaust.

While the piping, valves, and specialties for a design such as this look complicated and expensive, as a matter of fact, the economy is considerable, and the apparatus is all of a reliable nature, and automatic in action. In a large building, with an extensive system of piping, a system of circulating the steam by means of a partial vacuum on the air lines, or return lines is practically a necessity, as without this aid, too great a pressure is necessary to force the air out of the system, and the time necessary to complete the circulation is too great.

Size of Cylinders

In determining the size of the cylinders of a steam operated vacuum pump, the area of the suction cylinder will depend on the speed of the pump and the amount of condensation and air it is to handle.

There are many formulae for working this out, for necessarily all need some modification, on account of allowances for inleakage of air into the system, and also to take care of the estimated "peak" load, when steam is first turned into the system in the early morning hours. These allowances are so many, and vary so widely that a purely empirical formula is now much used, which works out very well with the most complicated ones, based on friction losses, gallons of water per minute, and cubic feet of air per minute.

As the formula is used by some of the largest pump manufacturers and vacuum specialty manufacturers, it may be accepted as being safe and reliable, and has the very great advantage of simplicity.

To Find Capacity

To find capacity, in square feet of direct radiation, of vacuum pumps:

$$R = \frac{d\,d\,l\,n}{2}$$

Where
R = Square feet of radiation.
d = Diameter of water piston in inches.
l = Length of stroke in inches.
n = Number of strokes per minute.

As an example, a vacuum pump having a 10 inch diameter water cylinder with 12 inch stroke, and making 50 strokes per minute would be:

$10 \times 10 = 100$
$100 \times 12 = 1{,}200$
$1{,}200 \times 50 = 60{,}000$
$60{,}000 \div 2 = 30{,}000$, square feet of direct radiation as the capacity of the pump.

This would be the case, of course, without regard to the power used for operating the pump, whether line shaft, motor, or steam.

Area of Steam Piston

To arrive at the area of steam piston, where steam pump is used, there are also many complicated formulae, but for our purposes, another simplified arithmetical formula may be used which will very closely approximate good standard pump practice:

To obtain area of steam piston of a pump, when area of water piston is known:

$$S = \frac{(WL) + 100\%}{\frac{1}{2}P}$$

Where
W = Area of water piston.
L = Pressure per square inch on water piston. (i.e. that due to both suction and discharge resistance.)
P = Pressure per square inch on steam piston.
S = Area of steam piston.

Example
Area water piston, 78.5 sq. inches.
Combined suction and discharge pressure on water cylinder = 40 lb.
Pressure on steam cylinder = 35 lb.

Then
$785 \times 40 = 3{,}140.$
$3{,}140 \div 17.5 = 179$ square inches, or 15-inch diameter steam piston.

We see then that a vacuum pump maintaining approximately 10 inches of vacuum and discharging against boiler pressure of 35 lb., and serving 30,000 sq. ft. of radiation would be a pump 15 in. × 10 in. × 12 in. stroke × 50 strokes per minute.

Good Standard Practice

There is shown in Fig. 1 a complete layout of boiler and pump piping according to good standard practice for a two-pipe vacuum system, using a steam vacuum pump and returning directly from the vacuum pump to the boiler, without the use of an intermediate receiver and boiler feed pump.

The vacuum return line is shown returning in a trench, a lift pocket is placed when it rises to connect to the pump, a plugged tee being placed at the bottom; a grate valve is next in the line, followed by a suction strainer with removable cover, and a small plug in the bottom; connection to the suction opening of the pump is made full size of the pump tapping, and from this enlarged section a connection is taken to the automatic vacuum pump regulator and a small line extended to the vacuum gauge on the gauge-board.

The pump regulator automatically opens and closes the line from the boiler pressure, to operate the pump; this line is provided with a by-pass for use in case the regulator is out of service, and an automatic lubricator is connected into the side of the steam line to the pump. A small line is carried over and connected to the L. P. gauge on the board.

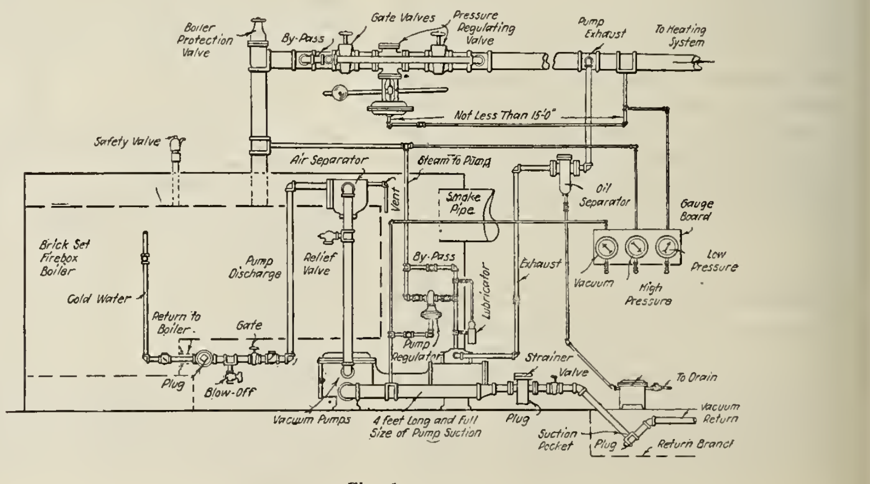


Fig. 1.

The line carrying the exhaust from the pump is connected back into the heating system on the low pressure side, an oil separator being placed to remove surplus oil and condensation before connection is made to the system; the oil separator is drained by an oil trap which discharges directly to the sewer or drain.

Suction of Pump

The suction of the pump carries all of the condensation from the heating system, as well as all the air. It must discharge the former to the boiler, and vent the air to the atmosphere. This is accomplished by carrying the discharge line from the pump vertically upward, and placing a vent trap, or air separator, on the top of the line; this device consists of a chamber containing a float mechanism which holds a valve port open to the atmosphere until the water within the chamber rises sufficiently to close it; in this manner the discharge to the boiler is entirely freed of air. In order to prevent accident to the air trap or collapse of the float, should the gate valve on the discharge line beyond the trap be closed, a relief valve is placed below the trap; the discharge to the boiler enters one side of a cross, cold water entering the opposite opening, and the return to the boiler being taken from one end of the cross, the opposite to that being plugged for cleaning purposes; a gate and check valve is placed on the pump discharge, and also on the cold water supply, and a blow-off as indicated from the bottom of the return header.

All of these connections are outside the brick-work.

Steam to supply the pump and the heating system is taken from the top of the boiler, a tee for the pump and gauge being placed immediately at the boiler. The riser extends to the topmost point, where a "boiler protection valve" is placed; the function of this is to assure sufficient pressure to operate the pump; if below that, no steam will be allowed to get into the heating system.

Beyond this valve the pressure regulating valve is placed, equipped in the usual manner with two gate valves for cutting it out of service, and a smaller valved line by-passed around all of these valves, for use when the pressure regulating valve is cut out. From a tee located 15 feet or more distant, a ¾-inch line is taken and carried to the bottom of the diaphragm which operates the regulating valve from the reduced pressure side; a ¼-inch line is carried from this same branch to the low-pressure gauge on the gauge board.

Clarence McNaughton Steeves, B.Sc., has been appointed construction engineer of the N.B. Hydro Commission, St. John N.B.

L. L. Craig, formerly manager of the hydro electric system at Stamford, Ont., has been appointed manager of the hydro electric system at Petrolia, Ont.

Show Value of Electric Power

Annual Meeting and Exposition of Association of Iron and Steel Electrical Engineers Held at Buffalo, N.Y.

THE annual meeting of the Association of Iron and Steel Electrical Engineers was held in the Broadway auditorium, Buffalo, Sept. 24 to 28. The program included 17 technical papers, meetings being held at 9.30 a.m. and 2.30 p.m., on Monday, Tuesday, Wednesday and Thursday.

In accordance with the policy inaugurated several years ago, an exhibit of electrical equipment for use in the metal-working industries was held in connection with the convention. About 120 manufacturers took space at the show, exhibiting a wide variety of motors, control equipment, and other accessories.

About 20 companies co-operated in the operation of a miniature foundry, the principal units of which were a small electric furnace, molding equipment, sand-mixing machinery, cleaning apparatus, and the necessary accessories.

Many foundrymen will recall that an attempt was made several years ago at a meeting of the American Foundrymen's Association, in Atlantic City, N. J., to produce hot metal in a miniature plant erected on the steel pier. It developed that the expense, inconvenience to other exhibitors, and obstacles arising from lack of proper facilities, prevented the plan from being executed successfully. This early attempt was made before the electric furnace had been developed to its present state of reliability and, therefore, the unforeseen difficulties in connection with the operation of an electric furnace plant under the restrictive conditions at Buffalo cannot be studied in the light of the experience of the Atlantic City trial.

The majority of the 1923 exhibitors displayed equipment used in the application of electricity for producing iron and steel, such as motors, control systems, panels, wiring details, insulators, recording meters, fuses, switches, transformers, and electrical heating equipment.

Another feature of the general exhibit was the display of accessories used in applying electrical power. This classification included such products as ball and roller bearings, valves, lubricants, bearings, gears, flexible couplers, pinions, etc.

Still another group of exhibitors offered equipment for the production of power from the combustion of fuel, such as boilers, refractories, arches, pumps, superheaters, turbines, etc.

The Association of Iron and Steel Electrical Engineers is in its sixteenth year, and during the past few years has grown rather rapidly, owing to its activity in encouraging the discussion of problems related to the application of electricity to the iron, steel, and metal working industries.

The technical program included a number of papers on subjects that have created a great deal of attention among electrical engineers in the steel industry. It is noteworthy that while eight separate sessions were provided, only 17 papers were scheduled. This arrangement gave ample time for the presentation of each technical paper and also afforded ample opportunity for the thorough discussion of each paper.

Operators and engineers interested in blast furnace problems were interested in the papers on skip hoist characteristics and traverse control of ore bridges presented Tuesday afternoon. Fuel problems were considered in papers presented at the Thursday morning session, while factors in the generation of steam were discussed in the afternoon.

The annual banquet was held at 7 p.m., in the ballroom of the new Hotel Statler, Thursday, Sept. 27. No technical session was scheduled for Friday afternoon, this time being left vacant for those desiring to attend the exposition.

The exposition was open from 9 a.m., to 6 p.m., every day of the convention, and remained open Wednesday from 7 to 10 p.m.

THE WORD "ENGINEER"

Mr. Editor, the word "Engineer" has the whole world in a quandary, for it's so incorrectly used and terribly abused that the word seems to need the laundry.

A "civil" calculates things right, usually works half the night, and his pay is too small to mention, while the "efficiency engineer" 'tis true, he "does things nights too," and his methods are a quite recent invention. He claims to doctor your "biz," owns a better car than a "Lizz," collects real money—or at least that's his intention.

Some engineers are known as operating or gas, and for almost any trade the title seems to pass. Some engineers rely on muscles, some on brains, while some use only steam to move stumps, rock, dirt and trains.

Now, Mr. Editor, I believe you and I agree that some day engineer will be correctly used and defined and less abused by those so inclined and the fellows who right it will include you and me, and 5,000 others who will compose the real engineering association.—C. A. S. E.

Carbonates of lime precipitate out of water heated to 212 deg. F. as in an open heater; but the sulphates require 250 to 270 deg. F. before they will precipitate by heat alone.

Eliminating "Grunts" in the Power House Pump

By **PUMP ENGINEER**

Clamp, Bronze Bushing and Litharge Stop Leakage on Brine Circulating Pump — Faulty Lubrication Causes Noise in Steam Pump—Change in Lubricator's Position Ends Trouble

A FEW weeks ago I was called upon to remedy some troubles in connection with two pumps in a Montreal plant. The first case I took in hand was a large duplex brine pump. One stuffing box was leaking badly, although the piston rod was in very good condition. By close examination I located the crack on both sides of the stud bolt hole, as shown in Figure 1.

On the outside the crack extended back about half the length of that part of the casting composing the stuffing box. In order to make a thorough examination and permanent repairs, I had the piston rod removed and found that the crack on the inside extended back to the bottom and partly across.

In order to stop the leak it was apparent that more than one expedient would have to be resorted to.

Repairing the Leak

First the clamp was made. Then a piece of 1-16 inch sheet packing was cut wide enough to cover crack on the outside. Next, some litharge putty was applied to the sheet packing and laid in place on the clamp. When the clamp bolts were drawn up tight this, of course, forced the litharge into the crack and filled any unevenness at this point.

In the meantime the bronze bushing, one-eighth of an inch in thickness, was an easy driving fit. Before driving the bushing into place, the outside was well coated with litharge in order to fill the crack on the inside of the stuffing box. Next the thread on the stud or gland bolt was cut the full length of the bolt in order to use a lock nut to cover the crack on the front of the casting. The side of the lock nut next to casting was well coated with litharge and screwed tightly into place.

The bronze bushing, of course, reduced the width of the packing space, which made it necessary to send for split packing rings of the proper dimensions.

While waiting for the new packing rings, the litharge had ample time to set.

In Use Twenty-four Hours

This pump is now in use twenty-four hours per day, seven days per week, and there is practically no sign of leakage. Before these repairs were made several pails of brine leaked out of the stuffing box each day.

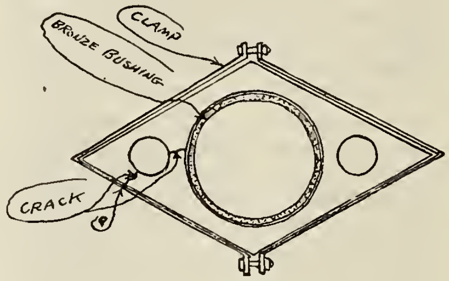


Fig. 1.

Next I looked over the other pump, which is an old type duplex tank pump, size 7½x7½x6. These pumps are often referred to as atmospheric pumps because they are built for pumping water under low heads or pressures but little above the atmosphere.

All considered, the pump handled the water better than would be expected taking into consideration its construction, and also that the water pressure required is about thirty pounds, but "she grunted badly all of the time" was the expression used by one of the men employed in the engine room, and the "grunt" was always in the steam end. Sometimes the noise was louder than at other times. When liberal qualtities of cylinder oil were used the pump would run reasonably quiet. About a gallon of cylinder oil had to be used per twenty-four hours. This was rather expensive, considering that another pump of about four times the capacity required only about one quarter as much.

Noise on One Side

When listening with the ear close to the steam chest cover, the noise appeared to be on one side only and it sounded as if there was a dry spot between the valve and its seat. When the valves were examined they were found in good condition. There was plenty of side clearance and in so far as the writer could see there was nothing to prevent the oil from reaching all parts.

However, when looking over the steam connection I saw that the pipe was led some little distance in a horizontal position to the steam chest. The double connection lubrication was connected to the riser to the main steam line as in the usual way, and although the horizontal connection was longer than usual there was nothing to show that this was the cause of the trouble. Several different kinds of cylinder oil were tried, but as the pump still continued to indicate audibly that none of these oils had reached the dry spot, the writer removed the steam chest cover and had a hole drilled and tapped for one inch pipe thread, and connected the column for the lubricator, as shown in Figure 2. The idea is to have the oil enter the steam chest directly over the valves.

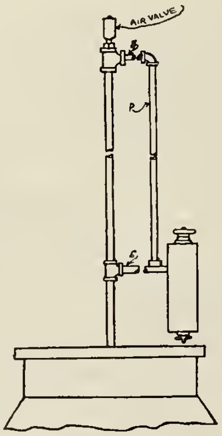


Fig. 2.

The Trouble Located

This arrangement did not seem to improve matters any, at the start, because where the pump was started again the "grunt" was as loud as before, and after about an hour the lubricator stopped feeding. The trouble was located in the upper part of the column, which had become air bound.

The confined air prevented the steam from entering pipe P where it is condensed, and since this type of lubricator depends on the column of water, or pressure due to the head of water to force the oil out through the feed nozzle, the lubricator was useless under these conditions, but when the air valve was located as shown, this released the air. The "grunt," however, "was still on the job." Strange as it may seem, after about twenty-four hours the noise gradually died away, and the pump is now running as quiet as any of the other pumps in the plant.

During the cooler months this pump is operated continuously twenty-four hours per day. It now requires only one and one-half pints of cylinder oil, and compared with the amount previously used the saving is considerable.

Remarks on the principle of hydrostatic or double connection lubricators may seem out of place under this title, but from remarks I heard by men employed in this plant, and by men employed in other plants, it seems that some men are not fully acquainted with the principle of this type of lubricator.

They have the idea that the lubricator depends on steam pressure for its operation, or that the steam pressure forces the oil into the steam chest. In a measure this is so, but mainly the lubricator depends for its operation on the displacement of the oil by a body of water which is formed by the condensing of steam in the pipe P, Figure 2. The condensed water passing into the body or oil chamber displaces the oil, forcing it up through the feed nozzle. The oil then rises to the surface of the water in the sight feed glass

(Continued on page 44)

Boiler Feed Water Evaporation and De-Aeration

Operating Engineers Devoting Much Energy To-day to Purification of Make-up Feed Water and Prevention of Corrosion in Plants Throughout the World

TWO important questions receiving the attention of operating engineers throughout the world at the present time are the purification of the make-up feed water and the prevention of corrosion in the boiler plant. In the scientific treatment of the water supplied to the boilers lies the solution to the serious troubles and expense arising out of the corrosion of economizers and boilers; and the elimination of the causes of corrosion will widely extend the range of utility of ferrous metals for turbine blading, and thus enable turbine builders to meet the exacting requirements of modern conditions with less difficulty.

The problem resolves itself into two parts: first, the provision of make-up water free from solids and scale-forming matter; second, the elimination of all corrosive gases in the water discharged to the boilers.

Many plants to-day use a softening apparatus to eliminate the calcareous and magnesium salts which are usually present in raw water, but this process, while lessening the formation of hard scale, does not appreciably modify the total weight of solids in the water. Often the result is that the solids become concentrated in the boiler and, unless the boilers are frequently blown down with the consequent loss of heat, priming takes place with its attendant evils.

Cut Blow-Down Losses

One of the duties of the engineer is to reduce blow-down losses to a minimum by keeping the concentration as high as possible, and at the same time to avoid priming. This concentration of solids in the boilers becomes a serious question under peak load conditions, because it places a very definite limit to the steam generating capacity of the plant. The use of pure feed water avoids the blow-down loss and also permits the boilers to be operated at a very much increased rate of evaporation to meet peak conditions without danger of priming. It thus increases the efficiency of a boiler plant and enables a smaller plant to meet a given steaming output.

For these reasons the use of distilled water from evaporators is rapidly finding favor with power plant engineers. In many cases a very inferior water is obtainable without expense, and by means of an evaporating plant, this water can be converted into pure distilled water when otherwise the make-up would be taken from the town supply, at considerable expense; moreover, even town water often requires treatment before it can be fed into the boilers.

In Multiple Effect

Evaporation can be carried out in single or multiple effect, and assuming the make-up to be evaporated is five per cent. of the station feed, the steam required is six per cent., 3.5 per cent. and 2.2 per cent. for single, double and triple effect working respectively. Of the heat supplied to the evaporator at least ninety-five per cent. can be absorbed in the main feed water; thus with single, double and triple effect systems, the feed water can be raised 60, 35 and 22 Fahr. respectively at full load, and the system to adopt should be that which allows the recovery of this heat under all working conditions.

The size of evaporator required for a given output depends chiefly upon the temperature difference between the steam supply and the vapor leaving the evaporator, and, for a given temperature difference, the capital cost of the plant will increase in proportion to the number of effects used.

This is easily understood if a single effect evaporator and a double effect plant working under the same conditions be compared. In a double effect plant for a total output of three tons per hour (that is, one and a half tons from each effect, each working on half the total temperature difference), each evaporator would be the same size as a single effect evaporator giving three tons per hour and using the total available temperature difference.

Fig. 1 shows a horizontal evaporator of the "Contraflo" type and it may interest Canadian engineers to know that the Goldie & McCulloch Co., Ltd., of Galt, Ont., are the Canadian licensees for the manufacture of this evaporator, as well as "Contraflo" high vacuum type condensers and feed water de-aerating apparatus. In the evaporator illustrated the coils are secured in groups of four to parallel headers. The couplings are of simple and rugged design, the inlet and outlet ends of each group being secured by a single bolt.

The formation of the coils is such that when steam is admitted to them, any scale which may have formed outside is cracked, falls to the bottom of the evaporator, and is then discharged through the evaporator blow-down.

For a moderate steam pressure, the well-known vertical type, as shown in Fig. 1, is preferable; this type is a development of the marine evaporator and embodies experience gained over a considerable number of years.

The evaporator illustrated in Fig. 3 is a special design for low-pressure working, and consists of two parts, a heater and a flash chamber; the make-up water to be evaporated is circulated through the heater tubes, which are surrounded by low-pressuer steam, and the water, after being heated, is sprayed into the vacuum in the flash chamber.

The heat absorbed by the water in passing through the heater is given off in the flash chamber in the vapour released by the fall in temperature, and the water falling to the bottom of the chamber is again cir-

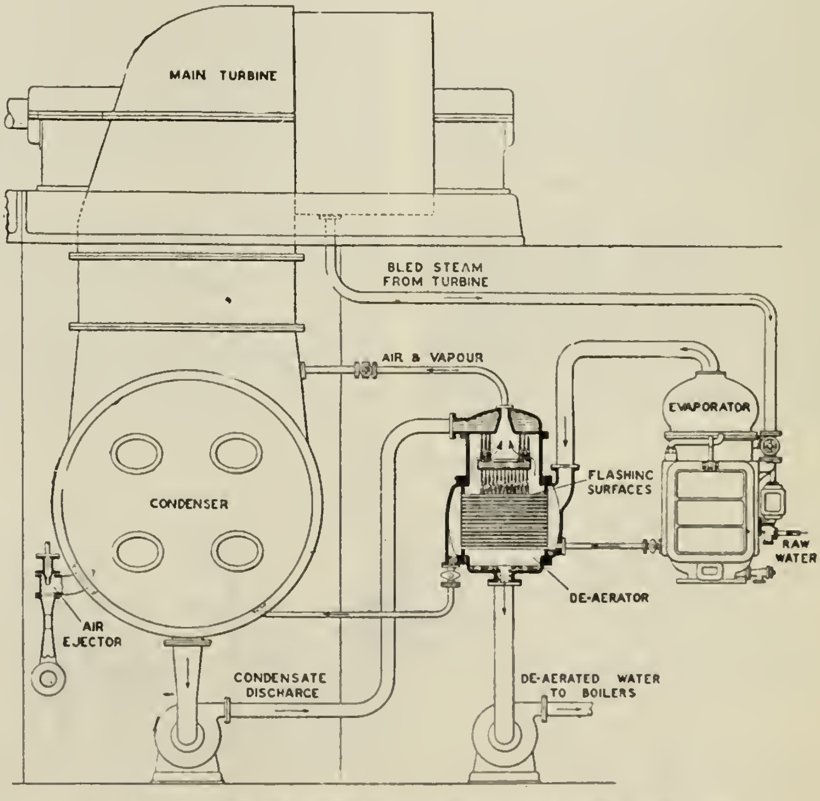


Fig. 1—Vertical evaporation and de-aerator for a single power unit.

culated through the heater. This evaporator possesses two important advantages: the scale-forming solids are kept in solution during the passage of the water through the heater (and thus the formation of scale on the heating surface is avoided), and as the circulating pump is arranged to discharge against a pressure greater than atmospheric, continuous brining is a simple operation, even though the evaporator is operating under a vacuum.

Turning now to the question of the elimination of corrosive gases, chemical research has definitely established that the corrosion of iron and steel in the presence of water is almost invariably due to the action of oxygen which is present in solution in the water. Water exposed to the atmosphere absorbs oxygen with great avidity, and the lower the temperature of the water, the greater the quantity of oxygen it will take up in solution.

Fig. 4 shows the approximate oxygen contents of water at various temperatures when exposed to the atmosphere.

As an example of the oxygen contents of feed water in an open feed system of a typical power plant, it is interesting to note that the water discharged by the condensate pump was found to contain 0.9 cubic centimetres of oxygen per litre. By the time the water was halfway through the system it had absorbed so much air from the atmosphere that it contained 3.55 c.c. per litre, and when measured at the discharge of the feed pump to the boilers the oxygen contents were 3.75 c.c. per litre. The make-up in this plant is taken from the town supply and contains 7.5.c.c. per litre.

Because of these facts modern power plants are being fitted with the closed feed system in which the condensate drawn from the condenser is returned to the boilers without being exposed to the atmosphere and thus the absorption of oxygen is prevented.

The closed feed system, in itself, is not sufficient to secure immunity from corrosion, since the condensate extracted from the condenser contains oxygen in solution. The quantity of oxygen it contains depends upon the vacuum in the condenser, the temperature of the condensate, and the air pressure at the condensate pump suction.

As an average figure the oxygen contained in condensate, when discharged separately from a condenser, may be taken as 0.5 c.c. per litre, but it is possible to reduce this figure if the plant be fitted with an efficient air pump, and the air leakage kept to a minimum, by maintaining the vacuum system as air-tight as possible, a condition which demands constant care and attention.

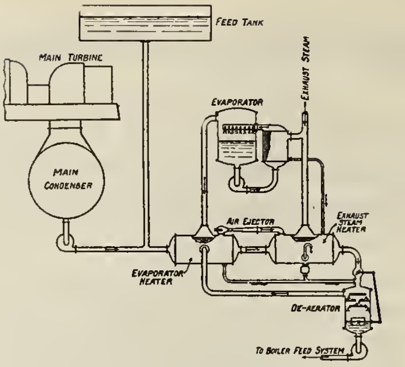


Fig. 3—Special combination using exhaust steam.

Engineers to-day are demanding that the feed water delivered to their boilers should be de-aerated to the extent of at least 0.1 c.c. per litre. Where steel tube economizers are used, a greater degree of de-aeration is desirable, and with well-designed de-aeration plants it has been found that every measurable trace of oxygen can be removed.

Water sprayed into steam gives up a certain proportion of the contained air in being heated, but this process alone is not enough for efficient de-aeration. In a power station in which the condensate and make-up are discharged together into a direct contact heater, the water was found to contain 5 c.c. of oxygen per litre before passing into the heater, and, although the oxygen contents were reduced, the water leaving the heater still contained 1.1 c.c. per litre.

Tests have proved that complete de-aeration can be obtained by supplementing direct contact heating by flashing the heated water on a surface of high temperature under a vacuum, so that the water is shattered into minute particles and the complete liberation of the contained gases thereby effected. This flashing process is the principal feature in the design of the de-aerator shown in Figs. 1 and 2. This de-aerator is self-contained, and possesses a bank of steam-heated tubes over which the water is sprayed.

The vapor rising from this hot tubular surface heats the falling water to boiling point in the upper part of the de-aerator by direct contact, and partial de-aeration is effected. The partly de-aerated water then comes into contact with the hot tubes and is completely disintegrated as it falls from tube to tube, the remaining air being liberated and withdrawn at the top, while the air-free water flows out at the bottom on its way to the boilers.

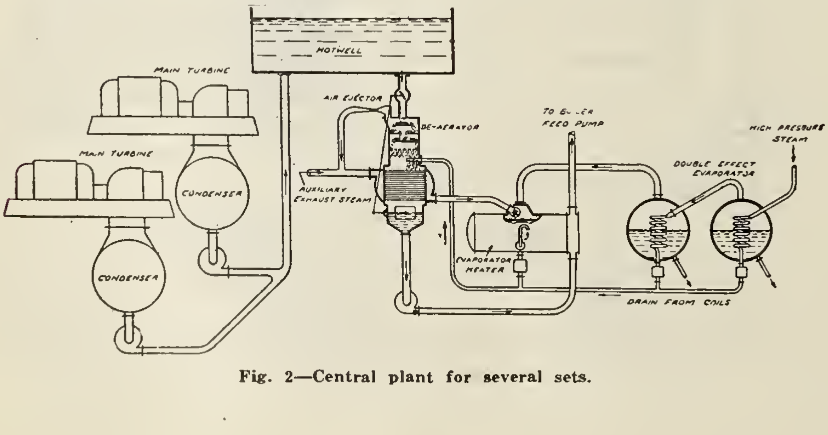


Fig. 2—Central plant for several sets.

The action of this de-aerator is such that, not only oxygen, but all other gases are eliminated to the same extent in relation to their solubility. The necessary vacuum in the de-aerator is maintained by a small steam-operated ejector, or by a connection to the main condenser, whichever is the more convenient.

This de-aerator, being also a heater, can be fitted so that a separate heater is not required, and it is particularly suited for operation in place of the usual bleeder heater. Where auxiliary steam containing oil is available, it makes use of the steam without allowing the oil to mix with the de-aerated feed water. It can be fitted very easily into existing plants, does not require the careful attention necessary with chemical de-aerators, and its efficiency is not affected by variations in the feed water supply.

Evaporators and de-aerators are complementary in their functions in a power plant, and can be arranged to operate together as shown in Figs. 1, 2 and 3. Fig. 1 shows an economical system for use in connection with a single power unit. The make-up water is fed into the evaporator and the steam required for its evaporation is bled from a low-pressure stage of the turbine.

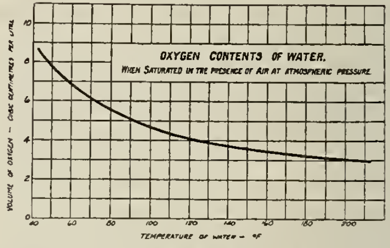


Fig. 4—Curve showing normal oxygen contents.

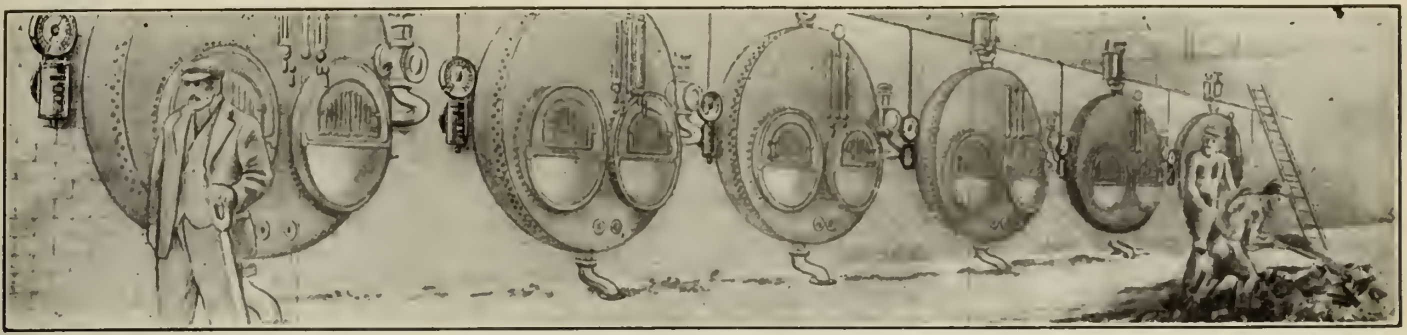
The vapor generated in the evaporator passes into the heating surface of the de-aerator, where it is used to heat and de-aerate the condensate passing through the de-aerator on its way to the boilers. The drains, after passing through the main condenser, are de-aerated along with the main condensate.

The arrangement in Fig. 2 shows a high-pressure evaporating plant of two effects, providing distilled make-up water for a number of power units. The condensate from all the power units is discharged into an elevated hot well or storage tank, from which it flows into the de-aerator. A float, placed in the base of the de-aerator, controls the inlet of water in accordance with the requirements of the boiler feed pump. Auxiliary exhaust steam is used in the heating surface of the de-aerator and the surplus passes into the evaporator heater which receives the vapor from the last effect. The de-aerated feed water in passing through this heater is heated to a still higher temperature.

The various drains are collected and passed into the de-aerator where their heat is conserved and they are de-aerated along with the main condensate.

A small steam-operated ejector maintains the vacuum in the de-aerator, and discharges along with the heating steam in-

(Continued on page 44)



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.
Director of Engineering, Central Technical School, Toronto.

IN REVIEWING for the American Society of Mechanical Engineers, a well-known engineering handbook, which has been entirely rewritten and put on the market during the last few months, a critic writes in part as follows: "......at last the hand fire has been relegated to the place it belongs—obscurity."

The writer of these lessons cannot agree with the above mentioned critic, because he feels that there are still many instances where hand firing can not profitably be replaced with automatic stokers. The engineer, who made the above criticism, is no doubt accustomed to dealing with the power and heat problems of the larger central stations, and appears to consider the small one-man plant and the seasonally operated plant as negligible.

In the light of the total amount of fuel burned and the national economy of operation of such small plants, they may be negligible. They are nevertheless of just as great importance to the owner, as the largest plants are to their owners, and therefore, any economies which can be effected in the small plants are relatively just as important as in any other plant.

Results in Savings

Where temporary or intermittent service is required from a plant, or in small heating plants which are operated during only a portion of the year, it would probably be found that the interest and maintenance costs on a stoker installation would more than offset the slight saving in labor and fuel which might be effected over hand fired equipment. Thus hand firing is still an economic proposition in some plants.

There are in Canada many such plants. Also under the present conditions of commerce and finance, few plant owners are willing to increase their capital investment except where it will mean a decided increase in production. Even though such owners are assured that such changes as the installation of automatic stoker equipment will result in sufficient saving in operation to more than meet overhead charges produced thereby, the capital required for such alterations is hard to get, and even if available could probably be used more effectively if invested in other parts of the business.

For the above reasons hand firing is bound to be carried on extensively for many years yet, and it would be a serious mistake for engineering publications to ignore this topic. In any case the same principles apply in the combustion of fuel under hand fired as under stoker fired conditions, especially when the latter conditions are associated with natural draft.

Fuel on the Grates

Coal never burns at a uniform rate over the whole fuel bed. This may be for any of numerous reasons, such as, one shovel of coal may contain more slack, while another shovelful may contain a large proportion of lumps, in which case the resistance to the flow of air through the finer coal will be great enough to prevent it burning as fast as the lumpy coal; or the air flow may be partially obstructed in some areas by accumulations of clinkers or hard crusts of coal, and the coal will naturally burn fastest where the air flows most freely. Because of this uneven burning, thick and thin spots are sure to develop in the fire. Wherever the fuel burns most rapidly, the thin spots are sure to form.

The fresh coal should always be placed on the thin spots of the fuel bed. Before throwing the coal into the furnace the fireman should take a quick look to locate these spots. Since the thin spots are those in which the fuel has been burning fastest, they will easily be recognized as being the brightest spots in the fire. The thick spots will either be very dull or will be burning with a sluggish smoky flame.

In endeavoring to level up the fire in this way it will be found much easier to place the coal where required if small rather than large shovelfuls are taken. The thinnest spots in the fire should not be filled up level at one firing, especially if a coking coal is being fired, or this coal may fuse into a solid crust, which will effectively choke the flow of air at any point, causing slow combustion and starting a new thick spot.

Cause of High Spots

Since high spots are caused by coal not burning fast enough at these points, the fireman should not place more fuel on them, or he still further checks the draft, thus aggravating the condition. If the slow combustion in the high spots is caused by dirty or slack coal or by a hard crust on the surface of the fuel, this will gradually burn through or crack, as long as it is not covered with fresh fuel, thus allowing a free flow of air and the spot will come back to normal.

Of course, if the high spots are caused by clinkers obstructing the flow of air from the grates, the fire bed can not become normal until after the clinkers have been removed.

If the thick and thin spots become so troublesome that the load can not be carried while the fire bed is being levelled up in the above manner, it may be necessary to break up lumps of caked fuel and spread it evenly over the grate with the rake. This levelling process is just so much extra work for the fireman, which in most cases could have been avoided by the proper placing of the fuel. It is also wasteful of heat, as it allows an excess of cold air to pass through the furnace.

In levelling care should be taken not to disturb the ashes, or clinkers will be almost sure to form, which will aggravate the slow combustion in spots. Large lumps of coal are another fruitful source of uneven fires. No lumps bigger than the first should be placed in the fire.

A skilful fireman is able to keep his fuel bed level for hours by placing the coal properly. The unskiled man often has to rake his fires every second or third firing, thus handling a large proportion of the coal twice. He will also have much more work in cleaning the fires, which is really the hardest and most disagreeable part of the work in the boiler room.

Thickness of Fires

A good general rule for hand-fired furnaces burning run-of-mine coal with natural draft is to keep the thickness of the fire between four and eight inches. If forced or induced draft is used these figures may often be considerably exceeded. When the coal consists mostly of lumps and large pieces the thickness may be greater than when the coal contains much slack or fine pieces.

Since the capacity of a boiler is almost directly proportional to the amount of fuel which can be completely burned on the grate, it will be found advantageous to keep the fuel bed in such state that it will burn at the fastest possible rate if required. In order that the fire may burn fast, large quantities of air must pass through it. Thus the resistance to the flow of air through the fuel must be low, which means a comparatively thin fuel bed.

Cuts Boiler Capacity

Every pound of coal requires from fifteen to twenty-five pounds of air for its complete combustion; therefore, with a thick fire allowing only a limited amount of air to pass through, we will either burn a small quantity of coal, thus cutting the capacity of the boiler, or we will incompletely burn a very large quantity of coal and lose three quarters of its heat value in unburned gases going up the chimney. A thick fire is also one of the most prolific sources of clinkers.

Some engineers may not agree with the above statement because they have been brought up to believe that too much oxygen is liable to pass through a thin fire without uniting with the carbon. This is, however, a mistaken idea for tests have shown that the gas coming off from even fuel beds three or four inches thick, contains less than two per cent. of free oxygen, while there may be in it up to twenty-five per cent. of unburned gas which requires still more air to be admitted above the grates before combustion will be complete. With a thicker fire there is likely to be considerable smoke and soot given off, especially when a fresh charge of fuel is put on.

It would thus appear that a few small holes in the fire would not be a serious fault, as the air which would come through them would serve to complete the combustion of the unburned gas rising from the fuel bed. If, however, the holes were big, the air would not be likely to mix intimately enough with the gases to burn them, and would therefore serve only to cool down the boiler.

Of course it takes more skill to handle a thin fire, but a good fireman is proud of his skill, for when it is properly used in firing it saves fuel for the employer as well as saving work for the fireman in reducing the coal, ashes and clinker to be handled.

(To be concluded in next issue)

The town council of Jonquierre, Que. are contemplating a $75,000 addition to their hydro-electric plant.

C. A. S. E. Notes

A special meeting of Toronto No. 1, C. A. S. E., was held on Monday, Sept. 24, at Cumberland Hall to introduce R. S. Rutherford, Director of Technical Education for Ontario, to the members. Mr. Rutherford, honorary chairman of the education committee of the C. A. S. E., in an address urged engineers to attend the classes in stationary engineering in the technical schools throughout the province. He described the new booklet, recently issued by the Department of Education, which covers the requirements of each grade of certificate.

The department will initiate classes in any part of the province if a sufficient number of applications are received.

T. H. Fenner, in outlining the work of the educational committee of the C. A. S. E., said that engineers ought not merely to aim at securing the minimum of knowledge required to obtain the necessary certificates, but should endeavor to qualify themselves for better positions.

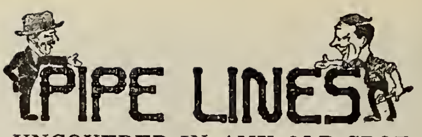
The policy of the educational committee this year is to make the meetings practical as well as theoretical, the question box will be retained and the relation of costs to the production of power will be briefly dealt with when the opportunity is presented.

A series of half-hour lectures will be prepared by different members of the committee dealing with combustion, steam heating, refrigeration and electricity. These lectures will be typed and sent out to the different lodges, so that the absence of someone capable of delivering a lecture will not interfere with the educational program.

G. M. Brown, chairman of the Ontario Board of Stationary and Hoisting Engineers, attended the meeting and replied to numerous questions in regard to the certificates issued by his department. In the discussion which followed, an interesting fact in regard to some of the laws of the province was brought out. It is perfectly legal to leave a heating boiler under steam all night without any attention, but if a night watchman is employed, he must have a certificate.

The meeting, which was open to the public, was well attended, but the visitors, with one exception, seemed loath to take part in the discussions.

A board for the examination and regulation of the licensing of electrical contractors and workers has been appointed in Toronto, the members being: Henry Rohler, representing the electrical contractors; George Summer, Sr., representing the electrical workers; Percy T. Gaston, representing the electrical inspection department of the Ontario Hydro Commission; and W. G. F. Price, city architect. After October 1, electrical contractors and workers must be licensed.



PIPE LINES

UNCOVERED IN ANY OLD SPOT

There was once a maiden of Siam,
Who said to a fireman, young Kiam,
"If you kiss me, of course
You'll have to use force,
But I'll wager you're stronger than I am."

* * *

It is not necessary that the copper bars in the rotor winding of a squirrel-cage type induction motor be insulated from the core for satisfactory operation. In fact, many of the modern induction motors are built without any insulation whatever.

* * *

A peanut sat on the C.N.R. track,
Its heart was all a-flutter;
The 3.45 *came thundering past—*
Toot! Toot! Peanut butter!

* * *

Before starting a commutating-pole type rotary converter, the brushes should be raised before starting and lowered after the machine is synchronized at full voltage; otherwise severe sparking will occur at the brushes.

* * *

A Halifax engineer wrote in the other day asking if a burglar entered a fuel yard would the coal chute? Our new blonde reporter who happened to see the query said that she didn't think so but she was certain the kindling wood.

* * *

An alternating current differs from a direct current in that the latter flows only in one direction in the circuit, its value at any instance being determined by the resistance on the circuit, whereas the alternating current is continually changing its direction.

* * *

An able engineer now has come along to tell us about getting electricity out of coal, which no doubt, accounts for the shock we experience when we receive our bill.

* * *

The comparative capacity of synchronous converters on a basis of average heating at unity power factors to that of a direct-current generator, where the direct-current generator capacity is taken as equal to 100; the same machine operated as a single-phase converter; will be 85; operated as a three-phase converter 134; as a quarter-phase converter 164; as a six-phase converter 196; and as a twelve-phase converter 224.

* * *

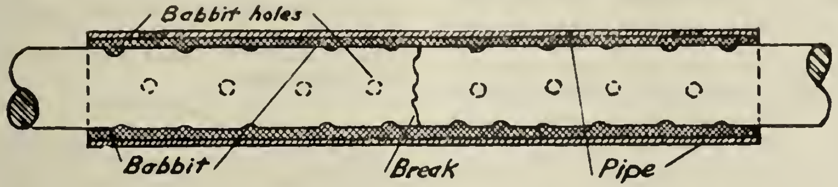
Writing from Winnipeg, Walter Hudson says: "I refuse to take a drink unless it is given to me in a tin cup, so that I can have the cup to beg with in case I go blind."

Practical Ideas From Practical Men

REPAIRING BROKEN SHAFT

In the power plant of a paper mill which I had charge of the 2-inch shaft driving the forced draft fans snapped in two; as a result the plant was completely shut down at a time when steam was most needed.

The plant was located far from civilization or any machine shop, and as a new shaft could not be obtained for some time, a temporary repair was made as shown in the sketch, enabling the plant to start up in two hours.



Small holes were drilled in the shaft with a breast drill for approximately 8 in. on each side of the break to give the babbitt a grip. A piece of 2½-in. pipe was secured and two ½-in. holes bored in line at each end, serving as pour holes.

One end of the shaft was pushed back to allow the pipe to be slipped on, then the broken shaft ends pushed tightly together.

The space between the shaft and the ends of the pipe was then stopped with clay, the pipe heated with a blow torch while hot babbitt was poured in to fill the ¼-in. space between the shaft and the pipe.

The babbitt, as it solidified and cooled, gripped the shaft tightly, the cooling of the outer pipe causing it to shrink tightly to the babbitt and make the job more secure.

The repair was intended only as a temporary measure and furthermore was done in a rush, but when the new shaft arrived some weeks later the babbitt job looked as if it would have lasted indefinitely.

—JOHN F. McKENZIE, Toronto.

PIPE BENDING HINTS

In bending large pipe, fill with dry sand and plug the ends. Heat to a red heat in localities to be bent and bend. Be sure that the sand is dry. Where bends are slight, it is often unnecessary to use sand or resin. The object of sand or resin is simply to keep the sides of the pipe from collapsing, or to prevent reduction of flow area. If wet sand is used, and if the ends are plugged, the pipe may burst when heated, due to the steam pressure generated.

Resin, also, is good. There is, however, a "right way" and possibly several wrong ways to use it. An example of a wrong way was recently brought to my attention where the mechanic filled the pipe with sand. The result was—a violent explosion.

The way to use resin is to pour it into the pipe and allow it to cool and harden. As soon as the resin is hard, bend the pipe cold. Don't heat it. Then after the pipe is bent, heat the pipe all over sufficiently to melt and remove the resin.

There are many excellent mechanical devices on the market for bending pipe. To bend large, stiff pipe slightly, and inexpensively, there is nothing handier or more efficient, in my judgement, than hydraulic pipe bender driven by a hand pump.—N. G. NEAR.

LUBRICATION OPERATION

The location of a hydrostatic lubricator with respect to the unit it is to lubricate should be at a convenient height above but close to the throttle valve. The independently acting type of lubricator is attached to the steam line at two points, one above the apparatus itself and one at the point, of discharge.

The length of the pipe connecting the upper attachment to the condenser bulb should be at least eighteen inches, in order to insure sufficient water pressure acting upon the oil within the lubricator reservoir to cause constant and regular flow of the oil through the discharge pipe.

When filling a lubricator, first close the valve in the oil discharge pipe and the value just below the condenser bulb. Then remove the filling plug and drain the lubricator by the bottom drain valve, before putting in new oil.

Adjust Flow of Oil

To put the lubricator in operation, open the valve in the oil discharge pipe, and also the water valve and then adjust the flow of oil by means of the regulating valve below the sight-feed glass. The regulating valve should not be opened for at least five minutes after steam has been turned on. This will allow sufficient steam to condense in the lubricator to fill completely the reservoir space not occupied by the oil.

If this precaution is not taken, steam will enter the lubricator and "churning" will occur. This churning will deposit globules of oil on the sight-feed glass.

If the oil drops appear to form too large, they may be reduced by filling the sight-feed glass with a solution of water to which about a teaspoonful of common table salt has been added. Increasing the specific gravity of the solution in the glass causes the oil drop to leave the feed cone before it has time to become too large. The formation of large oil drops is usually due to dirt collected around the top of the oil feed cone.

The sight-feed glass can be cleaned of dirt or oil deposits either by blowing steam through it or by swabbing with a piece of cloth. In the latter case remove the plug at the top, wrap a piece of lintless cloth around a thin stick, soak in kerosene, and swab the sides of the glass. Be careful not to allow any shreds to remain in the glass.

Open Drain Cock

When it is desired to clean by blowing through with steam close the oil-regulating valve below the sight-feed glass and then open the sight-feed glass drain cock in the bottom setting. Then by opening the valve in oil-discharge pipe, steam can be blown through the sight-feed glass to clean it.

In general leaky connections will cause irregular feeding of the oil. Should the sight-feed glass become clogged, it may be due to setting up too tightly on the bottom nut when the glass was installed. This often causes the rubber gasket to be squeezed out of place and perhaps into the glass. If the oil-feed cone should become displaced or off center, it may cause the globules of oil to move up the sides of the glass, and perhaps to stick there, causing the glass to fill with oil.

The glass should then be removed and the cone filed down, or it will be found effective to solder a fine copper wire to the side of the cone, leading it upward through the center of the glass, nearly to the top. The oil drop will then follow the wire, and the glass will remain clean. It is not advisable to allow a hydrostatic lubricator to run empty of oil, owing to the danger of the sight-feed and gauge glasses becoming hot, thus causing oil to stick and gum to the sides of the glass.

When a lubricator is installed where it is exposed to the weather, and there is danger of freezing, it should be shut off and thoroughly drained when not in use. When this is necessary an extra valve should be installed in the upper piping, close to the main steam pipe. All valves should be closed tightly in order to prevent leakage of steam and resultant condensation in the lubricator.

When a small, slow feed is required, it is often found difficult to maintain this uniformly owing to the changes in the viscosity of the oil by virtue of changes in temperature. Therefore, weather or engine-room temperatures may be factors that will necessitate more attention being given to the operation of the lubricator.—E. R. NEWTON.

EQUALIZER SHORT CIRCUITS

On multipolar, multiple-connected armatures trouble may be experienced, due to unequal distribution of the current through the several armature paths. This will underload some brushes and overload others, and if the current inequalities are too great, the overloaded brushes will spark.

The unequalized conditions are minimized as far as possible by cross-connecting some of the commutator bars which are at the same potential when the armature is in operation. In the diagram one equalizer is shown in dotted lines to connect three equipotential bars, another equalizer would connect three more and so on until the desired number are connected.

In a certain instance a six-pole armature came into the shop for repairs. Apparently, the trouble was a burnout among several leads where they were connected to the commutator. The leads were spliced, reinsulated and reconnected to the commutator. It was necessary to send the armature out without any conclusive test, because the motor frame was not available, and when subjected to a bar-to-bar test, an equalized armature will give indications similar to those obtained from an armature having short-circuited coils.

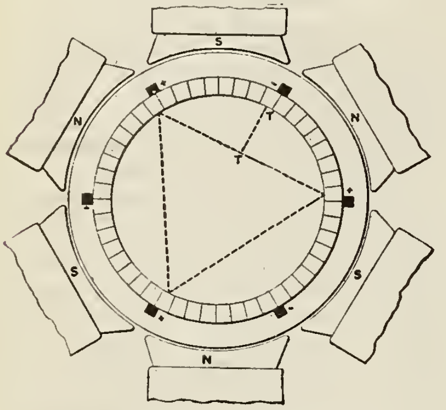


Diagram of short circuit on equalizer.

The armature was returned very soon with the complaint that it would "turn a little and then stop."

In the diagram the length of the equalizer is shown to connect bars located at points twice the distance between brushes. In this particular machine six sets of bars were equalized and the equalizing conductors were made up into a wreath and installed behind the commutator under the regular leads. As their overlying insulation had appeared to be good, the repairman had not disturbed it. Investigation disclosed that under the insulation two equalizer conductors had become short-circuited to each other in a manner such as to produce the condition indicated by dotted line *TT* in the diagram. Here it will be noted that the equalizer short-circuits the brushes. On removing the short-circuit, operation became normal, and no further complaint was made.—HYDRO ENGINEER.

LOCATING OIL TROUBLES

MOST operating engineers in these days make a very strenuous effort to conserve all the heat that is represented by the returns and condensate from heating coils, drying systems, etc., with the result that very often oil is encountered in the boilers, causing a scaly coating, or resulting in the bagging or blistering of tubes or sheets.

The presence of oil in the boiler is rather a serious matter and no operating man should tolerate such a condition, though in some cases the running down of the cause of the trouble will often seem to be baffling and difficult. Where trouble from oil in the boilers is experienced and the cause is not easily detected, it is advisable to approach the problem in a systematic manner, arriving at the solution by a process of elimination.

The factors that should have consideration are: (a) investigation of the character of the returns coming back to the hot well or heater to make sure that they contain no oil either in the free state or as an emulsion; (b) feed water heater should be examined to determine whether oil is being introduced with the exhaust steam at that point; (c) quantity and quality of oil used should be investigated; (d) an examination should be made of the raw water supply.

Frequent Cause of Trouble

Perhaps the most frequent cause of oil trouble is the admission of oil into the feed heater or hot well by means of returns of condensate. This happens because often exhaust steam is passed into the heating or drying system without first taking steps to remove the lubricating oil contained in the steam, and hence the resulting condensate carries with it all the lubricating oil impurity. Hence in all cases where exhaust steam is used in the heating or drying system, the purity of returns which are to be utilized for boiler feed should be insured by arranging to separate the oil from the steam by means of an oil separator on the inlet line. If the returns come from different sources a separator should furnish protection on each supply main. Care should be taken to see that the oil extractors are of proper size, are large enough to handle the steam passing through them, and that they are continuously and effectively drained.

Often it is found that while the main exhaust lines are protected with extractors, at some point or other in the system there is discharged some pump or small engine exhaust line not similarly protected, and because of the large amount of oil consumed by such small units, sufficient oil can be carried into the system to give trouble in the boilers. Hence this possibility for trouble should always be investigated.

Rource of Supply

Therefore, the first step is to investigate every single source of steam supply, and see that it is properly protected from oil entrance, or, another way, to see that proper oil filters or extractors are provided where the returns come off the system.

In one case the writer found the pump exhausting directly into the hot well tank in order to secure the heating effect of this steam, but no provision had been made to remove the oil other than occasional skimming off of the tank, and this did not remove all the oil that was present in emulsified form.

In order to detect the presence of oil coming back with the returns, these lines should be arranged so that samples of the condensate can be drawn and tested at intervals. The oil will show up in the water as a yellowish emulsion, or may even float on the surface of the water in free form.

Trouble in Heater

The next most frequent cause of oil trouble lies in the heater where the feed water is brought in actual contact with the exhaust steam. Normally these heaters are furnished with oil separators for first removing the oil from the steam, but it is well to check up this part of the equipment to see that it is all in working order, that the drainage of the apparatus is functioning, and that the outfit is not overloaded. Often putting too much steam through the heater will result in overloading and ineffective oil protection.

Interior inspection of this heating apparatus will often disclose whether the oil is coming in with the steam, or, if coming in with the returns, depending on where the coating of oil is found, and often the information so obtained will direct the engineer to the proper place to look for the trouble

Investigate to see whether any steam is entering the heater other than through the separator. Often an engineer will enter a small pump exhaust in the back of the unit without proper oil protection.

Another case was developed in which the operating man was feeding slight quantities of oil into his feed on the advice of some friend of his that it would help to cut down his scale troubles.

Poor Quality Oil

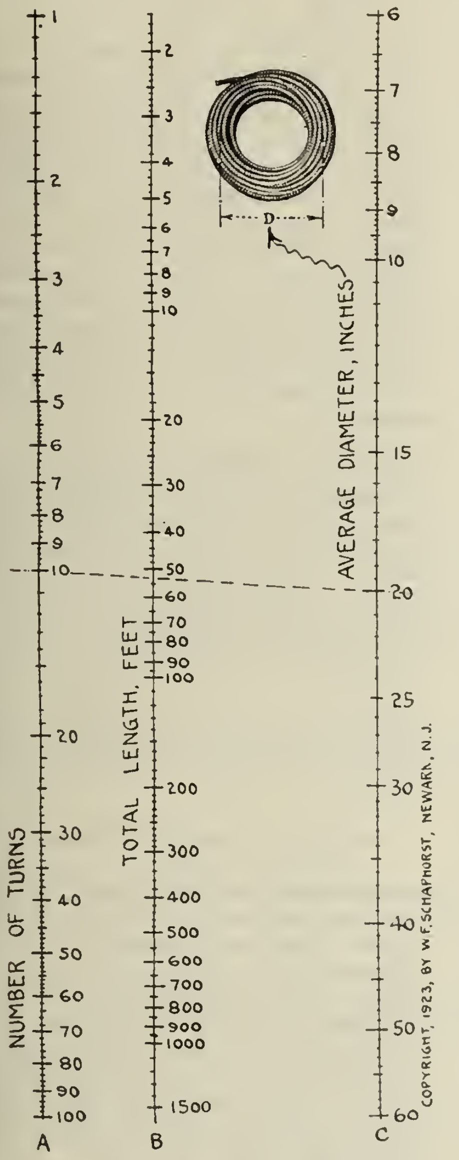
In many cases it will be found that apparently all the apparatus is in proper working order, and of proper size, and in well kept condition, but that oil still gets into the system. This may be due to the use of a poor quality of oil, for it must be borne in mind that practically all oil extractors work on the principle of removing the oil from the steam because the oil, in its solid form, is much heavier than the steam and can be readily thrown out of it by centrifugal force or by suddenly changing its direction. If the oil is of a poor quality it will vaporize at some steam temperatures and will thus be present in the steam as a gas or vapor which the extractors cannot remove. It is important, therefore, that no lubricating oil be used which will vaporize at the steam temperature attained in the engine cylinder. This can be readily tested by making a flash test on the oil in an open vessel and noting the temperature at which it vaporizes, which temperature in turn can be compared with the temperature corresponding to the steam used.

After the cause of oil trouble has been located, it must be borne in mind that frequently the return water will not clear up quickly because of the vast amount of impurities which line the piping, which often takes weeks and months to be washed out. Consequently, the returns should be sent to waste for several weeks until inspection shows them to be cleared up sufficiently to be safely used again. Where it is not desired to waste the water during such a cleaning out period, the system can often be effectively purged by blowing steam through it at intervals, or again the whole system can be flushed out by pumping through it a weak solution of soda ash or caustic soda which quickly cuts the oil from the surfaces.—OTTAWA ENGINEER.

THE LENGTH OF COILS

Very often all of us have coils or rolls of some kind that are to be used for some purpose or other and we wonder how long the rope, wire, cable, hose, belt, etc. might be. We don't like to go to the bother of unrolling or uncoiling simply to obtain the approximate length. The important question usually is "Is it long enough?"

The accompanying chart will be found useful for this very purpose for finding the length in feet of any ordinary roll or coil. All that is necessary is to count the number of turns in the coil or roll and measure the "average" diameter as shown on the sketch in the chart. Then, lay a straight-edge across the chart as indicated by the dotted line. Or, simply stretch a thread across. The answer is immediately found in column B.



For example: how many feet of rope in a coil the average diameter of which is 20 inches and the number of turns 10? Simply connect the 10, column A, with the 20, column C, and the answer is shown in column B as very close to 53 feet.

The range of the chart, it will be noted, is large enough to care for most of the conditions to be found in ordinary practice, ranging from one turn to 100 turns and the diameters range from 6 inches to 60 inches.

The chart can be used backwards as well as forwards. For example: if it is desired to take along a coil of cable containing 300 feet and the workman wants to know how many turns to take, a straight-edge laid across 300 on the middle scale will show how large the coil should be, and the number of turns required in order to obtain the desired length. It is very convenient and quick.—W. F. SCHAPHORST, M.E.

Power Notes

James Paterson, Parliament Buildings, Victoria, B.C., has called for tenders for electrical equipment, for the supply of induction motors, transformers, etc., for the Acute Building, Mental Hospital, Essondale, B.C.

The Universal Oil Burner Co., Ltd., have recently been incorporated with head quarters at Windsor, Ont., to manufacture the Universal Smokeless Oil Burner. The burner is electrically operated and fitted with a safety device. Donald Stuart, the president and chief engineer of the company, is the inventor.

J. Kennedy & Son, Acton, Ont., have received the contract for electrical work in connection with $18,000 theatre being built at Oakville, Ont.

The Standard Paper Box Co., 2724 Park Ave., Montreal, are in the market for an 80 h.p. boiler.

Plans are being prepared for a $30,000 power plant to house seven boilers generating 4,600 h.p. for the Victoria Lumber & Manufacturing Co., Chemainus, B.C.

Plans are being prepared for a substation for the Toronto Hydro Electric System to be erected on the south-east corner of Danforth avenue and Morton road, Toronto.

The Drake Avery Co., 103 John St. N., Hamilton, Ont., have been awarded the contract for heating in connection with the $300,000 power and screen house for the Ford Motor Co., of Canada, Ltd., Ford, Ont.

The contract for the boiler-house to be erected for the Rockwood Hospital, Portsmouth, Ont., has been awarded to McKelvey & Birch, Ltd., 69 Brock Street, Kingston, Ont. Approximate cost $18,000.

The Limerick Electric Light & Power Co., Ltd., with head office at Limerick, Sask., has been incorporated.

The Orillia Construction & Service Corporation, Ltd., Orillia, Ont., has been incorporated and will carry on an electrical installation and heating business.

The firm name of the Ituna Light & Power Co., Ltd., Ituna, Sask., has been changed to the Ituna Electric Light & Power Co., Ltd.

D. Fraser & J. Hawkins, Nelson, B.C., have been awarded the contract for building a new power line from Nelson to Balfour, B.C., at a contract price of $11,200.

J. B. Hamilton, town engineer, Estevan, Sask., has closed a contract with Electrical Engineers, Limited, of Calgary, Alta., for a 300 kw. unit, as an addition to the present power plant. Mr. Hamilton has recommended the purchase of a Skinner Uniflow Engine and a Westinghouse Generator.

The London Cold Storage Co., London, Ont., will install a 50-ton high-speed ammonia compressor, and are asking for prices on same.

The Triumph Machine Co. has received an order for a 20-ton refrigerating machine complete to be installed in the plant of Swift & Co., Regina, Sask.

Among recent shipments made by the Goldie, McCullough Co., Ltd., Galt, Ont., is that of a large heating unit, weighing 14,725 lbs. The machinery and motors are being installed in the new plant of the Norfolk Shoe Co., Tillsonburg, Ont.

The Harbour Commissioners of Quebec have called for tenders for the construction of a cold storage warehouse and power plant in the city of Quebec. Tenders for necessary machinery, piping, electric wiring, sprinklers, etc., will be received separately.

J. H. Harding, Durham, Ont., has received the contract for the installation of a new hot-water heating system in the North Grey Registry Office, Owen Sound, Ont. Work will be commenced shortly.

Tenders are to be asked at an early date by Belleville, Ont., for a gasoline-driven pump of about 3 million gallons capacity and also a pumping station building at a cost of about $25,000. The engineers are Gore, Nasmith & Storrie, of Toronto.

The Quebec Harbor Commission, through Secretary Charles Smith, will receive tenders till Oct. 10 in connection with a $500,000 refrigerator to be built at the corner of Dalhousie and St. James Sts. Tenders will be accepted on the building complete, or on the following items separately: Machinery, including piping; power wiring in the power plant; cooling coils and connections from, and to, the brine coolers; heating apparatus and air condition machines; air ducts, etc.; electric wiring, for lighting of all buildings; elevators in main warehouse; sprinklers in main warehouse and fish warehouse buildings. General Tremblay is the engineer in charge.

Kilgour Bros., of Toronto, are building a $100,000 factory at Windsor Mills, Que. Tenders for plumbing, heating and sprinkler systems are being received by Mr. Prattes, 21 Wellington St., Toronto.

The Canadian Comstock Co. Ltd., Montreal, have been awarded the general contract for a transmission line from St. Jerome to Lachute, Que. The engineers in charge of the work are Beaubien, Busfield & Co., of Montreal.

Wm. I. Bishop, Ltd., Montreal, are the general contractors for a dam and power house on the North River to be built for J. C. Wilson, Ltd., St. Jerome, Que.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

PUMP EXHAUST

IS IT possible for a boiler feed pump lifting its water to exhaust into the suction pipe without destroying the vacuum? If the water is delivered to the pump under pressure will it work satisfactory when the exhaust is piped to the inlet side of the pump?—W. G., Toronto.

Answer:—If you were to pipe the exhaust steam to the suction side of the pump, in all probability it would give you no end of trouble. The exhaust steam would be condensed so rapidly that it would back up to the pump valve, then pressure would build up and force the water back. The net result would be extremely faulty operation of the steam end and continual water hammer.

Pump makers advise keeping the exhaust as free as possible if smooth operation is desired.

The exhaust steam from the pump would heat the feed water about 10 deg.

If you wish to save this heat, the exhaust steam could be piped through a coil in the tank from which the feed water is pumped, or if the water is taken directly from the city mains, a large pipe could be placed around the suction line somewhat similar to the condenser in an ammonia refrigerating plant.

If the water is delivered to the pump under pressure, the troubles mentioned with the water backing up in the steam exhaust line would be worse than when the water is being lifted.

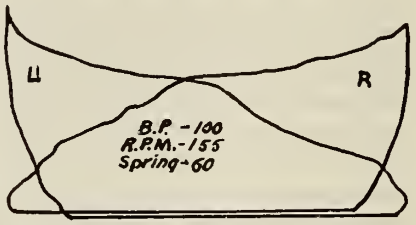
INDICATOR DIAGRAMS

The enclosed card is from an 18x24 *D* slide valve engine, exhausting through a closed heater to the atmosphere. The steam line is five inches and the exhaust six inches.

I would like your opinion of the card, what is the probable cause of the high back pressure and the pressure drop during admission? R.p.m.—155, boiler pressure —100 pounds, spring 60—GEO. G. LEE, Ottawa.

Answer: The high back pressure shown may be caused either by the closed heater or some obstruction in the engine itself. To determine whether or not the trouble is in the heater, exhaust directly to the atmosphere and take some cards. If the high back pressure is then relieved the trouble is in the heater, if not it is somewhere in the engine or exhaust line. In a good closed heater properly set up the back pressure should not be more than from 3 to 5 pounds per square inch.

You do not say whether the engine is governed by throttling or by variation of the cutoff. Cutoff is apparently at about half stroke at both ends of the cylinder. With the simple *D* slide valve cutoff at half stroke makes compression start early. Apparently the early cutoff with high back pressure is causing the steam at the end of the stroke to build up to higher than boiler pressure. The curved admission line is then a result of the pressure dropping back to that of the boiler and possibly to wire-drawing of the steam through the small port area.



The card marked *R* has a very ragged expansion line no doubt due to this end of the slide valve leaking badly.

In the card marked *L*, the expansion line looks very fair.

Both cards measure up only very slightly over 80 pounds per square inch at the point of cutoff. This, however, may be due to throttling by the governor.

A *D* slide valve having the admission and the exhaust controlled by the one valve makes a better looking card when set to show cutoff at about five-eighths stroke, but this does not mean that the economy is any better than with the cards shown.

We believe if you reduce this back pressure, apparently caused by the heater and the exhaust pipe, and look for a leaky valve on one end, you should straighten out some of the peculiarities of the diagram.

USING OIL FUEL

If you have any information or data as to the number of gallons of fuel oil required when burned under boilers to make a ton of distilled water ice, we would greatly appreciate it as we are contemplating changing our 80-ton plant from coal burning to fuel oil.—
—R. SMYTH.

Ans.:—The heating values of coal and oil depend upon their relative compositions. A comparison of the relative heating value of coal and the amount of oil for the equivalent amount of heat is shown by the following tabulation:

B.t.u. per pound of coal	Pounds of Coal Equal to 1Bbl. Oil	Barrels of Oil Equal to 1 Short Ton of Coal
10,000	620	3.23
11,000	564	3.55
12,000	517	3.87
13.000	477	4.19
14,000	443	4.52
15,000	413	4.84

This table shows that if your furnaces consume a ton of coal having a heating value of 12,000 B.t.u. per pound of coal, 3.87 barrels of ordinary fuel oil will have the same heating value. Under general considerations also, the oil burning furnace will operate at a slightly higher efficiency than the coal burning furnace. This is due to the fact that the oil is more readily broken up into small particles and brought into contact with the necessary amount of air for combustion, and that the loss due to excessive air requirements is reduced.

From the foregoing, it will be noted that one barrel of oil will produce approximately from 1½ to 2¼ tons of ice.

The foregoing calculations have been based upon a barrel containing 42 gallons of oil and a weight of 310 to 350 pounds per barrel, and also on the fact that the ordinary distilled water plant will produce from 5 to 8 tons of ice per ton of coal.

These are necessarily general considerations, but will indicate to you the general conception of the amount of oil required.

JOINTS IN AMMONIA WORK

I should like to obtain detailed information regarding the methods in use for making screwed pipe joints tight in ammonia work.—J. THOMAS.

Answer:—The three types of screwed joints used in ammonia work are: 1—the hand soldered, 2—the sweated, and 3—the litharge joint. We believe they are named in the order of their relative value and cost, but good results are known to have been obtained with all, if made as described.

Thoroughly clean the fitting. Thread must be free from grease and oil, and the metal comprising the solder box or recess around the thread in the fitting must be bright. The end of the pipe, about ¾ inch back from the last thread, must be ground or filed so as to show bright metal, and likewise made thoroughly clean.

Next, put some oil on the thread of the pipe and screw fitting or flange on to the pipe, taking care to line up the flange with regard to the location of the bolt holes. Next, set the pipe connection up on end in such a way that the solder box will be level. Expose the joint to at least two flames of torches, blow lamps or Bunsen gas burners, for at least three minutes so as to thoroughly heat up the metal of the fittings and of the pipe. This will serve to burn off any surplus oil.

Burn Off Surplus

While the flames are still playing on the joint, pour in a spoonful of acid. This is the usual acid used for soldering, and is composed of muriatic acid that has been been "killed" or neutralized by the insertion of strips of sheet zinc, sufficient to stop effervescence in the acid.

A soldering hook is found very useful for tinning the joint. This hook may be made of a piece of 3/16-inch round wire about 15 inches long, bent "L" shaped, the leg being about 1¼ inch long and flattened out like a hatchet. Dip the hatchet-end of the hook into a tray containing acid, and from there dip it into a tray containing powdered salamoniac, and work the hook around the joint in the solder box; then take a stick of solder and work that around the joint in such a way that the entire surface comprising the solder box and the bright part of the pipe will be thoroughly tinned. When the entire surface has been thoroughly tinned, the stick of solder may be rubbed around the joint, the heat of the metal causing the solder to melt, and thus gradually fill up the solder box. When nearly filled up, take a piece of lump chalk and rub around the beveled edge of the solder box of the fitting for the purpose of preventing the solder from overflowing, and continue with the stick of solder to fill up the solder box as much as possible, finishing with a smooth fillet.

Now the blow torches may be removed and the point allowed to cool, which will take but a few minutes. Before it is entirely cold clean off the joint with a brush or rag.

"Half and Half"

The best results are obtained by using a thin stick of solder composed half by weight of tin and half lead, a composition which is known as "half and half."

Thoroughly clean the fitting or flange and the threaded end of the pipe, filing the pipe a little way back from the thread so as to show bright metal. If a number of joints have to be made, soldering is facilitated by using a soldering bath composed of 50 per cent. by weight of tin and 50 per cent. by weight of lead, into which the fitting and pipe can be dipped for heating. Otherwise the pipe and fitting will have to be heated by means of two or more blow lamps or torches, and the threads tinned, tinning the pipe about ¾ inch back from the thread, by means of acid and salammoniac the same way as described above, and using a stick of solder.

First, tin the pipe and afterwards the fitting or flange. This must be heated to a high temperature and then screwed on to the pipe as tight as possible without delay, the idea being that the heated flange is expanded by heat, and will practically make a shrink fit. As soon as screwed on and lined up square with regard to bolt holes, if any, fill up the solder box with solder, as already described.

Whenever possible the pipe joints should be made at the bench and not in place, because it is absolutely necessary to have access to all parts of the joint so that one can see and leave no cavities of any kind.

In case of a slight leak the engineer can often reduce same by caulking the joint, but this must be done with the greatest care, and, if possible, with the high pressure off the pipe. To make a joint on a horizontal pipe in place is rather difficult, but may be done by first cleaning and tinning the joint thoroughly, as described, then using an improvised metallic ring held against the solder box and provided with a slot at the top through which the hot solder may be poured in. This expedient might also be feasible in the case of a joint on a vertical pipe in place, the joint being on the underside of a fitting in such a way that ordinarily the solder would flow out. In this case also the joint may be thoroughly cleaned and tinned, and a ring used of "L" shaped cross section, so arranged that hot solder can be poured in from the top.

LOWERS ENGINE SPEED

Without any change of load or alteration of the governor adjustments, why does lowering of boiler pressure result in reduction of speed of an engine?—JOHN DOAN.

Answer: Overcoming the same resistance requires the same m.e.p. to act on the piston. In an engine regulated by a throttling governor and fixed cutoff, the same m.e.p. would require the same average steam-chest pressure, which for lower boiler pressure would not be satisfied except for the larger opening of the governor throttle valve that would be obtained for a slower speed of governor.

In the same manner, lower initial pressure of steam supplied to a cutoff engine would require a later point of cutoff for development of the same m.e.p. which would be satisfied by a governor position corresponding to a slower speed than the shorter cutoff corresponding with higher speed required for higher initial pressure.

On the other hand, with the same load, increasing the boiler pressure results in an increase of speed, for in the case of a throttling governor the engine speeds up until the governor's throttle opening is no more than necessary to obtain the former steam-chest pressure; and in the case of an automatic cutoff governor the engine speeds up until the cutoff becomes short enough to result in the required m.e.p.

EXPANDING TUBE ENDS

Why are the tube ends and nipples of water-tube boilers simply expanded without being beaded over as required for tube ends of fire-tube boilers?—W. HUDSON.

Answer: The object of beading over the ends of tubes of fire-tube boilers is to obtain better protection from the corrosive action of the fire and retain greater resistance against stripping action of the tube-sheet holes.

The ends of tubes and nipples of water-tube boilers are not exposed to the action of the fire, and, if anything, properly performed expanding and flaring without beading has greater holding power, as beading over the ends is likely to produce splitting or disintegration of the material.

CHANGE OVER IMPRACTICAL

An automatic engine has a riding cutoff valve that is controlled by a shaft governor which swings the eccentric around on the shaft. Could the engine be run with a shaft governor operating a slotted eccentric?—E. WYLIE.

Answer: When the governor swings the eccentric around on the shaft, the variation of cutoff is effected by changing the angle of advance of the eccentric and the valve travel is constant.

With a slotted eccentric there would be variation of the eccentricity and variation of valve travel, and consequently a valve designed for constant travel would not be properly operated by a governor controlling a slotted eccentric.

ELECTRICAL TERMS

What are the more common terms used in connection with electric circuits? How can the resistance of a single wire, equivalent to three wires in parallel, be found?—C. A. S. E. MEMBER.

Answer:—The electrical terms in use for circuits are:

AMPERE (I)—The practical unit of current flow is the ampere, which is the current that will flow through a conductor having a resistance of 1 ohm and a potential of 1 volt between its ends. One ampere (direct current) will deposit 0.001118 grams of silver per second from a silver solution.

VOLT (V)—The practical unit of electromotive force (e.m.f.) is the volt. One volt is required to force one ampere through a resistance of one ohm.

OHM (R)—The practical unit of resistance is the ohm, and is that resistance through which the fall of potential is one volt when the current strength is one ampere.

COULOMB (Q)—The unit of quantity of electricity is the coulomb, and is that quantity which passes a cross-section of a conductor in one second when the rate of flow is one ampere.

WATT—The practical unit of power is the watt. One watt is produced when 1 ampere flows under an e.m.f. of one volt.

One kilowatt equals 1,000 watts.

1 watt = 0.00134 h.p. = 0.057 B.t.u. per min.

WATT-HOUR—Watt-hours and kilowatt-hours are the units of energy used in commercial work.

One watt-hour = 2655.4 ft. lb. = 3.412 B.t.u. = 0.001341 h.p.-hr.

For series-connected resistances the combined resistance is the sum of the separate resistances.

For parallel circuits the combined conductivity is the sum of the separate conductivities or

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \cdots$$

The equivalent resistance for three parallel resistances R_1 R_2 R_3 is

$$R = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}$$

For four parallel resistances R_1, R_2, R_3, R_4,

$$R = \frac{R_1 R_2 R_3 R_4}{R_1 R_2 R_3 + R_2 R_3 R_4 + R_3 R_4 R_1 + R_4 R_1 R_2}$$

If

$R_1 = 2$ ohms

$R_2 = 3$ ohms

$R_3 = 5$ ohms

$$\text{Then } R = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1} = \frac{2 \times 3 \times 5}{2 \times 3 + 3 \times 5 + 5 \times 2} = \frac{30}{31}$$

ohms.

Trade Catalogs

The Gates Engineering Company, Ltd., of Montreal, have issued a bulletin entitled Air Cooled Refractories, showing the various materials for boiler settings and furnaces handled by them. The Gates air-cooled suspension arch, for use with chain grate stokers, waste fuel furnaces for burning tan bark, hot fuel and sawdust, air-cooled furnace blocks, interlocking fire-box lining, in which a lug at the back of each brick holds the block solid instead of the use of cement; boiler door arches and jambs, and rear combustion chamber arches, are described in detail.

Bulletin No. 117 of the Uehling Instrument Co., of Paterson, N.J., represented in Canada by the Combustion Engineering Corporation, illustrates, in diagrammatic form, the simple principle of operation of Uehling CO_2 recording and indicating equipment. This equipment is unlike all other CO_2 recorders in that it has no moving parts and employs no chemicals in liquid form. Instead, it operates on a simple scientific principle based on varying gas tension between two orifices. Of rugged construction, the equipment is designed to meet all power plant conditions.

Convention Notes

The annual convention of the National Association of Stationary Engineers was held in the Broadway Auditorium at Buffalo, N. Y., Sept. 11 and 12. Booths exhibiting equipment and supplies used in a power plant, were arranged in splendid order. Lattice work partitions separated each booth, which was very effective from an artistic point of view as well as being economical. The sessions while thorough were conducted from the standpoint of economy of time.

The Question of the revision of the constitution was dealt with by means of a referendum vote. Among other matters, the question of buying coal on a B.tu., or heating value basis was turned over to a committee for further investigation.

The following are officers of the Canadian Electrical Association, appointed for 1923-1924:—President, P. T. Davies, commercial manager of the Southern Canada Power C., Montreal; vice-president, J. E. Woodyatt, general manager, Southern Canada Power Co., Montreal; vice-president, J. E. Woodyatt, general manager, Southern Canada Power Co., Montreal; vice-president, R. J. Beaumont, manager of subsidiaries, Shawinigan Water & Power Co., Shawinigan; treasurer, C. Johnstone, auditor, Southern Canada Power Co., Montreal; secretary, Louis Kon, manager publicity department, Montreal Light, Heat & Power Co., Montreal.

The N.A.S.E. is still holding its own from a membership standpoint, having about 20,000 members in good standing. A special committee is dealing with the educational program, but discussion on this subject revealed the fact that only a small percentage of the engineers avail themselves of this opportunity to improve their education. The membership drive was very disappointing, and it was agreed that steady work and gradual increase alone brought results.

F. Martin, of the National Board of Fire Underwriters of New York, spoke to the Association on "Preventable Fire Losses an Alarming and Criminal Economic Waste." He also explained the elements of success by giving a new interpretation of the words "Enthusiasm," "Ambition," and "Application." Slides were used to illustrate the points referred to by Mr. Martin, showing recent losses of life and property in Canada and the United States.

Five years ago the N.A.S.E. loaned to the C.A.S.E. several sets of slides for educational purposes, which have been in circulation in Canada ever since. At the recent convention they offered to exchange these slides for others which they believed would be of more use to-day to the C.A.S.E.—GEO. J. SOUCY, Executive Secretary, C.A.S.E.

Construction

Dunkley Baby Car Co. of Canada, Ltd., Ford, Ont., has been incorporated to manufacture and deal in conveyances and vehicles of every kind, and accessories and parts, with $50,000 capital, by William H. Dunkley, Birmingham, England.

The Montreal Harbor Commission is building a machine shop to cost about $40,000.

The Municipal Electric Light and Power Co. plant at Melville, Sask., was damaged by fire with a total loss of about $100,000.

Equipment will be purchased soon for the new plant to be erected at Collingwood, Ont., by the Canadian Postal Locknut and Bolt Co.

The Alberta Granite and Marble Works, Edmonton, Alberta, will erect a factory to cost $10,000, and will instal additional equipment.

Plans are being revised and new bids called for the erection of a foundry for the Canadian Westinghouse Co., Aberdeen Ct., West, Hamilton, Ont.

The Yorkton, Sask., Power Plant will build an addition costing approximately $75,000, and will instal two 300-horsepower engines and two generators.

Moore Bros. Machinery Co. Ltd., has been incorporated to deal in and manufacture mill supplies and machines at Montreal, Que., with $40,000 capital.

Among the recent incorporations in the Province of Quebec, is the Ottawa River Power Co., Ltd., head office at Hull, Que., and with a capital of $450,000.

Continental Motor Services, Ltd., has been incorporated for $100,000 to manufacture and deal in automobiles, gas engines, flying machines, and accessories, at Toronto.

The Vipond Consolidated Gold Mines, Timmins, Ont., are increasing their mill capacity to 150 tons, and it is understood additional electric equipment is required.

The Continental Equipment Co. Ltd., Montreal, Que., has been incorporated to manufacture and deal in electrical machinery, motors, dynamos, etc., with $25,000 capital stock.

The Thompson Enterprise Co. Ltd., Toronto, Ont., has been incorporated to manufacture floor polishing machines, electrical machinery, equipment, etc., with $40,000 capital stock.

The Stalker Engineering Co. Ltd., has been incorporated to carry on a business as iron founder, mechanical engineer and manufacturer of machinery, at Simcoe, Ont., with $40,000 capital stock.

The Ottawa River Power Co. have completed plans for development at Bryson, 50 miles above Ottawa. The first installation will be one unit of 25,000 h.p. The transmission line to Ottawa is expected to be completed by October 15.

The Essex Border Utilities Commission is having plans prepared for the construction of a filtration plant at Ford, Ont., to serve five municipalities at an estimated cost of $150,000. Bids will be received about Nov. 1. J. C. Keith, 300 Ouellette Ave., Windsor, is the engineer. The owner is in the market for materials and equipment.

Comments in the Power Plant Field

"A Degraded Certificate"

The Editor, Power House:

I have just had my attention called to a letter published in your valuable medium, "Power House," in answer to my letter in the issue of August 20, on "Examination Tactics."

If your readers will give my letter the "twice over" they will see that my criticism was timely and to the point, for not only does Mr. J. M. Brown fail to justify the variable standards of examination, but he hands out a new basis of standardization by suggesting that "the diligent and proficient should have the preference" in advancement, instead of the "tried and true with a long service record," who are more competent to exercise judgment and more efficient in the long run, although perhaps lacking somewhat in book knowledge.

Increased knowledge is a good thing, but the safest thing for our national industries is to set a standard requiring a certain amount of general experience to counterbalance a large fund of general knowledge.

There have been cases where men granted the higher grade certificates have never had charge of a plant, some being only firemen in a heating plant.

"Dominion Wide" or a uniform Interprovincial certificate is what the stationary engineer wants, patterned after the Interprovincial Regulations for Boiler Inspections.

By these regulations, no province suffered, no boiler inspector was inconvenienced, and no manufacturer has so far complained. In fact all are better satisfied because a big subject was handled in a big way and not in the "provincial" way of the Ontario Engineers' Certificates,with exceptions and special privileges.

I would like to know how well the Ontario Stationary Engineers Act has been enforced since 1918. I am sure the supply of certificates has greatly exceeded the demand, at least, for second-class engineers. —GEO. A. BROWN, 659 Markham Street, Toronto.

SOME NEW THEORIES

In the June 20 issue of Power House, W. H. Casmey, in telling us how to save millions of tons of coal yearly, propounded some new theories which Canadian engineers ought to consider well as to their correctness.

Mr. Casmey says that it is the oxygen combined with the coal which results in the evolution of heat. Oxygen combined with coal or carbon gives carbon dioxide.

I have always understood that combustion is the rapid chemical combination of carbon and oxygen, or of hydrogen and oxygen. Possibly Mr. Casmey means that it is the act of combining which produces heat.

Further on in his article he states that "the only effect of the introduction of too large a quantity of air is to cool the furnace below the point of combustion." I presume that by the point of combustion he means ignition temperature. As the ignition temperature of carbon from bituminous coal is 766 deg. Fahr., and 925 for carbon from anthracite, it is hardly likely that the furnace temperature will be lowered below that point, in practice, even wasteful practice.

Increases Temperature

It is generally admitted that excess air, while lowering the furnace temperature, increases the exit gas temperature, thereby producing waste.

It is also accepted as correct that excess air by acting as a dilutent reduces the density of the smoke. This can be proved by leaving the furnace door open after firing and noting whether the smoke is as dense as it is when the doors are closed.

Another New Theory

Another new theory is that the reason that we use excess air is to make the temperature of combustion suitable for steam raising purposes. A common notion among engineers is that excess air is supplied for the purpose of securing complete combustion by mass action of the gases. With proper mixing devices, or a furnace so designed that good mixing results, a lower percentage of excess air is possible.

It is taught in our schools that for the perfect combustion of 1 lb. of carbon, 11.52 lb. of air, containing 2-2/3 lb. of oxygen and 8.85 lb. of nitrogen, are necessary. Mr. Casmey disagrees with this, claiming that 12 lb. of air are necessary for 1 lb. of coal, and that this air contains 2½ lb. of oxygen and 9½ lb. of nitrogen. As there is no coal containing 100 per cent. carbon, the weight of air per lb. of coal is less than 11.52 lb., being as low as 7 lb., with some samples of coal.

Mr. Casmey then asserts that low temperature, as a result of adding fresh fuel, will produce smoke. but we know from experience that high temperature will also produce smoke when fresh fuel is added. It is not clear how he arrives at the conclusion the 11 per cent. of the coal is lost up the chimney with black smoke. A. D. Pratt says "the direct loss from unconsumed carbon passing off in this manner is probably rarely in excess of 1 per cent. of the total fuel burned. even in the case of the blackest smoke."

Burn Coal Smokelessly

He also says that a smokeless chimney is not necessarily indicative of proper or even good combustion. Large quantities of excess air in diluting the products of combustion naturally tend toward smokeless stacks. Jas. W. Hays says that to burn coal smokelessly is a simple matter.

L. P. Breckenridge, who is considered an authority on combustion, declares, "the absence of smoke by no means indicates perfect combustion. It may simply mean excessive air dilution, and this means uneconomical operation."

Statements are frequently seen to the effect that one-quarter or one-third of the fuel burned goes off in black smoke from the chimney. It is doubtful if the black carbon particles which issue from chimneys, and which we call soot, ever amount to one per cent. of the fuel burned in any furnance. The appearance of black smoke is fortunately the signal of incomplete combustion, and the losses due to this cause are many times the losses due to the carrying away of the small soot particles.

Mr. Casmey hands the firemen a vicious slap when he says: "A smoking chimney announces to the neighborhood that the man at the fires is either ignorant or neglecting his duties." I will leave the fireman to defend himself, but when you consider the time and money spent in experimenting with different designs of furnaces and stokers it would almost seem as if furnace design had something to do with smoke production.

Damage to Buildings

Besides the loss due to incomplete combustion, which may be serious enough, there is a far greater loss, and the pity of it is, that the plant producing the smoke is not the one paying for it, and that loss is the damage to buildings, increased artificial light, made necessary by the decreased amount of sunlight, increased laundering and cleaning, and damage or injury to vegetation. Across the lake. in Cleveland, Ohio, this damage amounts to $12 per capita per annum, it is said.

Mr. Casmey, however, ably propounds one theory, with which I think many engineers will agree, when he says: "In making steam, the cost of which is the foundation of practically all manufacture, chaos, as a rule, reigns." He does not give the cause for this "chaos," so I may, in a subsequent contribution, give the opinion of a few authorities thereon.

I have cited a few instances in which Mr. Casmey, able engineer as he is, disagrees with views commonly held by engineers, and I would like to hear what other engineers think on the matter.— ROBERT McLAREN, Chief Engineer,
160 Dovercourt Road, Toronto.

BOILER COMPOUNDS

Noting that a fellow engineer has written to Power House asking if the boiler compound formula I mentioned on August 5th, would be suitable to his conditions, I now submit the following.

The water used in all Toronto plants is practically uniform and does not necessarily need to be analyzed to ascertain what kind of compound should be used, for that which has given good results at a plant in West Toronto should give equally good results in a Queen St. or Dupont St. plant providing the operating conditions are about the same. If the operating conditions differ it does not mean that a change of compound is necessary but that the quantity used should be altered to suit conditions.

For instance, if you are using a large quantity of returns and little raw water for make-up, it is not necessary to use as much compound as if you were using no returns. If no make-up water is used at all it would be better perhaps to do away entirely with the caustic soda. In any case the amount of caustic used should be reduced.

The formula is not of my invention but it has been used for some years in the plant where I am employed. As I did not like following in the footsteps of my predecessors without knowing what I was doing, I asked Power House for information on the subject and after reading same, I altered the formula to sixty pounds sal soda, four pounds caustic soda, four pounds Japonica, two pounds Irish Moss, two pounds manganese dioxide. Since using this I find, upon washing out the boilers, that there is considerably more mud and not so much scale as before.

The quantity of compound to be used and the method of feeding same, can best be found out by experiment. I use one quart of the above mixture per 100 h. p. per nine hour day and have been feeding it for the past nine months through the feed pump, putting the required amount in one injection. Recently I have commenced feeding it continuously throughout the nine hours.—E. GOLIGHTLY, 8 DENTON AVE., EAST TORONTO.

QUEER IDEAS

My work takes me into many power plants, and I have found some of the ideas used by the workmen, to say the least, rather queer. It hardly seems possible that some of the things I have seen could really exist in a power plant.

In one plant which contained five return tubular boilers, 66 inch by 16 feet, the connections of the steam pipe were so rigid that the vibrations from the engines were directly communicated to the boilers, which trembled and shook in a nerve-destroying manner. When I spoke to the boiler-room operator about it, explaining that there was practically no provision for expansion on the line, and that a wreck could be expected at any hour, they merely laughed and told me that the plant had been operating without accident for years, and was good for many years more. It seemed to prove the truth of the saying "Providence protects the ignorant and the foolish."

While visiting another power plant in the country, I noticed a neat pile of green oak branches cut into lengths three or four feet long, and from four to six inches in diameter. During the course of conversation with the man in charge of the plant, he informed me rather proudly that the green timber had all expensive compounds for the prevention of corrosion "skinned a mile." It seems that he cleans out the boiler once a month, and puts two or three of the lengths of wood in it on top of the tubes, removing the ones he had put in the previous month. The chemicals boiled out of the wood during the month's run prevented the formation of scale, and he claimed his boiler to be the only one in the neighborhood entirely free from scale and corrosion. It, of course, is possible that the tannic acid or other chemicals in the green wood would act as he claimed.

In a third plant I found a budding inventor who had packed the boiler feed pump with an oil soaked cloth so attached that the plunger got a rub from it at every stroke. He said he found the pump working easier and the packing lasting longer. Another "expert" connected a water pipe to the lubricator condenser, his idea being to get a quick flow of oil anytime he wanted it.

Many schemes discovered in plants remote from settled districts could likely be recorded by many readers of Power House, which would be just as strange as the foregoing.—JAMES E. NOBLE, 173 Macdonell Ave., Toronto, Ont.

C.A.S.E. ENQUIRIES

To the Editor, Power House:

Letters are coming in from all over the country enquiring how to become members of the C.A.S.E. Invariably I learn that this interest has been created through the C.A.S.E. Notes appearing regularly in the columns of Power House. The majority of the writers indicate that their chief interest is to obtain the advantages of practical education in their chosen field. I will quote from one writer, which is more or less representative of all the correspondents.

"I read with interest the C.A.S.E. notes appearing in Power House, and wish to assure you that my best wishes are with your association in the matter of their educational campaign. I sincerely believe that it would be to the credit of any operating engineer to be a member of such a society, especially when you consider that it offers a free medium for the exchange of ideas and thorough discussion of the problems of our chosen profession, and in consequence to know that you will receive a genuine practical solution. Kindly furnish me with full information as to how to become a member of this association, or how I can go about organizing a branch in our vicinity."

As this question is of interest to many of your readers, I presume you will permit me to furnish a brief outline for publication.

I will take for example, the engineer who writes in from Port Colborne, and requests information similar to that previously stated. The writer, in addition to enquiring how to become a member, the cost to join, and how to organize a branch, desires to know how he can get a copy of the answers to the list of questions published in Power House, in connection with last season's C.A.S.E. educational program. This goes to show that the majority of the engineers want to know and learn the answers given by competent and practical men to their every-day problems.

Briefly, the constitution states that when seven or more engineers (of any district) make application for a charter, the Grand President, having made enquiries as to their character and qualifications, and upon receiving a favorable report, will instruct the executive secretary to forward the charter to the applicants, upon the receipt of $25.00, and other necessary equipment and supplies to start a new branch. The outfit consists of two gavels, five rituals, twelve copies of the constitution, writing paper and envelopes, due cards and application cards, as well as the charter. Branch seals are extra, but furnished at cost.

The association is devoted to the promotion of educational, professional and engineering knowledge, thereby fitting its members for better and higher situations, and to maintaining the rights of the engineering profession; and for the transaction of any business that may be legally brought before it; also to the securing of the enactment, enforcement and unification of engineering laws throughout Canada.—GEO. J. SOUCY, 48 Moore Ave., Toronto, Executive Secretary.

Miscellaneous

Among the Federal incorporations of business gazetted this week are the following:—The Engineering & Inspection Co., Ltd., head office at Toronto, capital, $50,000; the Tidiout Refining Co. of Canada, Limited, head office Montreal, capital $200,000.

The Gates Engineering Co. of Montreal has just recently installed one of their Flat Suspended Air Cooled Arches, sixteen feet long by eleven feet wide, under a 500 h.p. unit in the Frasers Limited Power Plant at Edmundston, N. B. This Dutch Oven was built purposely for burning hog fuel and mill refuse, and is developing continuously 1,000 to 1,100 h.p. with fuel up to fifty per cent. moisture.

A. E. Rule, known in the power plant field as "Golden Rule," the man who did the bricking in of the boilers in the Royal Coliseum, Canadian National Exhibition, says that there is a great deal of activity in his line of business and that many power houses are having extensive repair work done on the boiler settings, especially on the furnace arches.

Montreal Tramways, Montreal, Dwight P. Robinson & Co., consulting engineers, have just purchased from the Combustion Engineering Corporation, Limited, for use in conjunction with 2–1,200 h.p. B. & W. boilers, 2 self-contained Type C. travelling grate stokers, 16 ins. wide, and 17 ft. 6 ins. long, each capable of burning sufficient coal to develop 300 per cent. of the boiler rating or 3,600 h.p. per stoker, it is claimed.

The stokers are the largest of their type in Canada and are similar to six recently purchased by the City of Birmingham, Eng., for the new Nechells Power Station.

One of several unique features in this installation is that the stoker driving mechanism and the forced draft fans with their air ducts are incorporated as part of the stoker, the fans being mounted one on each side of the coal hopper. The fans are direct motor driven. This feature eliminates air ducts in the boiler setting.

POWER
PLANT
EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA
TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK & WILCOX, Limited

Toronto Office
Bank of Hamilton Building

ST. HENRY—MONTREAL

Progress in New Power Equipment

A NEW SUPERHEATER

THE superheating of steam is now attracting a great amount of attention, not only in power station work, because of rapidly increasing boiler pressures, but also from the ordinary industrial steam user.

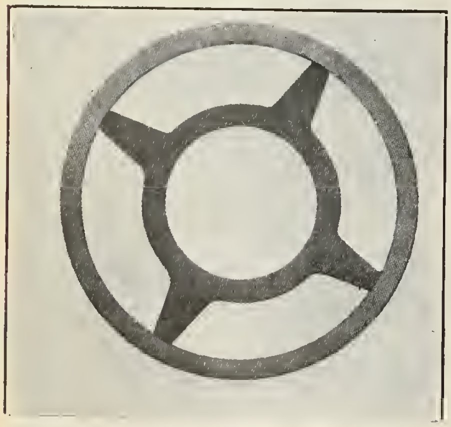
The benefits of superheating, both from the point of view of reducing the steam consumption of engines and turbines, and also in thoroughly drying the steam so as to reduce condensation losses in the pipe circuits, are so obvious that it is extraordinary the majority of industrial steam users have failed to realize the advantages to be obtained.

One of the latest developments in the science of superheating, is that Daniel Adamson & Co., of Dunkinfield, near Manchester, England, have produced a sectional modification, known as the "A.B. Sectional Type," of their accumulator superheater.

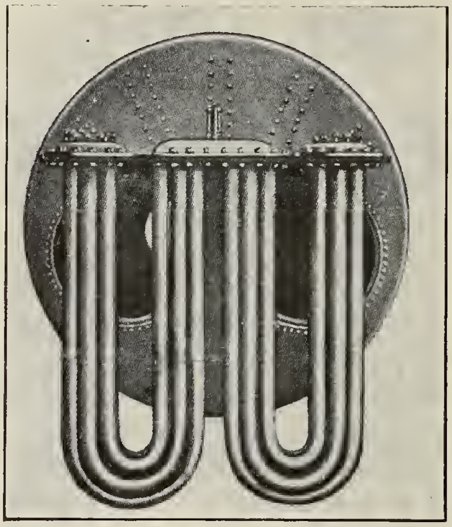
Split Steam Up

The essential principles of the design of the standard "Adamson" accumulator superheater consist in the use of specially heavy and large diameter (four inches) mild steel seamless tubes quarter inch thick, bent in the form of the usual simple loops suspended in the flames and hot gases, with an internal cast iron gilled core in each of the straight legs, so as to split the steam up into five separate portions during its passage through the tubes.

As a consequence the heat transfer to the steam is very efficient, each of the four outer divisions or portions of the steam, very narrow in width, being heated by the body of the steel tube, whilst the steam in the fifth and inner central division is heated from the cast iron core, which is touching the outer steel tube at a number of points, as well as being kept hot by the partially superheated steam in the four outer divisions. The five streams of superheated steam re-unite at the bottom in the loop portion of the tube, and split up again during the upward passage in the second leg, the bend being a simple tube without any internal gilled core, and the superheater is so arranged as to be in two separate divisions of loops, the steam passing first through one set of loops and then through the other, so that it is split up into five parts and re-united again four times in its entire passage through the superheater.



Section of tube with view of internal accumulator core.



View of superheater at the back of a Lancashire Boiler.

The inner cast iron gills or divisions are of course not subjected to unequal pressure and as they are of massive construction they store up a large amount of heat, acting as heat accumulators, thus avoiding the fluctuations in temperature characteristic of many types of superheater, a very important point.

Expanded at Each End

The four inch steel tubes are expanded at each end into circular top headers made of $1\frac{1}{4}$-$1\frac{1}{2}$" rolled steel slabs, with seven-eighths inch hydraulically pressed mild steel cover plates, the equipment also including a spring loaded safety valve, two thermometer sockets, and a heavy cast iron carrying frame with two eye-bolts to fit into the brickwork above the downtake of the boiler.

A number of advantages are claimed for this design, including strength, simplicity, outer flanged joints only, the doubling of the heating surface because of the internal accumulator core tubes, the thorough mixing of the steam and even superheating, together with efficiency of the heat transfer, and the equalizing of the temperature on the accumulator principle already mentioned.

The new "A. B. Sectional" modification retains these essential features, but in addition, any tube can be withdrawn, replaced, or blanked off, or an additional tube installed or withdrawn in a few minutes, whilst the parts are easily handled and packed for shipments, and the entire superheater can be put together actually in the boiler downtake, since the sections can be passed through very small openings.

COAL STORAGE

During warm weather and periods of light demand, such as August, mines have ample time to fully prepare coal. Washing, picking, sizing and other processes are carried forward as they should be and the finished product is in every way up to standard. Winter sees the mine rushed with orders. Under such circumstances it is almost impossible to maintain the same high standard of coal that exists during summer. This often means more to the consumer than is realized. Poorly prepared coal contains slate, bone and other elements that contribute largely to the ash content. And the greater the ash content, the more expensive the heat obtained.

Eliminating the seasonal element will stabilize the industry, improve preparation, aid production and help distribution. This bettered business practice reflects itself in prices, not only favorably to the consumer but to the miner, the operator and all concerned.

The storage of coal with the average industrial user is largely a matter of facilities. And because of this there are, here and there, factories that find it impossible to store coal. We are prone to look at "big" examples in everything, however, forgetting the smaller and more ordinary things. Perhaps because of this habit, those who are in a position to store coal hesitate doing so because of the erroneous belief that large investments and complex systems must be made.

In the discussion of ways and means of storing and reclaiming coal, Link-Belt, Limited, prepared the following plan which included a standard portable belt conveyor for unloading and storing the coal in the space available. This plan was adopted and a 31-foot machine was installed and put into operation. This conveyor, at an agle of 30 degrees will pile 13′6″ high, but as is shown in the drawing, the conveyor is lowered so that it piles but to a height of eight feet. This prevents burying the wheels. The machine was made to pivot, which enabled it to serve an arc about 36 long, with a minimum handling of the machine. Thus an 8′ pile 36′ long gives a storage of about 70 tons. The drawing shows how the portable belt conveyor backs away from the pile as the coal is stored out.

In actual operation this plan and equipment, it is claimed, worked out somewhat as follows:

Cost of handling coal:

Fixed charges per year:	
Depreciation at 20% (conservative)	$208.20
Interest, figured on an average investment of $521 at 6%	31.26
Upkeep per year	50.00
Electric current	25.00
Total	$314.46

Boiler Setting
Service

THE Gates Engineering Co., Limited, are in a position to contract for and specify on all boiler brick work with the least possible delay. Our Engineering Department is qualified to look after your interests, having made a close study of Combustion Problems.

Our Motto—Service and satisfied clients. The confidence of those who use Gates' Patented Air-Cooled Arch, etc., is unqualified, and is retained, because of the low maintenance cost and the guaranteed results.

Ask for our Descriptive Catalog.

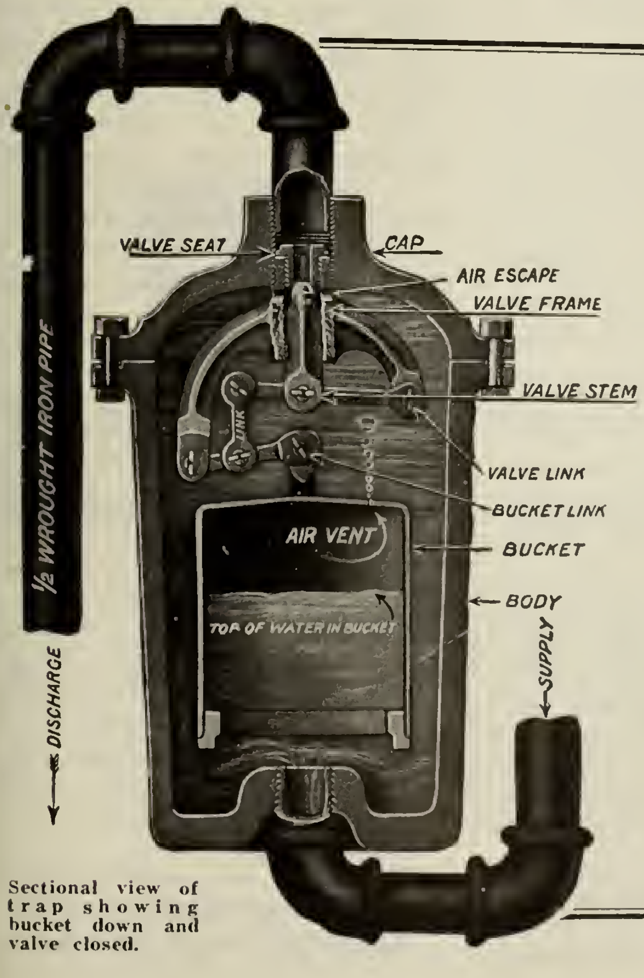
Gates Engineering Co., Limited
314 Notre Dame Street W., Montreal

PRATT & CADY VALVES

P. & C. Swing Checks are made in the regrinding type and with renewable asbestos, rubber or leather discs. They have a full port opening and may be used in either the vertical or horizontal position.

The Swing Type of check valve was first patented by Pratt & Cady in 1878.

Reading Steel Casting Co., Inc.
Pratt & Cady Division
An Associate Company of the American Chain Co., Inc.
General Sales Office: Bridgeport, Conn.
929 Connecticut Avenue
CANADIAN REPRESENTATIVES—CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.



Sectional view of trap showing bucket down and valve closed.

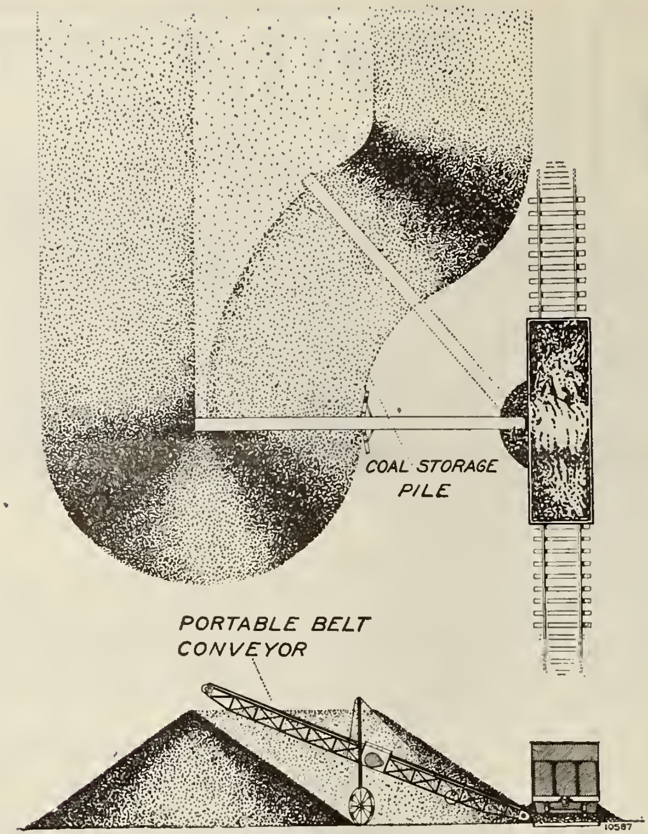
Armstrong Steam Trap

The Armstrong Steam Trap, in principle, is different. Its patented method of opening and closing the valve through the powerful leverage and positive action provided by an inverted, submerged bucket is unlike that of any other trap made.

That this simple principle has brought a difference in steam trap service—a greater reliability and a lowering of maintenance costs — is being proved by thousands of traps that have given hardly a moment's trouble since the day they were installed.

Let us send you full details.

The Arthur S. Leitch Co., Limited
High Grade Power Plant and Pumping Equipment, Engineering Specialties
1001-2 Kent Bldg. - Toronto



Showing method of handling coal from cars to storage pile. The arc shown in the side elevation is 36 ft. long, and has a capacity of about 70 tons (piled to a height of 8 ft.).

Labor charges when handling coal by portable belt conveyor, based on 4,500 tons (assume 90 cars) 10 hours per car at 40c per hour	360.00
Total	$360.00
Total cost of handling coal	$674.46
Or about 15c the ton.	

Compared with these figures, the cost of handling by hand, using 40c per ton for 4 500 tons, we have a total of $1,800.00, which equals a saving, it is claimed, of something over $1,100.00 in favor of a conveyor.

BOILER FEED WATER EVAPORATION

(Continued from page 30)

to the evaporator heater, from which the air escapes to the atmosphere as shown.

Fig. 3 illustrates an arrangement in which low-pressure exhaust steam is used in a specially designed evaporator, the vapor from which passes into the evaporator heater, through which the main condensate is discharged. The condensate is then passed into another heater where it is raised in temperature by exhaust steam, and then flashed in the de-aerator, in which a vacuum is maintained by a steam-operated ejector, which also serves to maintain a vacuum in the evaporator heater and consequently in the evaporator flash chamber.

The steam ejector discharges into the exhaust steam heater, and all drains are led into the de-aerator, the air escaping into the atmosphere.

In these arrangements the make-up consists entirely of distilled water, and all water must pass through the de-aerator before it is delivered to the boilers. Further, all heat is utilized for feed heating, and, wherever possible, the heating is done with low-grade steam from which energy has been abstracted.

ELIMINATING GRUNTS

(Continued from page 28)

and flows through the outlet passage into the steam pipe.

Subject to Pressure

From this it is clear that the oil in the body of the lubricator is subject to the pressure of the column of water extending through the small tube inside of the body, and the pipe P. If the steam pressure is 80 pounds per square inch, and the pressure due to the column of water is, say, one pound, the total pressure is eighty-one pounds. Liquids communicate pressure equally in all directions, therefore the oil in the body of the lubricator will press in all directions with a force of eighty-one pounds, but where the oil rises to the surface of the water in the sight feed glass, a force of eighty pounds back pressure is encountered, and since the steam pressure is practically the same at S and S, Figure 2, these forces neutralize each other, and there is left the pressure of the water or hydrostatic head extending through pipe P.

There is some back pressure due to the short column of water in the sight feed glass, but this is so small that it may be neglected, since this pressure is always less than the pressure on the oil in the body of the lubricator. Therefore, the oil as it leaves the feed nozzle, in the form of drops, is no longer acted upon by the pressure in pipe P, and rises through the water in the sight feed glass from the force of gravity because the oil is lighter than water.

It makes no difference whether the steam pressure is eighty pounds or only ten pounds. This is the reason the lubricator feeds as well when connected as shown in figure 2 as when connected to the steam pipe as usual, so long as the column is high enough to produce sufficient pressure in pipe P.

This arrangement is not a new idea and is used when it is not convenient to connect lubricators to vertical steam pipes, as, for example, in a case where the steam pipe must be brought up through the floor and led to the steam chest in a horizontal direction. In such cases the lubricator may be connected to a column located between the throttle valve and steam chest.

Obituary

Thomas J. Harris, who was 21 years stationary engineer at the Queen St. pump house, Ottawa, died on Sept. 22, at Ottawa, in his 68th year.

In This Issue

Editorial Point of View 21
By Campbell Bradshaw

Carbon Dioxide as a Refrigerant 22
By J. H. Pratt

Electric Boiler Economies 24
By F. Johnstone Taylor

Operating a Vacuum Heating System 26
Showing the value of the steam pump
By James MacKay

Electric Power Values 27
Meeting of the Association of Iron and Steel Electrical Engineers

Eliminating Grunts 28
Pump Troubles

Feed Water De-Aeration 29
Purification of Make-up Feed Water

Power House Engineering Lessons 31
By M. Barry Watson, B.A.Sc., M.E.

C.A.S.E. Notes—Pipe Lines 32

Practical Ideas 33
Repairing Broken Shaft
Pipe Bending Hints
Lubricator Hints
Equalizer Short Circuits
Locating Oil Troubles
The Lengths of Coils

Power Notes 35

Problems and Answers 36
Pump Exhaust
Indicator Diagrams
Using Oil Fuel
Joints in Ammonia Work
Lowers Engine Speed
Expanding Tube Ends
Changeover Impractical

Convention Notes 38
Trade Catalogues
Construction

Comments in Power Plant Field .. 39
A Degraded Certificate
Some New Theories
Boiler Compounds
Queer Ideas
C.A.S.E. Enquiries
Miscellaneous

Progress in Power Equipment 42
A New Superheater
Coal Storage

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

J. A. BURNETT,
M.E.I.C., P.E.Q.
CONSULTING
& APPRAISAL
ENGINEER
Room 301—205 St. James St.
Telephone Main 6737. Montreal.

When Answering Advertisements Mention
POWER HOUSE

Economize this Winter

Get the facts and figures on the Sturtevant Fuel Economizer which, in addition to saving 10% to 20% of your fuel bills, offers five other distinct savings of importance to thrifty managers.

Ask for folder 609.

B. F. STURTEVANT CO. of Canada, Ltd.
Montreal, Galt, Winnipeg, Toronto

The reason the champion is always the favorite is because he's better advertised.

POSITIONS WANTED

FACTORY SUPERINTENDENT—OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

EQUIPMENT FOR SALE

NEW AND USED MACHINERY AND SUPplies; get our prices for machinery on monthly rental. Apply Box 113, Power House.

PIPE THREADING TOOLS—"TOLEDO" AND "Jardine" are the best; catalogue P-3 tells you; all sizes up to 12-inch at one cut by one man. A. B. Jardine and Company, Limited, Hespeler, Ontario.

PIPE AND BOILER COVERINGS—ENGINE packings. Apply Box 111, Power House.

SAWMILL MACHINERY MANUFACTURED by sawmill machinery specialists. Apply Box 115, Power House.

SAWMILLS PORTABLE DOUBLE EDGERS; also all kinds of sawmill machinery. Apply Box 116, Power House.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—with house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

PISTON RINGS

EVER-TYTE and ZELCO Piston Rings with Patented Zelco Process save Gasoline, Oil, increase capacity, prevent cylinder from wearing out of round, lessen carbon; after using, make arrangement with us to sell them; made up to 80-inch; used in locomotives, boats, engines, compressors, ice machines, autos, trucks, tractors, etc.; are looking for distributors with mechanical knowledge; all or part time; real opportunity. Ever-Tyte, St. Louis, Mo.

A Striking Message

A STRIKING message to manufacturers of power-house equipment is derived from a letter written by a "Power House" reader in reply to a request for a criticism of the paper and for suggestions as to how it could be improved. Here is the letter:

"I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. **This is a mistake on their part, but for all I know to the contrary** it may be due to the lack of energy on the part of the Power House ad. manager in getting after them. **It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages SO MUCH AS ON THE ADVERTISEMENT PAGES."**

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES — $1 A MONTH
8754 ILLUSTRATIONS — $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines—the Indicator—Lubrication—PRACTICAL MANAGEMENT. GAS, GAS ENGINES—*Aeroplanes* and *Aviation*—HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers.—Mechanica Stockers—Oil Burners—Setting—Chimneys—Mechanical Draught—HOW TO SELECT A BOILER—BOILER DESIGN based on A.S.M.E. BOILER CODE—OPERATION FIRING. Pipes, Fittings—Heating and Ventilation—Refrigeration—Cooling Towers—Condensers—Distilling Apparatus—Elevators—Cranes—Ropes and Cables—Splicing—*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license—ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now—today and get this new master set for engineers. Pay only $1 a month.

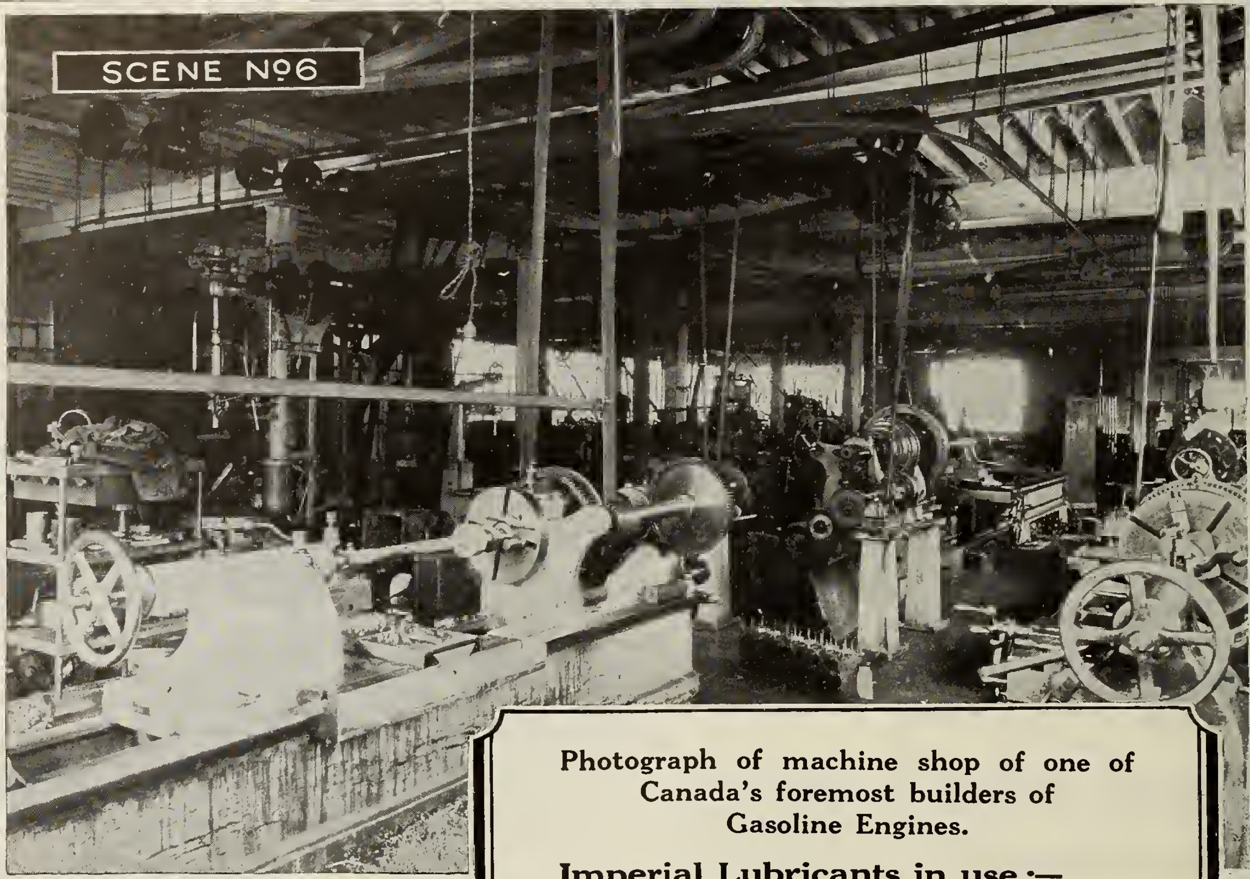
SEND NO MONEY

THEO. AUDEL & CO., 72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________
Occupation ____________
Employed by ____________
Residence ____________
Reference ____________

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W



Photograph of machine shop of one of Canada's foremost builders of Gasoline Engines.

Imperial Lubricants in use:—

Imperial Renown Oil.
Imperial Capitol Cylinder Oil.
Imperial Atlantic Red Oil.
Imperial Arctic Cup Grease.
Imperial Cutting Compound Antiseptic.
Imperial Polarine Motor Oils.

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

Hundreds of Canadian firms have used Imperial Lubricants exclusively for years. The fact that we manufacture a grade of oil or grease for every lubricating requirement and always maintain the same standard of quality and service, makes it easy and profitable for you to standardize on Imperial Lubricants.

Write our nearest branch for the advice or service of an expert lubrication engineer.

IMPERIAL OIL LIMITED

CO. LTD.

FALL REPAIRS

Now is the time to overhaul your Power Plant in anticipation of cold weather and expensive fuel.

PLIBRICO Jointless Fire Brick will give you a one-piece, monolithic lining. Our book, "Modern Furnace Building," will show you how.

PYRO-HERMETIC SEAL will make your boiler settings air-tight and stop all leaks.

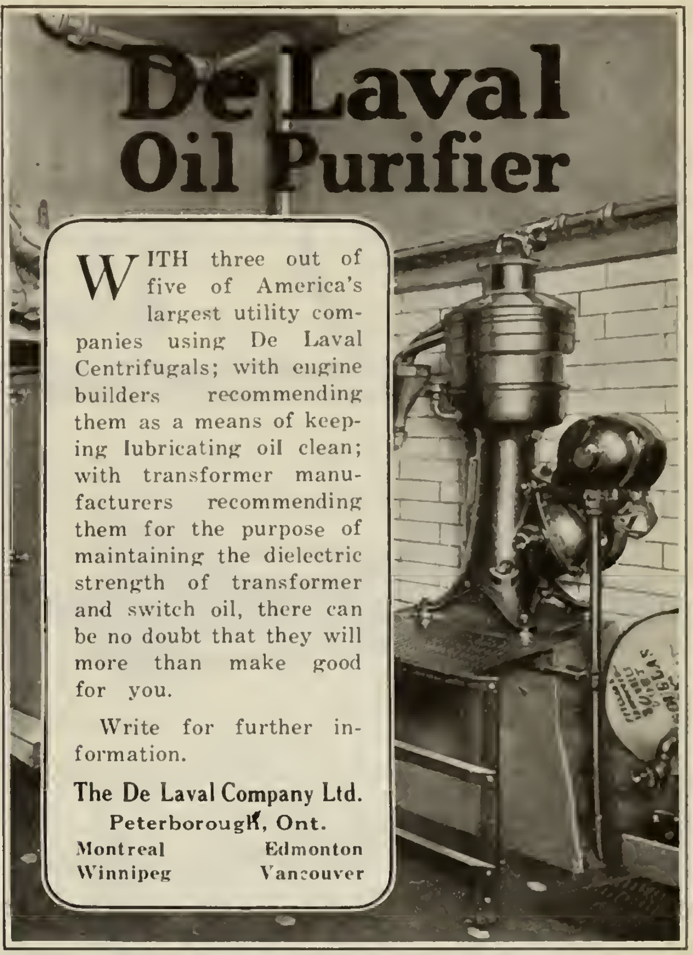
BOILER TREATMENTS.

ROOFINGS, Rubber, Plastic and Liquid, also Tarred Paper and Sheathings.

ROCKFACE, white water paint, both for interior and exterior use.

SOLIGNUM Wood Preservatives and Stains for shingles and woodwork.

Beveridge Supply Co., Limited
628-630 St. Paul Street West,
Montreal



De Laval Oil Purifier

WITH three out of five of America's largest utility companies using De Laval Centrifugals; with engine builders recommending them as a means of keeping lubricating oil clean; with transformer manufacturers recommending them for the purpose of maintaining the dielectric strength of transformer and switch oil, there can be no doubt that they will more than make good for you.

Write for further information.

The De Laval Company Ltd.
Peterborough, Ont.
Montreal Edmonton
Winnipeg Vancouver

Flue gases can be reduced 50 degrees by careful firing and clean boiler surfaces

Such is the substantial saving that can be effected by recording and measuring your flue gas temperature with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.
Recording Pyrometers

Of course, the temperature of outgoing gases can be decreased by economizers, or by a change in the baffling — but such changes are costly and the economy depends upon the cost of coal.

The information supplied by Bristol's Pyrometers, as to the temperature of uptake gases leaving the boilers, is of prime importance as an aid to super-efficient plant operation.

Hundreds of Bristol's Pyrometers are recording flue gas temperatures in prominent power plants. Let us tell you more about what they could do in your plant. Our new Catalog 0-1401 is waiting for your address.

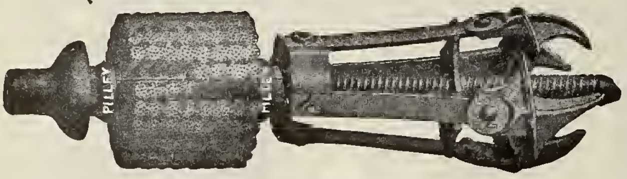
The Bristol Company, Waterbury, Conn.

Canadian Distributors:
Eastern Territory: Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory: Gorman's, Ltd., Edmonton.

Fig. 1007
A suit has been filed in the United States Federal Court against a pyrometer manufacturer who is infringing patents owned by the Bristol Co. covering Automatic Cold End Compensation for Thermo-Electric Pyrometers.

HINTS TO BUYERS

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

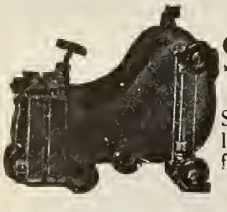
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

PREVENT
Costly Shut Downs
Due to
Scale in Your Boiler

Refinite Perfect Soft Water prevents boiler scale. Makes scale impossible. It takes out the lime and magnesium before the water enters the boilers. Write for full and complete information.

REFINITE COMPANY OF CANADA, LTD.,
Toronto, Canada. Continental Life Bldg.

REFINITE
RIVAL OF THE CLOUDS
TRADE MARK
Nature's Water Softener
Copyright 1920—The Refinite Co.

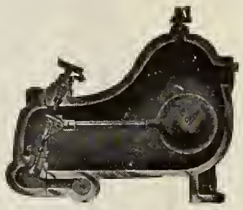


McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue
THE GARTH COMPANY
Craig Street.-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



The reason the champion is always the favorite is because he's better advertised.

FUEL OIL BURNING
for
HEATING and POWER PLANTS

Correspondence Invited

ENGINEERING & CONTRACTING

The **T.J. CUNERTY** *Company*
9 Richmond St E. *Toronto*

CARHARTT

FROM MILL TO MILLIONS
CARHARTTS
GLOVES OVERALL UNIFORMS AND PANTS
TRADE MARK

"FIRST IN THE HEARTS OF UNION MEN"

OVERALLS

MONCRIEFF'S "UNIFIC" WATER GAUGE **GLASSES**

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is **economical.** British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

BOICO BOILER COMPOUND Gets the Results!

Anti-Clinker Shell Bar Grates—Maximum air space ensures the last bit of heat from the last bit of fuel.

One-Piece Jointless Furnace Lining—Line your furnace with PLIBRICO. More efficient, less costly, lasts longer, easier to instal.

Tip-It Patent Welding Process. Gives you tools with shanks of carbon and tips of high-speed steel.

SHELL-BAR BOICO SUPPLY, Limited
1-15 Saunders Ave., Toronto.

SALES AGENTS: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot, Reg'd., Quebec; Adam Davis, Cobalt, Ont.

EDWARD For Exacting Duty

Fitted with EDWARD Protected Seat and Disc.

THE EDWARD VALVE & MFG. CO.

General Office and Works: East Chicago, Indiana.

CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal; Valve Engineering Co., Toronto.

VALVES

BOILER SETTINGS
SPECIALISTS IN
FIREBRICK AND ARCHWORK
FOR EVERY TYPE OF STEAM BOILER

A. E. RULE COY.
122 Garden Av. TORONTO Lakeside 1274

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS EQUIPMENT--PIPING

Oil Burning Systems Installed

Full line of Power Plant Equipment and Supplies.

LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL

Labor-saving ash-handling equipment of proven economy. Information on request.

Canadian Representatives:
CLEATON CO. (Canada) Ltd., Montreal.
GORMANS LIMITED, Edmonton, Calgary.
WM A GOOLD Winnipeg.
T M. GRINDLEY CO., Vancouver.

CONVEYORS CORPORATION OF AMERICA
326 W. MADISON STREET CHICAGO

Jardine's Self-feeding Tube Expanders

REGISTERED J TRADE MARK

All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co., Ltd
Hespeler, Ont.

NORTHERN CRANE WORKS. LTD
Walkerville, Ont.

Hays Apparatus
STANDARD GUIDES TO EFFICIENT COMBUSTION
The Jos. W. Hays Corporation
MICHIGAN CITY, INDIANA

SEND INFORMATION ABOUT
☐ AUTOMATIC CO₂ & DRAFT RECORDERS
☐ HAYS DRAFT GAGES
☐ HAYS IMPROVED GAS ANALYZERS
☐ HAYS AUTOMATIC GAS COLLECTORS
☐ "BESTIX"-COATING FOR SETTINGS
☐ "SPIZZERINKTUM"-BOILER METAL TREATMENT

NAME
POSITION
COMPANY
ADDRESS

INVESTIGATE THE
ADVERTISEMENTS
APPEARING IN EVERY ISSUE OF
OF POWER HOUSE

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
H. Mueller Mfg. Co., Ltd., Sarnia, Ont.

AIR COMPRESSORS
Laurier & Lamb Co., Montreal.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can, Fairbanks-Morse Co., Ltd., Montreal,
American Steam Pump Co., Battle Creek, Michigan.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto.

ALARMS (LOW WATER)
Bristol Co., Waterbury, Conn.
James Morrison Brass Mfg. Co., Ltd., Toronto.

AMMETERS
Bristol Co., Waterbury, Conn.

AMMONIA COMPRESSORS
The Vitter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

ASH CONVEYORS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal,

BEARINGS
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING
Can. Fairbanks-Morse Co., Ltd., Montreal.
D. K. McLaren Ltd., Montreal.
Gutta Percha & Rubber Co., Ltd., Toronto.

BELT LACING
Bristol Co., Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING LINK
Can. Fairbanks-Morse Co., Ltd., Montreal,

BELTING RUBBER
Can. Fairbanks-Morse Co., Ltd., Montreal.

BLOWERS, TURBINE
De Laval Steam Turbine Co., Trenton, New Jersey,
Turbine Equipment Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BLOWERS, FAN
De Laval Steam Turbine Co., Trenton, New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
De Laval Steam Turbine Co., Trenton New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BOILER TUBE CLEANERS
Pilley Packing & Flue Brush Co., St. Louis, Mo.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd. Toronto.

BOILER TUBES
Babcock & Wilcox, Ltd., Montreal.

BOILER SETTINGS
Celite Prodcuts, Ltd., Chicago, Ill.
Sterne & Sons, G. F., Brantford, Ont.

BOILERS, HEATING
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOILERS, RETURN TUBULAR
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOILERS, VERTICAL WATER TUBE
Geo. T. Ladd Co., Pittsburgh, Pa.

BOILERS, WATER TUBE
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BREECHINGS
Engineering & Machine Works of Canada, St, Catharines, Ont.

BRICK, FIRE
Goldie & McCulloch Co., Ltd., Galt, Ont.
Sexton Boiler Setting Co., W. R., Toronto, Ont.

BRICK, INSULATING
Celite Products, Ltd., Chicago, Ill.

CALORIMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

CASTINGS, BRASS & IRON
Canadian Steam Boiler & Equipment Co., Ltd., Toronto.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Kerr Engine Co., Ltd., Walkerville, Ont.
Gollie & McCulloch Co., Ltd., Galt, Ont.

CASTINGS, GREY IRON
Velter Mfg. Co., Milwaukee, Wis.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CEMENT, ASBESTOS
Sterne & Sons, G. F., Brantford, Ont.

CEMENT, IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

CEMENT, FIRE BRICK
Sterne & Sons, G. F., Brantford, Ont.

COAL AND ASH HANDLING MACHINERY
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COAL CRUSHERS
Babcock & Wilcox, Ltd., Montreal.
The Canadian-Fairbanks Morse Co., Ltd., Montreal.

COAL PULVERIZING EQUIPMENT
Combustion Engineering Corp., Ltd., Toronto.

COCKS, BRASS & IRON
James Morrison Brass Mfg. Co., Ltd., Toronto.

COCKS, GAGE
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COCKS, STEAM
James Morrison Brass Mfg. Co., Ltd., Toronto.

CO2 RECORDERS AND FLUE GAS ANALYSIS INSTRUMENTS
Sarco Co., Inc., N. Y.
Foxboro Co., Inc., Foxboro, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal.

CONDENSERS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine, Toronto.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

CONDENSERS (JET)
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Galt, Ont.

CONDENSERS (SURFACE)
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CONVEYORS (SEE COAL AND ASH HANDLING MACHINERY)
Babcock & Wilcox, Ltd., Montreal.

COUPLINGS, FLEXIBLE SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

COUPLINGS, SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

CRANES
Babcock & Wilcox, Ltd., Montreal.
John T. Hepburn, Ltd., Toronto.

DEALERS (MACHINERY)
Can. Fairbanks-Morse Co., Ltd., Montreal.

DISTILLING APPARATUS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.

DRILLS
Can. Fairbanks-Morse Co., Ltd., Montreal.

EJECTORS
Laurie & Lamb Co., Montreal,
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ELECTRIC GENERATING SETS (STEAM ENGINE)
Laurie & Lamb Co., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC GEN. SETS—(Steam Turbine)
Laurie & Lamb Co., Montreal.
E. Laurie & Co., Montreal.
De Laval Steam Turbine Co., Trenton,
Turbine Eulpment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ENGINES, DIESEL
Laurie & Lamb Co., Montreal.

ENGINES, CORLISS
Laurie & Lamb Co., Montreal.
Frick Co., Wanesboro, Pa.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, GAS & OIL
Laurie & Lamb Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, PUMPING
Laurie & Lamb Co., Montreal.

ENGINES, STEAM
Can. Sirocco Co., Ltd., Windsor, Ont.
Laurie & Lamb Co., Montreal.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ENGINES, UNA-FLOW
Vilter Mfg. Co., Milwaukee, Wis.
Frick Co., Wanesboro, Pa.

ENGINE REPAIRS
Goldie & McCulloch Co., Ltd., Galt, Ont.

EXPANSION JOINTS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FANS (SEE BLOWERS, FAN)
Can. Sirocco Co., Ltd., Windsor, Ont.

FEED WATER HEATERS
Goldie & McCulloch Co., Ltd., Galt, Ont.

FEED WATER PURIFIERS
Sterne & Sons, G. F., Brantford, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

FILTERS, FEED WATER
Babcock & Wilcox, Ltd., Montreal.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

FILTERS, OIL
Babcock & Wilcox, Ltd., Montreal.
Turbine Equipment Co., Ltd., Toronto.

FILTERS, WATER
Laurie & Lamb Co., Montreal.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

FIRE BRICK ARCHES
Combustion Engineering Corp., Ltd., Toronto.

FITTINGS, AMMONIA
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

FITTINGS, STEEL
Reading Steel Casting Co., Bridgeport, Conn.

FITTINGS, CAST IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

FLOATS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FUEL OIL SYSTEMS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal,
T. J. Cunerty Co., Toronto.

FURNACES
Can. Sirocco Co., Ltd., Windsor, Ont.

FURNACE LININGS
Sterne & Sons, G. F., Brantford, Ont.

GAGE COCKS (SEE COCKS GAGE)
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASS GUARDS
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASSES
Durabla Mfg. Co., New York City.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, DIFFERENTIAL
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

GAGES, DRAFT
Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

GAGES, PRESSURE
Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, RECORDING
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

GAGES, STEAM
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
Babcock & Wilcox, Limited, Montreal, Que.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, VACUUM
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, WATER
The Bristol Co., Waterbury, Conn.
The James Morrisson Brass Mfg. Co., Limited, Toronto, Ont.

GAS EXHAUSTERS
Can. Sirocco Co., Ltd., Windsor, Ont,

GASKETS
Jenkins Bros., Limited, Montreal, Que.

GEARS
E. Laurie & Co., Montreal, Que.
Turbine Equipment Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Limited. Montreal, Que.

GENERATORS, ELECTRIC
Laurie & Lamb Co., Montreal, Que.

GOVERNORS, PUMP
Northern Equipment Co., Erie, Pa.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

GRATES
Combustion Engineering Corp., Ltd., Toronto, Ont.
Can. Steam Boiler Equipment Co., Ltd., Toronto, Ont.

GRATE BARS
Canadian Steam Boiler Equipment Co., Toronto, Ont.
Engineering & Machine Works of Canada. Limited, St. Catharine, Ont.
Babcock & Wilcox, Limited, Montreal, Que.
John T. Hepburn Ltd., Toronto, Ont.
Goldie McCulloch Co., Ltd., Galt, Ont.

A book that can end furnace trouble

THIS new book will tell you how any man about the plant can install Plibrico Jointless Furnace Lining to resist temperatures to 3,100 deg. F. — to cut down the loss of heat through the setting — to give two, three and even four years' service without relining.

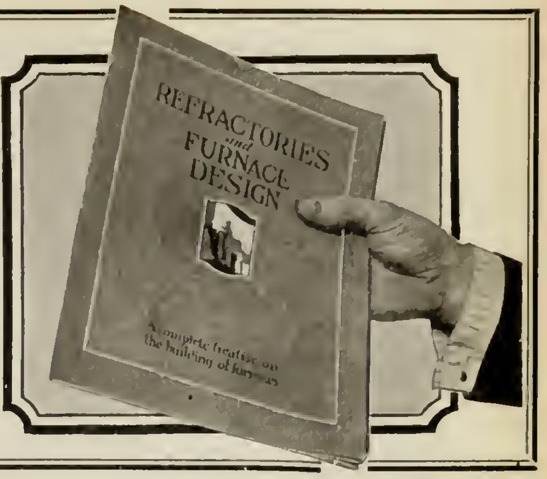
The knowledge gained can end the continual replacement of furnace linings that so many power plant operators find necessary. Every Canadian engineer should read it.

Do you want your copy? Just send a post card. No charge—no obligation.

PLIBRICO FURNACE LINING

JOINTLESS FIRE BRICK CO
1142 CLAY ST. CHICAGO

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Bolco Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver; Winnipeg Supply and Fuel Co., Winnipeg; Building Products and Fuel, Ltd., Saskatoon; Dominion Lime & Coal Co., Regina, Sask.


REFRACTORIES and FURNACE DESIGN
A complete treatise on the building of furnaces

MAGNOLIA ANTI-FRICTION METAL

is always uniform in composition and dependable in service. It adapts itself quickly to rough or scored shafting, makes smooth highly polished contact surfaces and "sets" particles of grit where they cannot cut the journal or appreciably increase friction.

Magnolia Metal melts and pours well, is easily peened and scraped in and is perfectly adapted to a very wide range of speeds and pressures. With the lowest frictional coefficient of any known bearing metal, it runs cool with less lubricant and is excellent protection against hot boxes and melting out where lubrication is neglected.

PRACTICAL ENGINEER POCKET BOOK

Over 600 Pages.

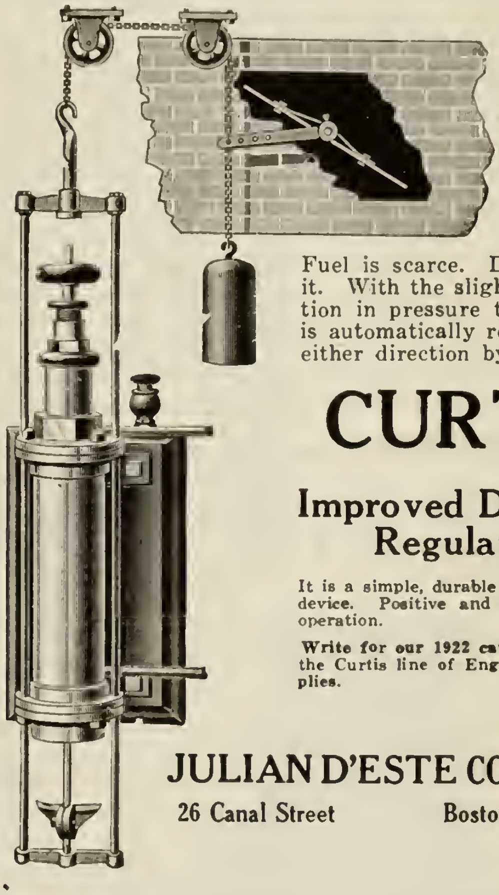
A valuable reference work imported from England and sold as an advertising medium at the low price of 50c. post paid—less than the actual cost of importation.

Address New York Office.
Write for test data.

Magnolia Metal Company
113 Bank St. - New York

Chicago	San Francisco	Montreal
Fisher Bldg.	Pacific Bldg.	37 Shannon St.

MAGNOLIA ANTI-FRICTION METAL
TRADE MARK



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1922 catalog showing the Curtis line of Engineering Supplies.

JULIAN D'ESTE COMPANY
26 Canal Street Boston, 14, Mass

EXTRAORDINARY BARGAINS

STEAM ENGINES

1 Goldie & McCulloch heavy duty, cross compound, latest type Corliss condensing engine with rope drive, line shaft pulley and idlers complete, equipped with Dean condenser. Cylinders are 20"x40"x42" stroke. Water heater included.

1 Robb-Armstrong, 18"x18" high speed automatic engine.

1 Robb-Armstrong 11"x14" high speed automatic engine, direct connected to a Westinghouse 70 k.w., 3 phase, 60 cycle, 220 volt generator, complete with exciter and marble control panel.

Also several smaller automatic engines and some air hoists from 4" to 10½".

CHAIN BLOCKS— 2 15-ton Herbert Morris chain blocks with trolleys.
1 10-ton Herbert Morris chain block with trolley.

WATER TUBE BOILERS--

2 250 h.p., 175 lbs. working pressure, government certificate. Everything complete and in first-class condition.

GET FULL PARTICULARS AND REMARKABLY LOW PRICES FROM

WILLIAM COATES
MAIL BUILDING PHONE GLAD. 1947 TORONTO, ONT.

GREASE EXTRACTORS
Babcock & Wilcox, Limited, Montreal, Que.

HEATERS, FEED WATER
Goldie & McCulloch Co., Ltd., Galt, Ont.

HEATING SYSTEMS
Can. Sirocco Co., Ltd., Windsor, Ont.

HOISTS, ELECTRIC
Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

HOPPERS, COAL & ASH
Combustion Engineering Corp., Ltd., Toronto, Ont.

HOSE, AIR
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

HOSE, RUBBER
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Babcock & Wilcox, Limited, Montreal, Que.

HOSE, STEAM
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

HOSE, WATER
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited. Toronto, Ont.

ICE AND REFRIGERATING MACHINERY (SEE REFRIGERATING MACHINERY)
Jamieson Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
Can. Ice Machine Co., Toronto, Ont.
York Mfg. Co., York, Pa.
Frick Co., Waynesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.

INDICATORS, SPEED
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INDICATORS, STEAM ENGINE
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INJECTORS
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

LUBRICATORS, CYLINDER
The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, FORCE FEED
The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, SIGHT FLOW
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

MACHINE WORK, SPECIAL
Engineering & Machine Works of Canada, Limited, St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

METERS, BOILER
Laurie & Lamb Co., Montreal, Que.

METERS, FLOW
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

OILING DEVICES
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PACKING, ASBESTOS
Durabla Mfg. Co., New York City.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.

PACKING, METALLIC
Laurie & Lamb Co., Montreal, Que.

PACKING, SHEET
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Durabla Mfg. Co., New York City.
The James Morrison Brass Mfg. Co., Ltd., Toronto Ont.

PACKING, VALVE STEM PIPE
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

PIPE, BRASS & COPPER
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE BENDING
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE COILS
York Mfg. Co., York, Pa.
Can Ice Machine Co., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE CUTTERS
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PUMPS, BOILER FEED
American Steam Pump Co., Battle Creek, Mich.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, CENTRIFUGAL
Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
E. Laurie & Co., Montreal, Que.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Co., Toronto, Ont.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, CONDENSER
Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

PUMPS, FORCE FEED
Laurie & Lamb, Montreal, Que.

PUMPS, OIL
Turbine Euipment Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PUMPS, POWER
American Steam Pump Co., Battle Creek, Mich.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, ROTARY
Turbine Equipment Co., Ltd., Toronto, Ont. Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

PUMPS, STEAM
Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
John T. Hepburn, Ltd., Toronto, Ont.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, TURBINE
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto, Ont.

PUMPS, VACUUM
Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Young Pump Company, of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PYROMETERS
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

REFRIGERATING MACHINERY
Jamison Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.
Frick Co., Wanesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

REGULATORS, DAMPER, DRAFT & FAN
Laurie & Lamb, Montreal, Que.
Julian D'Este Company, Boston, Mass.

REGULATORS, FEED WATER
Northern Equipment Co., Erie, Pa.

REGULATORS, TEMPERATURE
Sarco Co., Inc., New York.
The Bristol Co., Waterbury, Conn.
Julian D'Este Company, Boston, Mass.
The Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

REGULATORS, PRESSURE
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, AIR
Can. Sirocco Co., Ltd., Windsor, Ont.

SEPARATORS, AMMONIA
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.

SEPARATORS, OIL
Anderson Co., V. D., Cleveland, Ohio.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, STEAM
Anderson Co., V. D., Cleveland, Ohio.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SOOT BLOWERS
Pilley Packing & Flue Brush Co., St. Louis, Mo.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SPRAY NOZZLES
Can. Sirocco Co., Ltd., Windsor, Ont.

STACKS, METAL
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STACKS, RADIAL BRICK
Combustion Engineering Corp., Ltd., Toronto, Ont.

STEEL PLATE WORK
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STOKERS, CHAIN & TRAVELING GRATE
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que. Que.

STOKERS, OVERFEED
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.
Detroit Stoker Co., Detroit, Michigan.

STOKERS, UNDERFEED
Detroit Stoker Co., Detroit, Mich.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.

STOKERS, HAND OPERATED
Combustion Engineering Corp., Toronto, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

STRAINERS, WATER
Sarco Co., Inc., New York.

SUPERHEATERS
Babcock & Wilcox Ltd., Montreal, Que.
Goldie & McCulloch Co., Ltd., Galt, Ont.

TACHOMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Laurie & Lamb, Montreal, Que.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TANKS
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

THERMOMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

THERMOMETERS, FLUE GAS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

THERMOMETERS, RECORDING
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.

TRANSFORMERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

TRAPS, NON-RETURN
Anderson Co., Inc., V. D., Cleveland, Ohio.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Sarco Co., Inc., New York.

TRAPS, RADIATOR
Sarco Co., Inc., New York.

TRAPS, STEAM
Can. Sirocco Co., Ltd., Windsor, Ont.
Laurie & Lamb, Montreal, Que.
Sarco Co., Inc., New York.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TRAPS, VACUUM
Anderson Co., Inc., V. D., Cleveland, Ohio.

TUBE CLEANERS, BOILER
Pilley Packing & Flue Brush Co., St. Louis, Mo.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal, Que.

TURBINE BLADING
De Laval Steam Turbine Co., Trenton, New Jersey.

TURBINES, STEAM
Laurie & Lamb Co., Montreal, Que.
E. Laurie & Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

TURBINES, WATER
De Laval Steam Turbine Co., Trenton, New Jersey.

UNIONS & UNION FITTINGS
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVE DISK
Kerr Engine Co., Ltd., Walkerville, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, AIR
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BACK PRESSURE
The Fisher Governor Co., Inc., Marsballtown, Iowa.
Jenkins Bros. Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BALANCED
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto.

VALVES, BLOW-OFF
Babcock & Wilcox, Ltd., Montreal, Que.
Jenkins Bros., Ltd., Montreal, Que.
The Jas. Morrison Brasa Mfg. Co., Ltd., Toronto, Ont.

VALVES, BRASS & IRON BODY
Reading Steel Casting Co., Bridgeport, Conn.
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BYPASS
Kerr Engine Co., Ltl., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brasa Mfg. Co,. Ltd., Toronto, Ont.

VALVES, CHECK
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, EXHAUST RELIEF
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES FLOAT
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, GATE
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, GLOBE
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, HYDRAULIC
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, NON-RETURN STOP
Babcock & Wilcox, Ltd., Montreal, Que.

VALVES, SAFETY POP
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

Safety Plastic

METALLIC PACKING

Self-Lubricating
Practically Frictionless

In Cotton Tubes

Made of an alloy of the finest anti-friction metals, and the best lubricating materials which always remain in the packing; we have records to show that it has been in constant use in many engines, pumps, compressors, expansion joints, valves, etc., for over 12 years, giving consistent satisfaction.

Packing in bulk.

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL.

Let us send you further interesting details also about our "Safety" Superheat Sheet Packing.

Steel Mill Packing Co.
Windsor Ontario

Established 1899 *Agents Wanted*

Building a one-piece furnace lining without special forms.

BETSON'S
TRADE MARK
PLASTIC FIRE BRICK

Makes practicable, solid, one-piece furnace linings, including front and back arches, side walls and baffles. It costs but little to install in any make or type of boiler. It saves fuel, annoying shut-downs, costly repairs, and increases the amount of power from the fuel used.

Complete details of the many uses, methods of installing, how to order, measurement blanks, etc., are contained in a booklet of information which we will gladly send you. Tell us the individual to whom it should be addressed.

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6, Rome, N.Y.
Canadian Distributors
INTERNATIONAL CHEMICAL CO.
26-28 Adelaide St., Toronto, Ontario, Canada.

AIR For Every Industrial Purpose

Highly developed equipment and complete Engineering Service covering the following lines:

- Mechanical Draft
- Heating and Ventilating
- Generator Cooling
- Air Washing
- Fans and Blowers
- Steam Engines

Write for bulletins on any air-handling problem that concerns you. We put at your disposal the knowledge acquired through forty successful years.

CANADIAN SIROCCO CO., LTD., WINDSOR, ONT
BRANCH OFFICES IN ALL PRINCIPAL CITIES 332

"Sirocco" Products
TRADE MARK
BLOWERS EXHAUSTERS VENTILATING FANS AIR WASHERS ENGINES
FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

DRY STEAM

Under All Operating Conditions With the

ANDERSON STEAM SEPARATOR

The Anderson Steam Separator is a positive protection against engine break-downs because it delivers dry steam under all operating conditions. The moisture is completely separated by the combined action of centrifugal force and the sudden reversal of high velocity steam current—the moisture cannot be picked up again.

Anderson Equipment for Safety and Efficiency!

THE V. D. ANDERSON CO.
West 96th St., Cleveland, Ohio

TAKE YOUR TRADE PAPER INTO PARTNERSHIP

BY R. LEE SHARPE

(In Inland Printer)

By jimminy, I get peeved the way some business men treat their trade journals. They render an invaluable service in their special fields. They promote efficiency and economy. They offer information which can not be secured elsewhere. They work in season and out of season for the special field to which they are devoted. *They usually reflect the very best of the industry they serve.*—Evan Johnson, Editor "Office Appliances," Chicago.

"WHEN I took my trade paper into partnership, prosperity seemed to come my way," said a successful business man recently. Let him tell the story: "When I first began business I treated my trade paper with that indifference usually accorded a stepchild — until one day I suddenly 'woke up.' It was near the close of a warm July afternoon, and in my haste to get rid of details to leave for home, I tossed the current issue of my trade journal at the waste basket. It missed its mark and fell open on the floor. In stooping to place it in that ever yawning receptacle my eyes caught the heading 'Why Business Men Fail.'

"I became interested in the article, and read it before moving from my chair. That night, in the quiet of my home, around the evening lamp, I took a delightful trip through the whole magazine. To my surprise I found much that I could use in my business — and I learned 'why some business men fail.' Now I make it my steady job to go through each issue thoroughly to get the ideas and plans which I can use in my business. And I honestly believe the reason prosperity came my way was because I took my trade paper into partnership, for I strike pay dirt frequently in its columns."

* * *

We know many successful business men who are eager and impatient for the day when the postman puts their favorite journal on their desks. You don't find these men consigning their trade journals to the waste basket—as leaders and executives in their special lines they always have time to learn something new about their business and its problems.

The growth of the trade paper in the past few years has been marvelous. It is coming more and more to be the successful business man's partner and associate. It supplies him with ideas and plans he needs and must have in these days of modern business — it keeps him posted in things he must know to be progressive.

E. C. Simmons, the St. Louis "Hardware Prince" who made "Keen Kutter" famous around the world, once said: "I spend an hour each day in quiet study of the day's problems, and my trade papers give me the angles on how the other man solved these problems, and I have found this hour the most valuable time of my business life."

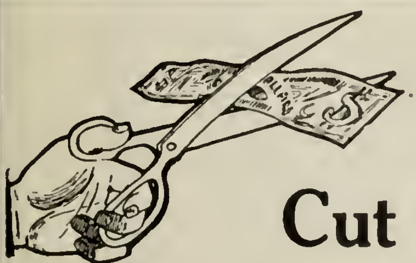
Prosperity usually goes hand in hand with the man who has the ability to avail himself of the things which the other man has learned — who takes his trade paper into partnership.

HEPBURN CRANES

These easily manipulated, well-built cranes will prove a decided saving in the Power House. Hand cranes can be supplied for a moderate outlay. And while you are at it—What about pumps?
We make all kinds — Centrifugal — Steam Simplex and Duplex, and Power Pumps.

Electric Hoist or Chain Block

JOHN T. HEPBURN, LIMITED
Engineers and Iron Founders
18-60 VAN HORNE STREET - TORONTO, CANADA



Cut Your Replacement Costs

Replacements of furnace linings, boiler settings, etc., is a costly operation nowadays. Why not avoid this trouble and expense by welding your Fire Brick into a solid one-piece structure with

STERNSON No. 30

the only Canadian Made High Temperature Cement that will give your furnace protection where it needs it most—at the joints. Sets harder than the bricks, withstands up to 3,000 deg. F. Try it out on a repair job.

"Let a Technical Firm do a Technical Job"

G. F. STERNE & SONS LIMITED
Chemical Manufacturers, Consulting Chemical Engineers
BRANTFORD - - CANADA

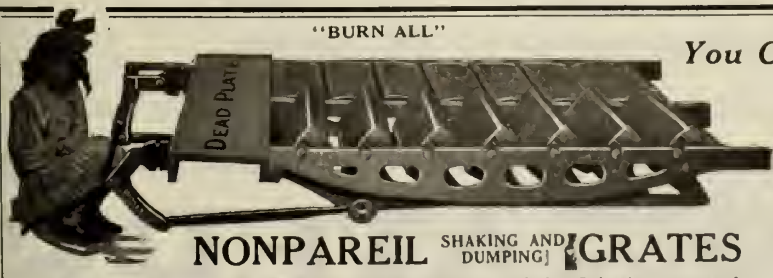
Power House
Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

$2.00 PER YEAR — **Every Power Plant employee should read Power House**



A Child Can Operate It.

NONPAREIL SHAKING AND DUMPING **GRATES**

Under perfect working conditions, their 65% air space and 95% underdraft is cutting fuel bills by 10%. SEXTON has installed them in a number of leading Canadian plants. Get a line on them today and be convinced.

You Can See
SEXTON'S FIREBRICK WORK

In many of the largest plants in Canada. Using only the best High Tension Fire Cement, he handles the work RIGHT — and without waste of time. That's why it lasts longer and gives 100% satisfaction.

Whether it's building-in boilers, general repair work (renewals and repairs for all kinds of shaking and dumping grates)—see SEXTON first.

THE W. R. SEXTON BOILER SETTING CO.
Established 1900 114 Grenadier Road, Toronto *Phone: Junc. 2765W*

Established 1907 **POWER HOUSE** Member A.B.C.

B. G. NEWTON, Manager
CANADA—**Toronto** (head office): 153 University Ave., Tel. Ad. 5740. **Montreal:** A. E. Guidal, 128 Bleury St., Tel. Plateau 946. **Winnipeg:** 810 Confederation Life Bldg., Tel. Main 3449.

S. S. MOORE, Advertising Manager
UNITED STATES—**New York:** J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. **Chicago:** A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. **Boston:** C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—**London:** The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada $2.00; United States $2.50; Great Britain, Australia and other colonies, 8s. 6d. per year. Other countries $3.00.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

Anderson Co., V. D. 53
Armstrong Cork and Insulation Co., Ltd. 15
Audel Co., Theo............... 45
American Steam Pump Co...... 6
American Schaeffer & Budenburg Corp. 15

Babcock & Wilcox............. 41
Betson Plastic Fire Brick Co... 53
Bristol Co., The 47
Buyers' Directory 50, 52, 54
Bird-Archer Co., The 8
Beveridge Supply Co. 47
Burnett, J. A. 45
Bell Fire Brick Co. 49

Can. Fairbanks-Morse Co. 4
Can. Ingersoll-Rand Co......... 17
Celite Products ....Front Cover
Classified Adv. Section......... 45
Conveyors Corp. of America.... 49
Cunerty, T. J. 48
Can. Sirocco Co. 53
Carhartt Co., Hamilton........ 48
Crane, Ltd. ....Inside Back Cover
Crane Packing Co. 12
Coates, Wm. 51

DeLaval Steam Turbine Co..... 8
DeLaval Co., Ltd., The......... 47
Dart Union Co., Ltd., The...... 56
D'Este Co., Julian 51
Diamond Specialty, Ltd......... 11
Durabla Mfg. Co. 4

Elk Fire Brick Co. 16
Engineering & Machine Works of Canada 9
Edward Valve Mfg. Co. 49

Foxboro Co. 7
Flexible Metallic Packing Co... 12
Frick Company 18

Garlock Packing Co. 5
Garth Co., The 48
Goldie & McCulloch Co........ 20
Greene, Tweed & Co. ....Inside Front Cover
Gutta Percha & Rubber, Ltd... 2
Green & Sons, Ltd., E......... 6
Gates Engineering Co. 43

Hints to Buyers 48
Hepburn, John T., Co. 55
Hays Co., Jas. W. 49

Imperial Oil Co. 46

Jardine, A. B. 49
Jenkins Bros. 13
Jointless Firebrick Co. 51

Kerr Engine Co., ... 16

Laurie Engine Co 49
Laurie & Lamb................ 12
Linde Can. Refrigeration Co., Limited 14
Leitch Co., Ltd., A. S.......... 43
Link-Belt, Limited 10

McLaren, D. K., Co. 19
Magnolia Metal Co. 51

Moncrieff Ltd., John 49
Morrison Brass Mfg. Co., Jas. Outside Back Cover

Northern Crane Works 49

Pilley Packing & Flue Brush Mfg. 48
Pratt & Cady Co. 43

Reading Steel Casting Co....... 43
Refrigeration Dept. 14
Refinite Co. of Canada......... 48
Refrigerating Engineers 16
Rule, A. E. 49

Smooth-On Mfg. Co 12
Superheater Co. 56
Sturtevant & Co., Ltd., B. F... 45
Shell Bar Boico Co............. 49
Sterne & Sons, G. F........... 55
Stephen Chemical Co. 49
Sexton Boiler Setting Co., W. R. 55
Steel Mill Packing Co. 53

Taylor Instrument Co. 16

Underfeed Stoker Co. of Canada, The 3

Vilter Mfg. Co. 14

Wall, W. J. 49
Waterous Engine Works Co..... 1
Watson, M. Barry 45
Watson & McDaniel Co........ 48
Wilson & Sons, J. L........... 16

Yarnall-Waring Co. 11
York Mfg. Co 18

Bronze to Bronze **DART** **At the Joints**

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

SUPERHEATERS
ELESCO

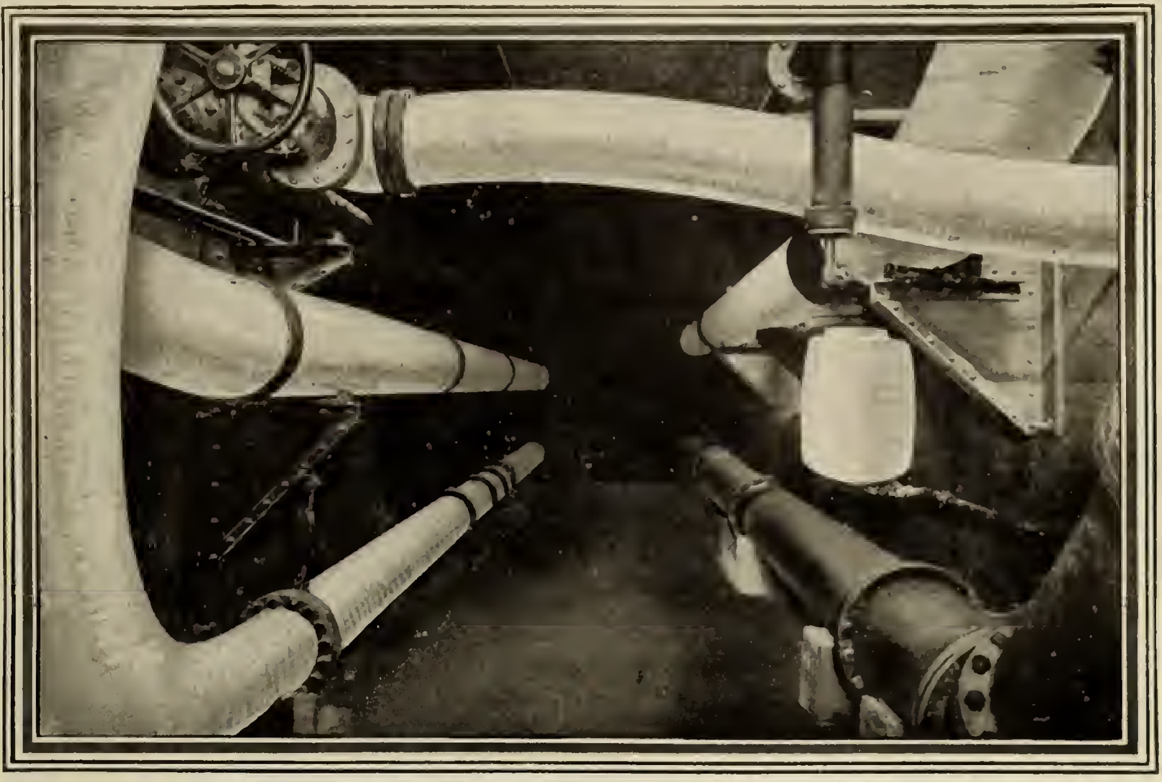
DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.



CRANE EQUIPMENT GIVES THE ASSURANCE OF UNFAILING SERVICE FROM THESE PIPE-LINES OF A LARGE FURNACE PLANT

WHEN DEPENDABLE STEAM PIPING COUNTS

Steam pipe-lines located in tunnels or basements or buried in the ground must give dependable service at all times. Crane valves, fittings and pipe bends for such installations are designed and produced to stand up under the most extreme conditions. Only selected materials are used in the manufacture of Crane equipment. Production operations are checked by rigid inspections, and searching factory tests guard uniform quality in the finished units. This careful factory practice gives exceptional endurance to Crane piping equipment.

CRANE

CRANE LIMITED, GENERAL OFFICES: 386 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., HEAD OFFICE: 45-51 LEMAN STREET, LONDON, ENG.
Branches and Sales Offices in 21 Cities in Canada and British Isles
Works: Montreal, Canada, and Ipswich, England

Efficiency Wash Sink with Pedal Valve

MORRISON

Steam Specialties

As the twig was bent
so the tree has grown

The pace set by Morrison Steam Specialties fifty years ago is fully upheld by the Morrison Specialties of to-day.

"Every installation is a demonstration of merit"

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide Street W., Toronto

Annual Reference Number — With Japanese Foreword

POWER HOUSE

Fostering Economy in Steam, Oil and Hydro-Electric Power Development

Vol. XVI—No. 20 Published Semi-Monthly by The MacLean Publishing Company, Limited, Toronto, Ont. **October 20, 1923**

A Jenkins Disc is Quickly Renewed
—without removing valve from line

A Jenkins Disc in a Jenkins Valve is the right combination—a tight-closing valve is assured. The disc has very long life, and, when necessary, it can be quickly renewed with the valve left in the line.

The compositions of the various Jenkins Discs are the result of constant study and 58 years' experience in disc manufacture. Each is exactly suited to the particular service for which it is intended.

Use the disc ONLY in the particular service for which it is recommended. If in doubt as to the kind of disc you need, let us know what work it is intended to do, and we will recommend the right one or prepare a special composition to suit your requirements.

A Jenkins Valve fitted with a Jenkins Disc—assurance of perfect valve performance.

JENKINS BROS., LIMITED
HEAD OFFICE AND WORKS: 103 St. Remi St., Montreal.
SALES OFFICES: Toronto, Vancouver.
EUROPEAN BRANCH: London, W.C. 2, Eng.
FACTORIES: Montreal, Bridgeport, Elizabeth

Always marked with the "Diamond"
Jenkins Valves
SINCE 1864

The Euclid 105th Properties Saved 118 Tons of Coal with a 30% increase in load the first month with one Detroit Single Retort Underfeed Stoker

Mr. S. Cowan of the above company is authority for the following statement:

"We sell steam heat, hot water, electricity, and refrigeration, in the east end territory of Cleveland. We had been operating for 15 years with 3 . . . . . . Stokers and had been making approximately 96,000 units per month, until one Detroit Underfeed Stoker was installed in our plant as a test and we found that by the operation of this Detroit Underfeed Stoker that we saved one hundred eighteen tons of coal during our first month of operation. We produced 127,000 units of electricity during that period, an increase of 31,000 units over and above any previous month.

"We were so pleased with this showing that we contracted for the immediate installation of two additional Detroit Underfeed Stokers which are now in and giving entire satisfaction. We have no hesitancy in recommending the Detroit Stoker. We have tested and tried same in every manner possible and we find it absolutely satisfactory."

Experiences such as the above have caused concerns like the following to place repeat orders for Detroit Underfeeds:

Fifth Avenue Building, New York
J. K. Mosser Co., North Bend, and Newberry, Pa.
American Cotton Oil, St. Louis and Cincinnati
Harvey Hubbell, Bridgeport, Connecticut
National Home, D. V. S., Johnson City, Tenn.
Durant Motors, Flint, Michigan
God's Bible School, Cincinnati
Burroughs Adding Machine Co., Detroit, Mich.
Krippendorf-Dittmann Co., Cincinnati

If you want to effect *real* savings in your plant install a REAL Underfeed Stoker—the Detroit.

Ask for Bulletin 238

DETROIT STOKER COMPANY
Underfeed Forced Draft and Overfeed Natural Draft Stokers
238 GENERAL MOTORS BUILDING DETROIT, MICH.

DETROIT UNDERFEED TYPE U SINGLE RETORT **STOKERS**
ASSURE CHEAPER STEAM PRODUCTION

CANADIAN ALLIS-CHALMERS

— Steam Fire Pumps —

THE specifications under which our pumps are made have been adopted by the following associations:

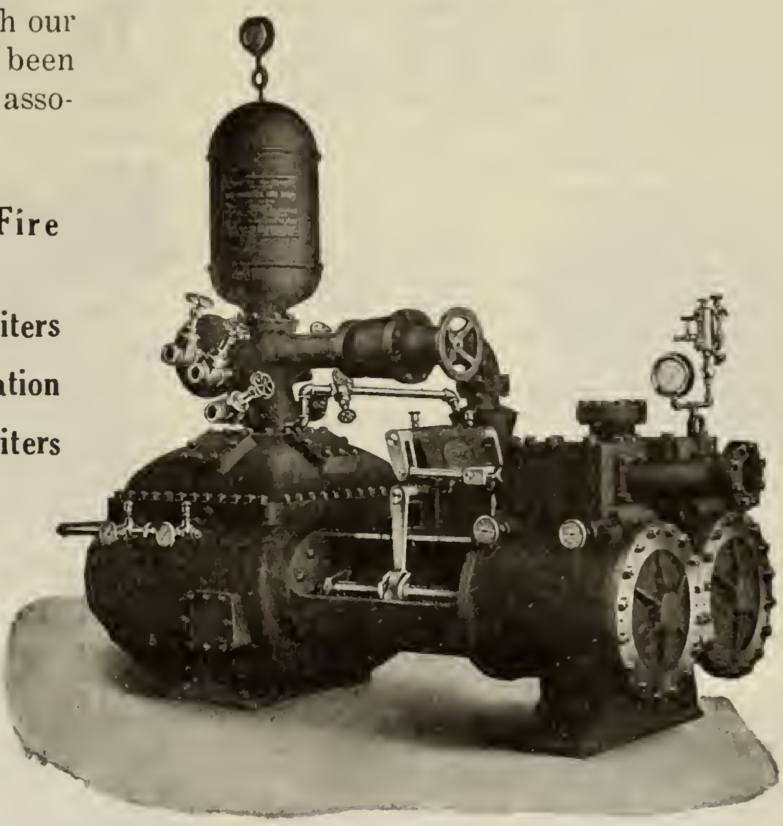
Associated Factory Mutual Fire Insurance Companies

National Board of Fire Underwriters

National Fire Protection Association

Canadian Board of Fire Underwriters

The Underwriter Fire Pump is a duplex steam pump, built in strict accordance with the specifications of the Associated Factory Mutual Insurance Companies, with the object of securing a fire pump superior in design, construction, and general detail to the ordinary trade pump.



"The National Standard"

1500-Gallon Underwriter Steam Pump

The Underwriter Steam Pumps Are Built In The Following Sizes:-

500—750—1000—1500 U.S.G.P.M.

AT A PRESSURE OF 100 POUNDS PER SQUARE INCH AT PUMP.

We Carry a Number of These Sizes in Stock and Can Make Prompt Shipment.

The Canadian Allis-Chalmers, Limited, were the first to develop this type of pump in Canada, and consequently having followed closely the various amendments to the specifications made by the Underwriters during the past twenty years, have a wider experience of the requirements than any other Canadian maker. In addition, we have designed special shop equipment and tools for the economical production of these pumps, ensuring absolute accuracy, interchangeability and the very highest efficiency in operation.

CANADIAN ALLIS-CHALMERS PRODUCTS

- Hydraulic Turbines
- Centrifugal and Steam Pumps
- Steam Power Plant Equipment
- Mining Machinery
- Crushing and Cement Machinery
- Flour and Saw Mill Machinery

CANADIAN ALLIS-CHALMERS LIMITED

Head Office—KING AND SIMCOE STREETS, TORONTO

BRANCH OFFICES: HALIFAX, SYDNEY, ST. JOHN, MONTREAL
QUEBEC, OTTAWA, HAMILTON, LONDON, WINDSOR, COBALT, SOUTH PORCUPINE
WINNIPEG, CALGARY, EDMONTON, VANCOUVER, NELSON AND VICTORIA

To Canadian Engineers—

The following letter from the Ingersoll Packing Company, of Ingersoll, Ont., is, we believe, the kind of advertising that appeals most strongly to intelligent, practical men.

> The Fisher Governor Co.,
> Marshalltown, Iowa.
>
> Gentlemen;
>
> We wish you would send us a new governor for our pickle pump to take the place of governor 8997 that we purchased from you 19 years ago.
>
> This governor has given us splendid satisfaction and we hope the new one will do the same.
>
> The size of the steam pipe connection is ½" and we use 50lbs. of air pressure on the diaphragm.
>
> Kindly send this to us as soon as possible.
>
> Yours truly,
> THE INGERSOLL PACKING COMPANY, Limited
> (signed) W. J. Peters
> Chief Engineer

The governor referred to is our Type 5 Diaphragm Governor. While the Ingersoll Packing Company used it to control a pickle pump, it is also in wide use on low pressure pumps where the controlling or discharge pressure is oil or other liquid, air or gas.

The construction of this governor is such that it is suitable for a number of other liquids.

The operation is very sensitive and positive and, as evidenced by this letter and hundreds of others in our files, the name "Fisher" means, long, satisfactory service.

The Fisher Governor Company

950 Fisher Avenue
Marshalltown, Iowa

Has No Weights or Levers To Tamper With

There is no danger of the Sarco Temperature Regulator being thrown out of calibration, for it has no weights, levers, or other parts to meddle with. Its calibration can be changed only by means of a key, which is removable and can be kept by the proper authority.

A special safety device prevents over-temperature from straining the instrument.

Only enough steam is supplied for the job, by its gentle throttling action—instead of supplying a large quantity and then shutting it off entirely. No other self-contained instrument has such a fine control as the

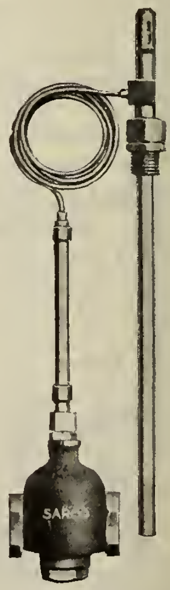
SARCO
Temperature Regulator

Its powerful hydraulic pressure enables the Sarco to cut through any scale that may get into it, thus preventing the valve from becoming stopped up.

The Sarco will operate in locations where a regulator of the volatile liquid type would not operate; due to the temperature of the room being almost as high as the temperature it is desired to control.

Other equally important advantages of the Sarco are explained in our interesting Booklet J-78. Write for a copy and information about our free trial offer.

SARCO COMPANY, Inc.
239 Broadway, New York, N. Y.
PEACOCK BROS., LIMITED, MONTREAL.



De Laval Steam Turbine Co.

TURBINE EQUIPMENT CO., LTD.
73 King St., West, Toronto

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

Products

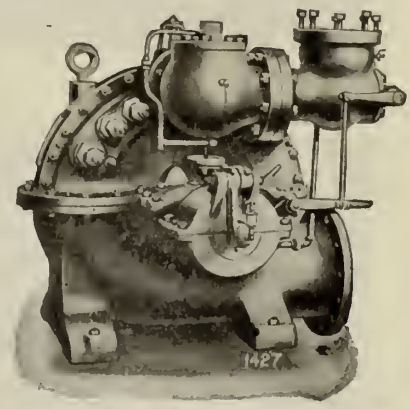
STEAM TURBINES; CENTRIFUGAL PUMPS; BLOWERS and COMPRESSORS; SPEED-REDUCING GEARS.

Also manufacturers of Special Centrifugal Machinery.

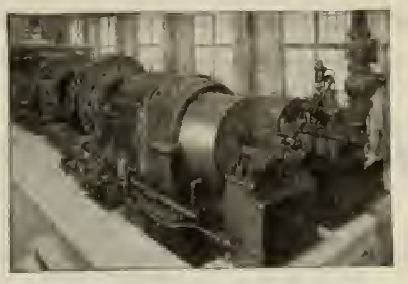
Steam Turbines

In the production of steam turbines, we offer the combined advantages of standardized design and quantity production, combined with a sufficient selection of types to suit each user's requirements.

De Laval turbines are built for all steam conditions, such as high pressure, condensing and non-condensing, back pressure, bleeder and mixed flow service. They are also adapted to driving machines at all speeds, either directly connected or through the De Laval double helical speed-reducing gear.



De Laval Velocity Stage Turbine
Throttle valve controlled by speed governor and shut-off valve by emergency trip.

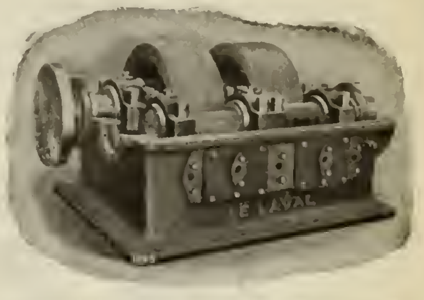


De Laval Geared Turbine Driving Direct Current Generator, 3750 Kw.

The De Laval velocity stage turbine has been designed to operate on high pressure, high temperature steam. The steam chest and governor valve, which are the only parts with which the steam comes in contact, are made of steel and so located that heat is not readily conducted to the bearings. De Laval velocity stage turbines are made in all sizes up to 1,200 h.p. The hand controlled valves for cutting out nozzles permit of high efficiency under varying loads and steam conditions.

Centrifugal Pumps

De Laval centrifugal pumps are characterized by conservative speeds, high class materials, construction on a limit-gage interchangeable basis, guaranteed efficiency and capacity, and a comprehensive system of testing by which the fulfillment of these guarantees is demonstrated. The casing is split horizontally, the suction and discharge connections and the bearing supports being included in the lower part. The De Laval labyrinth wearing ring assists materially in maintaining the original efficiency, as it does not require small clearance in order to prevent excessive leakage. Finished repair parts are supplied, made to accurate dimensions so that they can be put in a pump without requiring to be fitted.



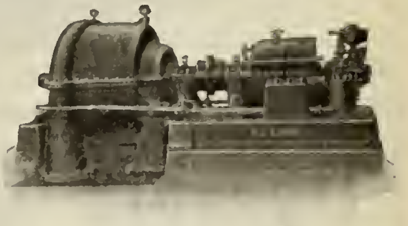
De Laval Double Helical Speed-reducing Gear.

Speed-reducing Gears

De Laval speed-reducing gears are of the double helical type and the result of over 25 years' experience in building reduction gears for steam turbine service. The cutting methods employed are such that the correct pitch, angle and tooth contour are produced, and quiet running and long life are secured.

Centrifugal Blowers and Compressors

De Laval centrifugal blowers and compressors are built for all pressures up to 120 lb. per sq. in. With electric motor driven compressors for high pressures, efficiency and economy are improved by the use of speed increasing gears.

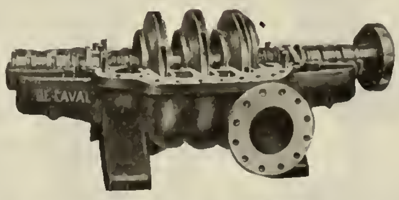


De Laval Turbine Driven Multi-stage Compressor.
16,000 cu. ft. of air against 8½-lb. gage pressure.

De Laval Construction

All De Laval apparatus is built on a limit gage, interchangeable basis. The performance of every machine is guaranteed, both as to capacity and efficiency, and a complete test is carried out before shipment. Engineering suggestions and special publications will be sent on receipt of letter describing the conditions.

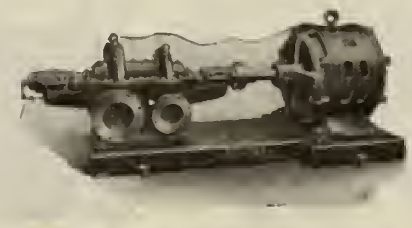
De Laval pressure stage turbines, built in capacities up to 15,000 h.p., give the highest obtainable efficiencies. Turbines of this type connected to De Laval double helical gears and driving standard direct current generators, excel in economy large turbo alternators when transformer and converter losses are included. Large geared turbine driven centrifugal pumps rival triple expansion pumping engines in duty.



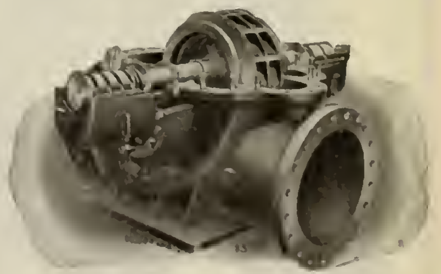
Multistage Pump with Casing Cover Removed.

One of Three De Laval Geared Turbine Driven Centrifugal Pumps for the City of Chicago.
60,000,000 gal. per day each against 150-ft. head.

De Laval Velocity Stage Turbine Driving Centrifugal Pump.



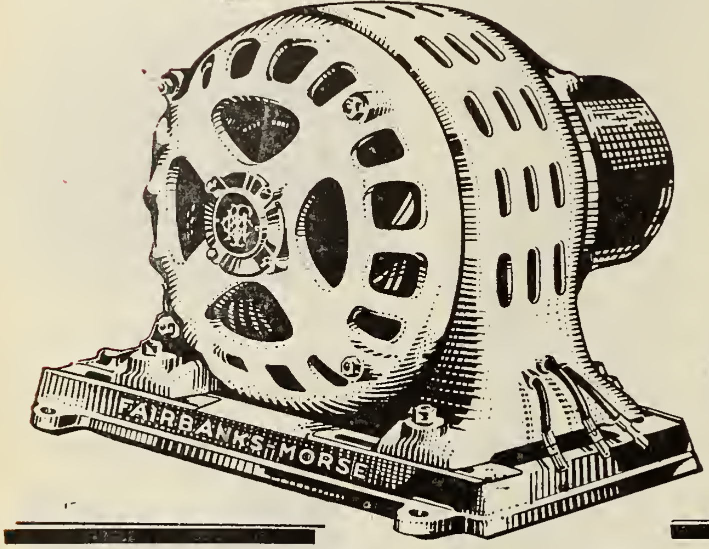
Two Stage Series Pump, Motor Driven.



Single Stage Pump with Casing Cover Removed.

Why

Fairbanks Morse
Ball Bearing
MOTORS



1. They reduce friction—therefore save current.
2. They require lubrication but once a year—therefore save lubricant and maintenance charges.
3. The one-piece rotor winding means no loose joints, flashing or sparking.
4. They outlast any sleeve-type bearing motor.

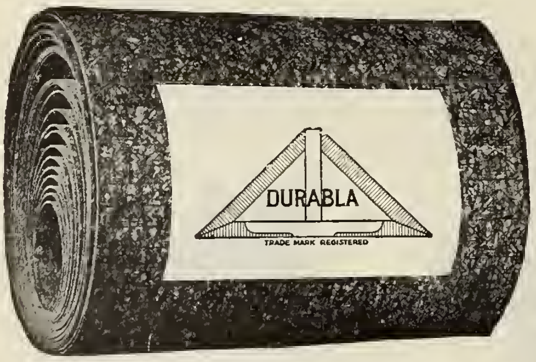
A full explanation of these and other points of superiority is contained in our booklets. Prudent executives will ask our nearest branch for them.

The Canadian
Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver, Victoria.

100

Durabla Gaskets Make Tight Joints



Withstanding all Temperatures and Pressures

Wherever a permanent Gasket is required, use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids.

Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla Trade Mark which guarantees strength and quality.

Made in Canada in Stock Sizes 36" wide x 150" long, in thicknesses of 1/64, 1/32, 1/16, 1/8".

Let us send you a trial shipment

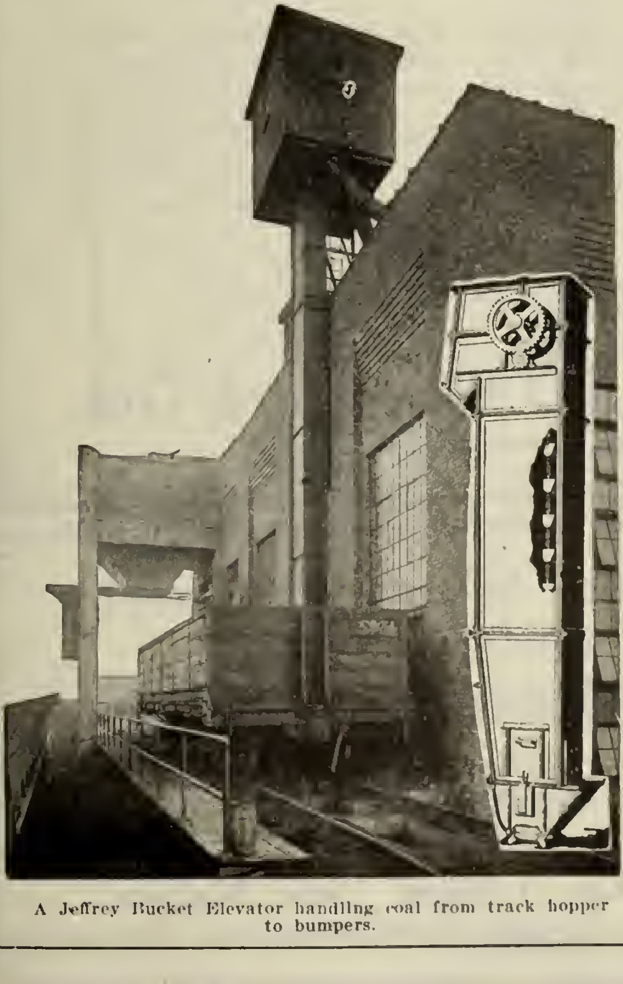
CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

Jeffrey Pivoted Bucket Carrier for handling coal and ashes in large size plants. *Catalog No. 210—fully illustrates and describes it.*

V-Bucket Elevator-Conveyer. May be used either as a rectangular or run-a-round conveyer or as a combined elevator and conveyer.



A Jeffrey Bucket Elevator handling coal from track hopper to bumpers.

For Over Forty Years

Jeffrey Engineers have co-operated with the men responsible for results in power plants:

This has been productive of successful coal and ashes handling equipments, which have been a deciding factor in producing a constant supply of power at the lowest possible cost.

To meet the imperative demands of industry today will mean in many plants, new methods, faster and more dependable material handling equipments, Jeffrey experts are ready to help you select the right equipment to meet the emergency.

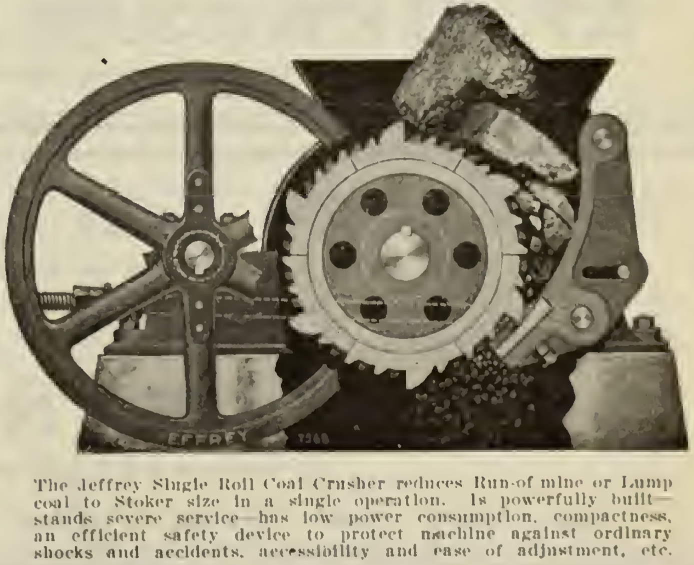
Jeffrey Coal and Ashes Handling Equipments include: Track Hoppers, Reciprocating Plate and Apron Feeders; Coal Crushers; Conveyors; Bucket Elevators; Weigh Hoppers, Skip Hoists; Portable Bucket Loaders and Belt Conveyors; Industrial Locomotives, etc.

The Jeffrey Manufacturing Company

Canadian Branch and Warerooms: Montreal

JEFFREY

MATERIAL HANDLING MACHINERY



The Jeffrey Single Roll Coal Crusher reduces Run-of mine or Lump coal to Stoker size in a single operation. Is powerfully built—stands severe service—has low power consumption, compactness, an efficient safety device to protect machine against ordinary shocks and accidents, accessibility and ease of adjustment, etc.

"BURN ALL"

A Child Can Operate It.

NONPAREIL SHAKING AND DUMPING GRATES

They save you money right from the start Under perfect working conditions their 65% air space and 95% underdraft cut fuel bills at least 10%. Get particulars today.

The W. R. SEXTON Boiler Setting Co.
Est. 1900 114 Grenadier Rd. Toronto *Junc. 2765 W.*

FIREBRICK WORK

Renewals and Repairs for All Kinds of Shaking and Dumping Grates and All Sizes of Boilers

Only the Best High Tension Fire Cement is Used

Sexton's firebrick work can be seen in some of Canada's largest plants. They will tell you that his work lasts longer and is 100 per cent. EFFICIENT and SAFE. See "Safety-First" Sexton FIRST.

THE W. R. SEXTON BOILER SETTING CO.
Est. 1900 114 Grenadier Rd., Toronto Junc. 2765-W

Reduce Your Coal Bills

Use Sternson Service

Boiler Brand—
Silicate of Soda

It is the simplest and most inexpensive and effective boiler feed-water treatment on the market. It not only removes scale, but it prevents new scale from forming. Less scale in the boiler, less fuel required!

Sternson No. 30—
High Temperature Cement

It ensures absolutely tight, enduring joints in your furnace. It makes the weak parts strong and withstands 3,000 deg. F. This fuel conserver is shipped to you ready to use.

Sternson No. 40—
Plastic Fire Brick

Monolith—a plastic ceramic mixture, which gives you a jointless, gas-tight furnace or fire-box lining—and a fuel saver which is lower in cost to apply than the old method of fire brick and mortar.

You require less fuel but get adequate heat from the moment you commence to use STERNSON SERVICE.

G. F. STERNE & SONS, LTD., Brantford, Ont.
Chemical Manufacturers, Consulting Chemical Engineers.

Why Individual Boiler Feed Water Treatment

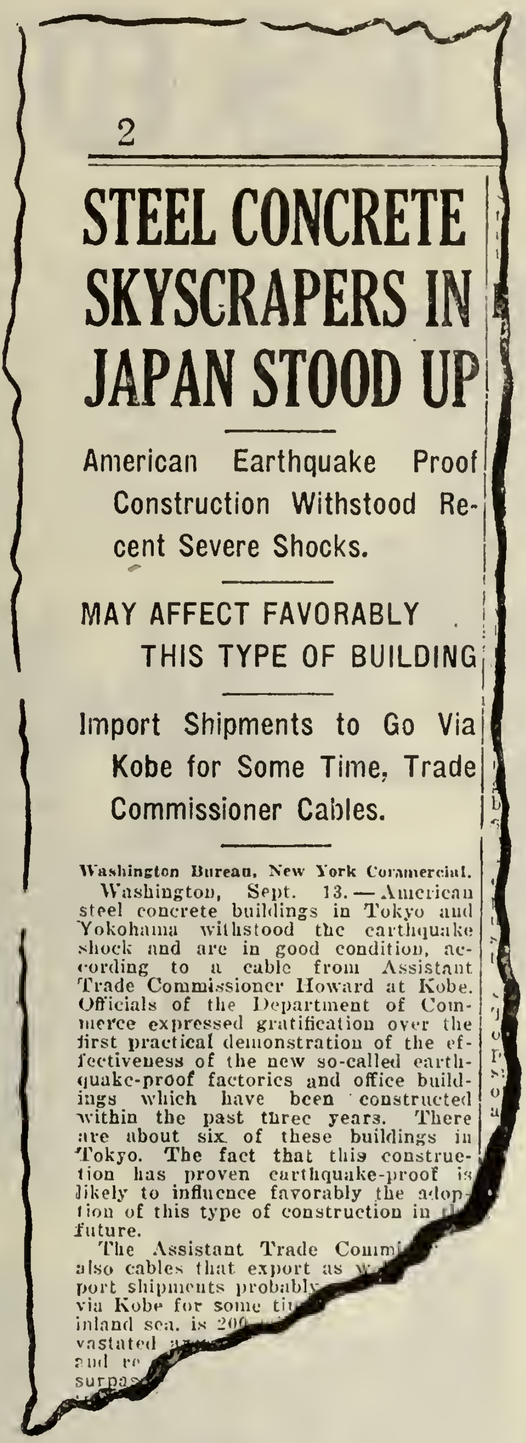
Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)
Distributors : William C. Wilson & Co., 21 Camden Street, Toronto
Phone Adel. 1054 or write for full particulars.



2

STEEL CONCRETE SKYSCRAPERS IN JAPAN STOOD UP

American Earthquake Proof Construction Withstood Recent Severe Shocks.

MAY AFFECT FAVORABLY THIS TYPE OF BUILDING

Import Shipments to Go Via Kobe for Some Time, Trade Commissioner Cables.

Washington Bureau, New York Commercial.

Washington, Sept. 13.—American steel concrete buildings in Tokyo and Yokohama withstood the earthquake shock and are in good condition, according to a cable from Assistant Trade Commissioner Howard at Kobe. Officials of the Department of Commerce expressed gratification over the first practical demonstration of the effectiveness of the new so-called earthquake-proof factories and office buildings which have been constructed within the past three years. There are about six of these buildings in Tokyo. The fact that this construction has proven earthquake-proof is likely to influence favorably the adoption of this type of construction in future.

The Assistant Trade Comm
also cables that export as
port shipments probably
via Kobe for some ti
inland sea. is 20
vastated
and re
surpas

CONCRETE
Proves its Permanence

Concrete, adopted in Japan as an earthquake-proof building material, has met and successfully weathered the severest of all possible tests — the biggest earthquake of modern times.

While buildings of less rugged construction and inferior durability crumbled under the repeated shocks or were licked up by the ensuing flames, those of steel and concrete remained unscathed. Neither quake nor fire could hurt them.

They stand to-day, in a sea of ruin, monuments to the indestructibility of Concrete construction, justifying the foresight of the men who built them.

CANADA CEMENT
CONCRETE
FOR PERMANENCE

Specify CANADA CEMENT Uniformly Reliable

We maintain a Service Department to co-operate in all lines of work for which Concrete is adapted. Our library is comprehensive and is at your disposal at all times without charge.

Canada Cement Company Limited

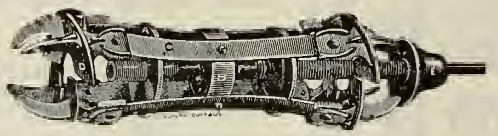
Canada Cement Company Building
Phillips Square - Montreal

Sales Offices at: Montreal Toronto Winnipeg Calgary

MORRISON

Consistently accurate and thoroughly reliable, Morrison Steam Goods represent the highest quality and the most modern designs in their line. They have earned a reputation among Canadian users that is unexcelled until, now, the name of Morrison on a steam specialty is an absolute guarantee of satisfaction.

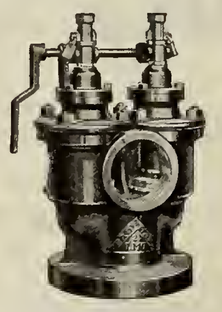
The Morrison line includes fit-

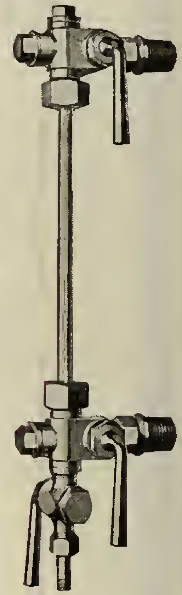

The Engineer's Favorite Tube Scraper.

J.M.T. Reducing Valve.

Beaver Valve.

Morrison Injector.


J.M.T. Twin Safety Valve.


Water Gauge

J.M.T. Globe Valve.

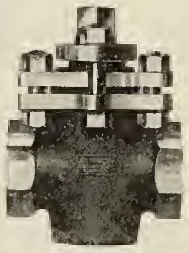
Atlas Gate Valve.

Bronze Throttle Valves.

J.M.T. Check Valve.

Model "C" Safety Valve.

Non-Return Stop and Equalizing "Y" Valve

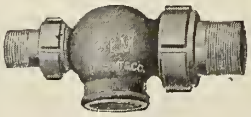

Asbestos Packed Cocks.

Steam Whistles.

Hand Cylinder Oil Pump.

Morrison Cellar Drainer.

Gauge Cock.


Gem Ejector.

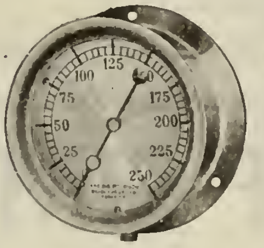
The James Morrison Brass

93-97 Adelaide Street West

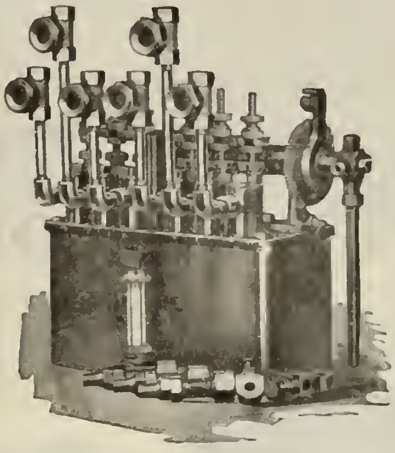
STEAM GOODS

tings for every requirement of the engine and boiler room, approved by the Provincial and Marine Inspection Departments of Canada.

The confidence and goodwill built up by the Morrison line is a natural sequence of a conscientious effort to apply the skill and knowledge secured by over sixty years' experience.



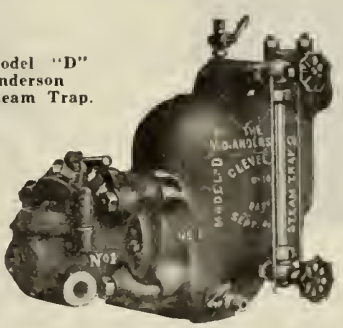
Pressure Gauge.



Force Feed Lubricator.

Recording Gauge.

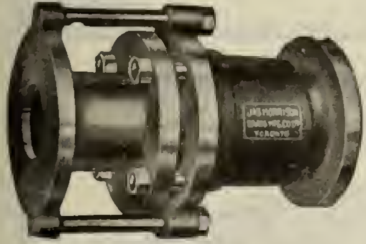
Compression Grease Cup.



Model "D" Anderson Steam Trap.

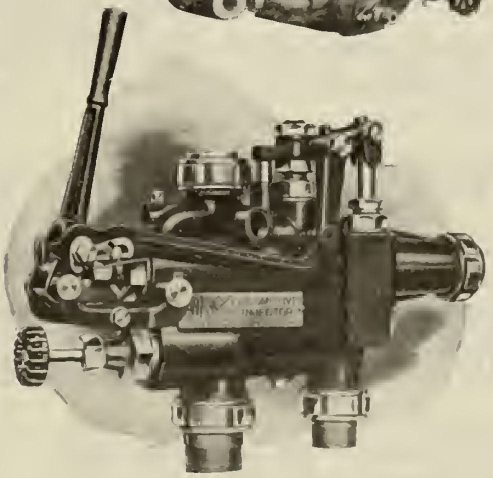
Automatic Sight Feed Cylinder Lubricator —Double Connection.

Safety Valve—Iron Body Bronze Mounted.



Expansion Joint.

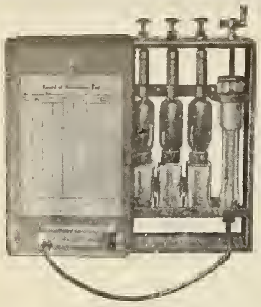
Strainer, Sectional View.



Locomotive Injector.

Manufacturing Company, Ltd.

Toronto, Ontario, Canada



Hays Improved Gas Analyzer.

Are You Wasting Fuel?

Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO_2, O_2 and CO; 1-chamber Analyzer for CO_2 only. Stocked by Canadian Agents listed below.

HAYS DRAFT GAGES, "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts and Draft Regulation."

P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
Michigan City, Indiana

General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.

A Marvel of SIMPLICITY

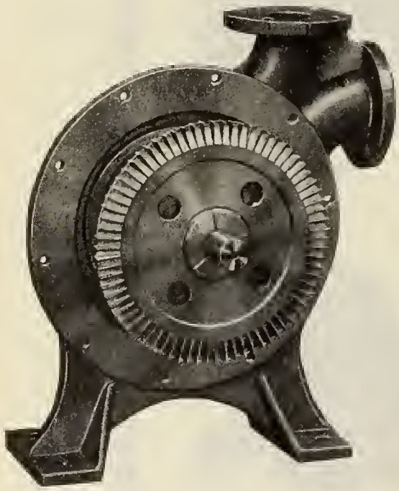
Westco Pumps

SPECIALLY ADAPTED FOR

Fire Protection, Oil Burner Installations, Boiler Feed Transfer and Booster Work

One Moving Part—SIMPLICITY

The simplicity of the Direct-Driven Valveless Westco Pump with a remarkable pressure supersedes the reciprocating pump in a large field of application. For fire protection it pumps 90 gallons a minute against 90 lbs. pressure; for driving oil burners Westco Pumps are giving satisfaction on 24 hours' continuous duty; and for boiler feed and booster work they give pressure beyond the ability of the smaller centrifugal pump with simplicity of direct motor drive.



Consult us—our staff of technical and practical experts will gladly assist in solving your pumping problems.

Westco-Chippewa Steady Stream Pump
For Deep Well Water Supply.

WESTCO MFG. CO. LTD., 220 King St. W., Toronto

Makes Short Work of Boiler Scale

In hundreds of plants BOICO has been adopted as the one sure clean-boiler insurance. The speed with which it removes the most stubborn scale formations is surprising. Hurts nothing but boiler scale. It's economical, too.

TRY IT FREE—let us send you a sample to convince you. Write us to-day—you've nothing to lose.

SHELL-BAR BOICO SUPPLY LTD.
1-15 SAUNDERS AVE. - TORONTO

SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ontario.

TURN OUT!

THE success of last year's Power Exposition showed conclusively that engineers, manufacturers and others interested in power plant equipment keenly appreciate the value of this show.

It offers an opportunity to gain a great deal of information in a short time and to establish personal contact with the various people who supply power equipment, and with engineers of national reputation.

In addition to the impressive array of primary apparatus, there will be exhibits of stokers, pulverized-fuel and coal handling equipment, firebrick, refractories and refractory cements, water purifiers, feed-water heaters, economizers, superheaters, blowers, valves, piping, pipe covering, steam separators, pumps, etc.

CONTROL APPARATUS will occupy considerable space and a special TRANSMISSION SECTION is being prepared.

The big national engineering societies will be there in full force, seeking new ideas and information. Many of the members, ready to buy power equipment, will doubtless follow precedent and avail themselves of this convenient opportunity to make their selections.

Don't Miss This Important Exposition!

Dec. 3rd - 8th, 1923

Grand Central Palace, New York

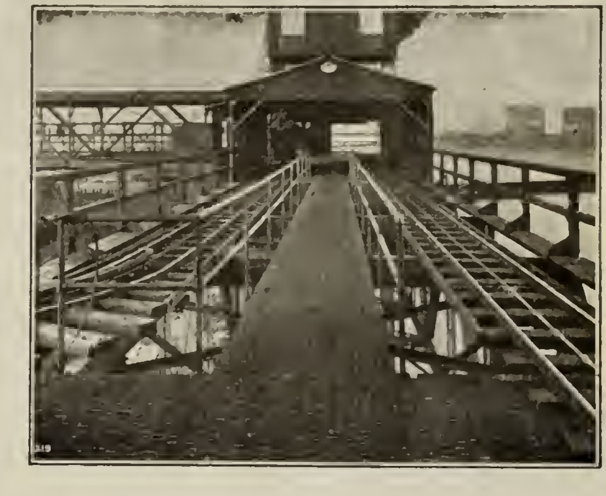
To Manufacturers!

If you have something of positive merit and capable of comparison which is used either in producing, transmitting or using power, or some mechanical equipment, or supply or materials used by the mechanical industry we welcome you as an exhibitor. Every application is subject to Exhibits Committee approval and no article can be exhibited unless it possess real merit.

For further information, address

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING
Grand Central Palace New York

IRVING SUBWAY TRADE MARK PATENTED
THE FIREPROOF VENTILATING FLOORING



IRVING SUBWAY
TRADE MARK (PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

Here is a time-proof, accident-proof floor that pays good dividends long after its first cost—which is its only cost—has been forgotten. Hundreds of acres of Irving Subway, in daily use for years under hardest service, show no appreciable wear. The non-slipping, foot-gripping surface is as effective against accidents as the day it was laid. And pressures, blows and traffic that would long since have destroyed any other grating or even a solid plate floor, have had no effect on Irving Subway. Ask for Catalog 4A50.

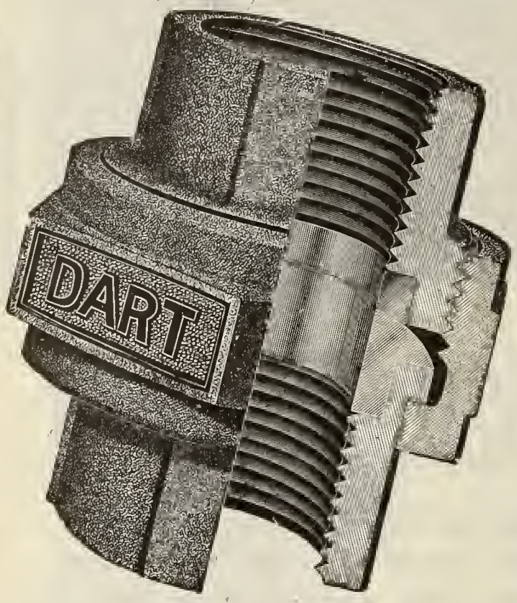
IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Canadian Agents:
Montreal, P.Q., 304 Coristine Bldg. Winnipeg, Man., 141 Bannatyne Ave. Welland, Ont., Standard Steel Cons. Co.

Manufacturers of

IRVING SAFSTEP
TRADE MARK (PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS

DART UNIONS



Stay Tight Permanently

No Upkeep Cost
No Replacement Cost
No Loss from Leaks

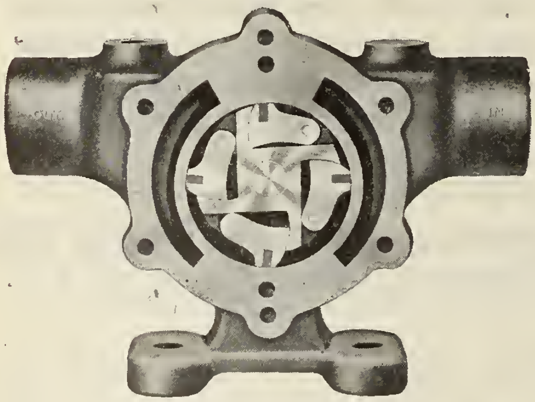
Because—THEY ARE BRONZE TO BRONZE AT THE JOINT

Your Jobber Sells Them

Manufactured by
DART UNION CO., LIMITED, TORONTO, ONT.

ROTO ROTARY PUMPS

designed for handling various liquids such as alcohol, brine, cutting compound, gasoline, syrup, varnish, vinegar, water, etc.



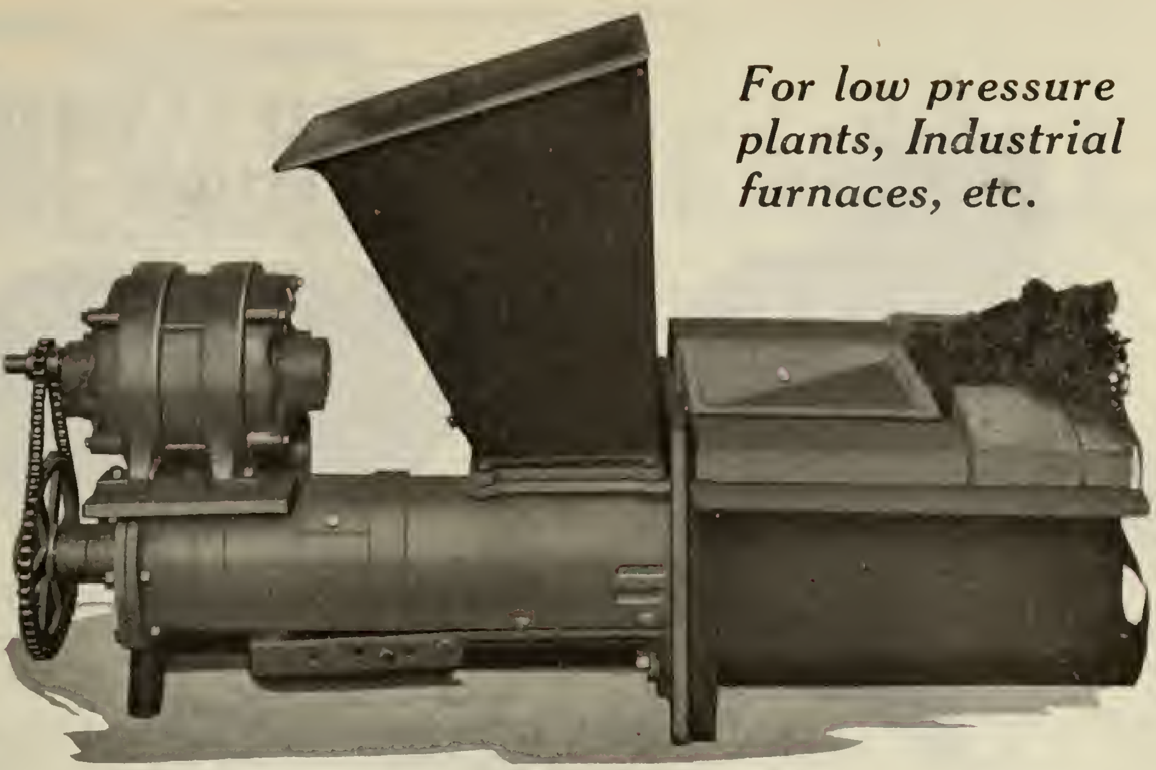
Interior view of Roto Rotary Pump, showing suction and discharge chambers, also rotor and vanes —note anti-friction facings on vanes.

Supplied for belt drive or for direct connection to motor without gear reduction. Double suction feature prevents side thrust and eliminates ports from the cylinder wall. Made of iron or bronze as required. Give us your requirements and let us quote you on pump best suited for your conditions.

YOUNG PUMP COMPANY OF CANADA

96 Mary St. - Hamilton, Ont.

Manufacturers of the Young Centrifugal Vacuum and Boiler Feed Outfit



For low pressure plants, Industrial furnaces, etc.

A Perfect Electric Drive for Jones Stokers

THIS simple and effective electric drive greatly broadens the range of application of the Jones Stoker. It solves the drive problem for low pressure heating plants or industrial furnace installations where steam for driving the stoker is not available.

The illustration shows the simplicity of the equipment—simplicity in keeping with the unapproached simplicity of the Jones Stoker. A small motor drives a large screw-threaded shaft, causing a nut to move as the shaft is rotated. The coal ram is secured to this nut and is moved inward or outward depending on the direction of rotation of the motor.

An automatic contactor, usually driven from the fan shaft, causes the motor to run in one direction until the charge of coal is fed and then the contactor reverses the motor and the ram is withdrawn.

The timing of the ram, and therefore the rate of firing, is automatically regulated, but provision is also made for hand regulation.

The device uses less than 1/3 H.P. per hour, making the power cost practically negligible. Ask for complete details of this and other improvements in Jones, Murphy and Riley Stokers—a make and type for every service.

Above: Jones "Standard" Stoker with new electric drive, omitting housing for motor and drive. Below: Automatic Contactor with provision for manual and automatic regulation.

The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.
RILEY JONES MURPHY

The Under-Feed Stoker Co., of Canada, Ltd.
146 King Street, Toronto

Sales Agency for: Jones Stokers, Riley Stokers, and Murphy Automatic Furnaces

Alta. & West. Sask.:	Man. and East. Sask.:	British Columbia
Mr. J. Twomey,	W. W. Hicks & Co.,	E. A. Earle, Limited,
Camrose, Alta.	Winnipeg.	Vancouver, B.C.

THE SATISFACTORY AIR COMPRESSOR.
Gives good, steady pressure under all conditions.
Keeps cool under heavy load.
A sturdy, substantial machine, occupying small space.
It is the compressor for the exacting engineer.

Built to Serve---

This Smart-Turner Compressor is specially adapted to the many uses to which a compressor is put in the various industries. Self-contained and water cooled it will produce up to 48 cu-ft. per minute for double and 24 cu-ft. per minute single cylinder.

Smart-Turner Machine Co., Ltd.

Hamilton - Ontario

Representatives in Toronto, Montreal, Winnipeg and St. John

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE **METALLIC** PACKING

"MADE IN CANADA"

Here Is The Way To Stop Packing Troubles

Avoid packings that require frequent replacements, that score rods and add dead load to machine operation.

Your equipment deserves "JOHN CRANE" Packing. Costs far less in the end—avoids frequent shut downs; does not wear or score rods and runs practically without friction.

"Metallic Packing" and Chart

Keep abreast of packing science. Let us tell you of the greater economies and service you can enjoy through "JOHN CRANE" Packings. Why thousands of engineers are using them. Free upon request.

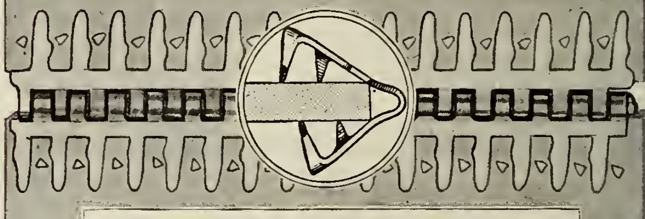
FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited. Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, B. C.

Specify "John Crane" On All New Equipment.

ALLIGATOR

TRADE MARK REG. U. S. PAT. OFFICE

STEEL BELT LACING



The Value of Reserve Strength

Alligator Steel Belt Lacing is the strongest flexible belt joint on earth. Its strength is an insurance against the joint yielding at the edge, stretching or breaking under sudden loads. Alligator Steel Belt Lacing forms a permanent, efficient joint which preserves the belt. It is smooth on both sides and flexible. Adapted to all general service. "Every Tooth a Vise."

Sold by leading dealers.

FLEXIBLE STEEL LACING CO.
4669 Lexington St., Chicago, Ill.
In England at 135 Finsbury Pavement, London, E.C. 2.

"Every Tooth A Vise"

Just a Hammer to Apply It

For Every Size and Kind of Belt

BOILER CHEMICALS

Made in Canada for You

Do it Now

Not a hit-and-miss ready-made compound, but made for you on scientific principles.

Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal **Factory: Cobourg**

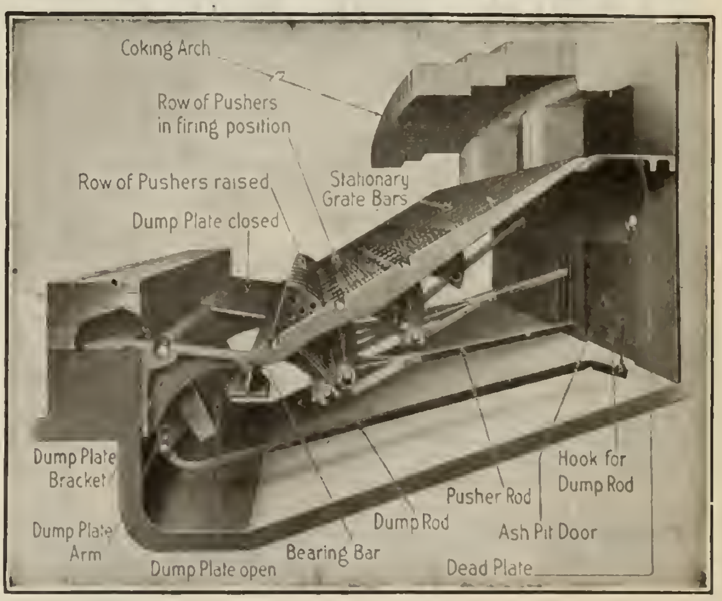
You Need the National hand fired Stoker

The National Hand Fired Stoker consists of a system of downward sloping grate bars, fuel pushers, dump plates, boiler front, bridge wall and ignition arch. In firing all that it is necessary to do is to dump the fuel on the upper end of the grate and when this is coked it is moved a stage further down by means of pusher rods operated from the front of the furnace, and the fresh charge of fuel may be dumped in.

No need to spread the fuel—any "green" hand can thus do the firing. The successive pusher rods keep the fuel marching downward, ensuring perfect and smokeless combustion, until the lowest or dump grates are reached. The draft is evenly distributed throughout the fire bed and excellent results can be secured with waste and low grade fuels.

You get all the advantages on a smaller scale, and without the great cost, of the large mechanical stokers.

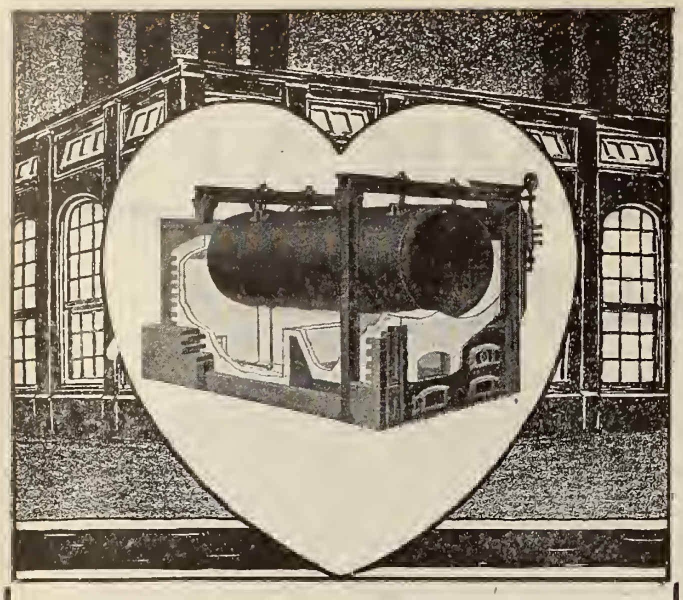
Booklet mailed on request.



Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: **HALL MACHINERY CO., Sherbrooke, Quebec, and Birks Bldg., Montreal**



The Heart of Your Plant Is the Boiler Fire Box

Insure long and efficient service of this vital organ by using only monolithic walls, arches and baffles. Eliminate separate bricks, blocks, tile and mortar joints. These are the weak points—the trouble makers.

BETSON'S

REG. U.S. TRADE MARK PAT. OFF.

PLASTIC FIRE BRICK

is the pioneer material for this purpose. Well-known Chief Engineers use and recommend it. Many Power Plants have used it continuously for 10 and 20 years. Replies to a recent questionnaire show that it has reduced the item of lining and baffle repairs 50 per cent.

Ask us for a list of BETSON users. Ask them. Investigate our claims. There'll be no more bricks to drop out and no mortar joints to open up once you use BETSON'S PLASTIC FIRE BRICK.

Shipped in substantial wooden barrels from warehouses in principal cities, either mixed ready for use or dry ready to be mixed with water. The cost is no more one way than the other.

Get the vital facts about Power Plant Efficiency and Economy. Write to-day for our FREE Booklet.

Betson Plastic Fire Brick Co., Inc.

P. O. Box 386-6 Rome, N.Y.

Canadian Distributors: INTERNATIONAL CHEMICAL CO., 26-6 Adelaide St. E., Toronto, Ont., Can.

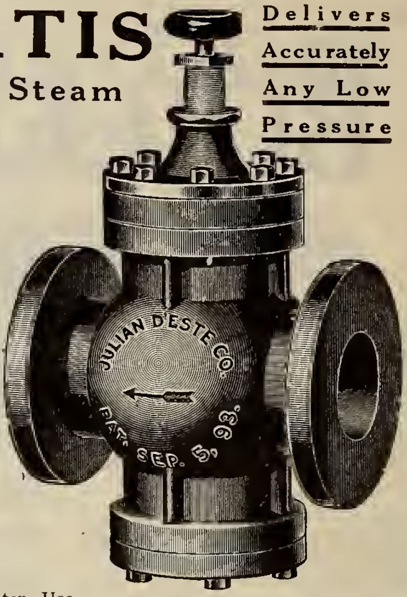
CURTIS

Improved Steam Pressure Regulator

Delivers Accurately Any Low Pressure

A compact, self-contained Regulator suitable for any boiler pressure. It delivers accurately and uniformly any lower pressure from one to within a few pounds of the initial pressure.

It has no levers, weights or projections; no glands or packing; no drip or leak of steam or water. Use it for efficient service on steam-heating apparatus, slashers, jacket kettles, air or water pumps, pulp mills, etc.



The Improved Steam Pressure Regulator is a lock valve, very simple and sensitive. Send for descriptive pamphlet.

JULIAN D'ESTE COMPANY

Main Office: 26 Canal St., Boston, 14, Mass.

Tycos and Condensers

The application of *Tycos* Bi-Record Recording Thermometers on condensers gives accurate records of both in-coming and out-going temperatures. A study of these records of rise and drops between two points enables operators to maintain condenser efficiency.

For every temperature need in the power house there is a *Tycos* Temperature Instrument, Indicating—Recording and Controlling that will completely meet that need.

Send to-day for our reference book on power plant temperature instruments.

Taylor Instrument Companies

110-112 Church St.,
Tycos Bldg.
TORONTO

There is a *Tycos* or *Taylor* Temperature Instrument for every purpose.

Tycos Temperature Instruments, Indicating — Recording Controlling.

878

THE JENNINGS HYTOR

VACUUM HEATING PUMP

Direct Connected to Electric Motor for Return Line Heating Systems, Dryer Exhaust in Paper Mills, and Other Vacuum Work Where Liquid is Handled with a Gas.

Typical Jennings INSTALLATIONS

Schools

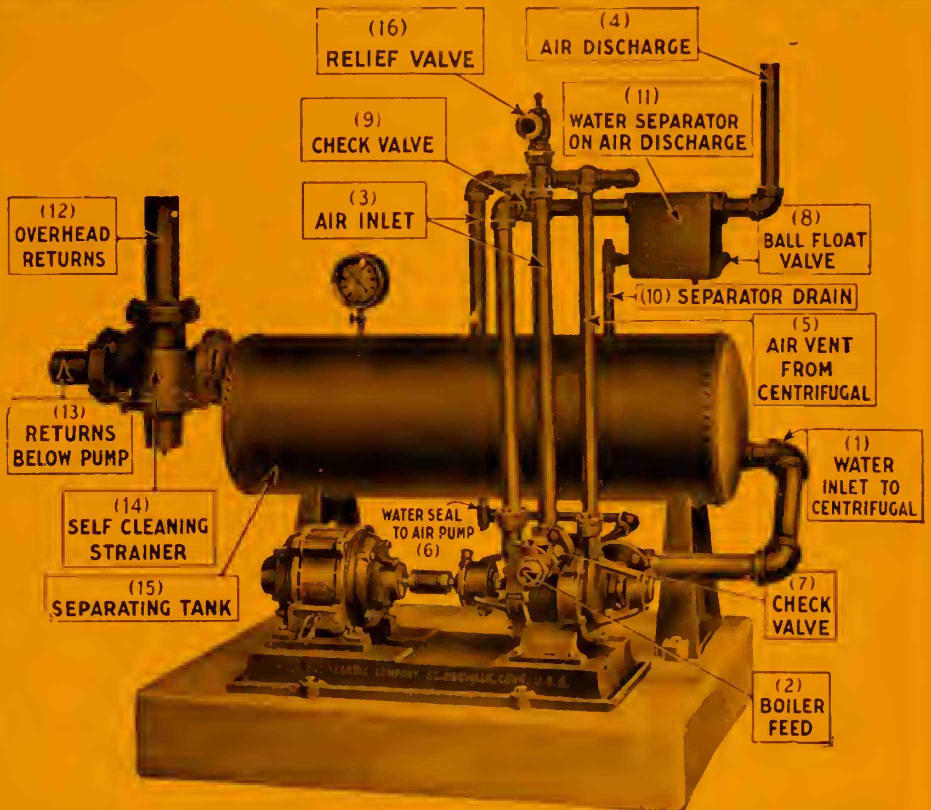
- Jarvis Street Collegiate, Toronto.
- University of Toronto.
- Bowmore Road School, Toronto.
- College of Education, Toronto.
- Wyandotte School, Windsor.
- Felix Avenue School, Windsor.
- Walkerville School, Walkerville.
- Sarnia Technical, Sarnia.
- Western University, London.
- St. Catharines Collegiate, St. Catharines.
- Sudbury Technical School, Sudbury.
- Galt Collegiate, Galt.

Industrial Plants

- Coca-Cola Bldg., Toronto.
- T. Eaton Co., Toronto.
- Canadian Salt Co., Windsor.
- Hamilton & Toronto Sewer Pipe Co., Hamilton.
- Reginald N. Boxer Co., New Toronto.
- Partridge Rubber Co., London, Ont.
- Dominion Tire Co., Kitchener, Ont.
- Lang Tanning Co., Kitchener, Ont.
- Canadian Bridge Co., Walkerville, Ont.

Paper Mills

- Foley, Reider Co., Northern Ontario.
- Spruce Falls Paper Co.
- Provincial Paper Mills, Mille Roche.
- Interlake Tissue Mills, Thorold.
- Lincoln Paper Mills, Merritton.
- Backus-Brooks Co., Fort Frances.
- Canadian Barrels and Kegs, Ltd., Waterloo.



Size C for 26,000 square feet radiation requiring only 2 H P. Motor at 1800 R.P.M. when delivering from a Vacuum of 10 inches of Mercury against a boiler pressure of 10 pounds.

THE Pump consists of two independent turbine units, an air pump and a water pump combined in one casing, with the impeller of each mounted on the same shaft.

One unit continuously exhausts air and vapors from the heating system, and the other removes the condensation as it accumulates and forces it directly into the boiler, or up to the hot well.

The boiler pressure is against the water only. The air and vapor, representing approximately four-fifths of the volume handled, are delivered to the atmosphere without back pressure. The saving in horse-power amounts to over 50 per cent.

No oil from the pump can get into the boiler, as the pump has no internal lubrication; and no air separating device or water leg is required, as the pump discharges direct to the boiler.

NASH ENGINEERING CO.

SO. NORWALK, CONN., U.S.A.

Represented by:

The ARTHUR S. LEITCH CO. LIMITED

Kent Building TORONTO

HIGH GRADE POWER PLANT AND PUMPING EQUIPMENT

Protecting the Steel Industry

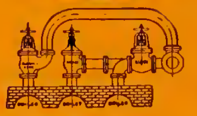
Safety to life and property and the elimination of preventable shut downs are of vital importance. The engineers of the big steel companies have left nothing to chance. The serious hazard due to sudden reversal of steam flow from a boiler room header into a damaged boiler or liability of a disastrous explosion following a break in a steam main has been removed in their plants by the installation of

"4300"

Golden-Anderson

Patented Automatic Double-Cushioned Triple-Acting and Non-Return Valves

1. Automatically cut out a boiler the instant that a tube ruptures or other internal break occurs.
2. Automatically cut off the steam flow from every boiler the instant that a steam pipe bursts.
3. Automatically equalize the pressure between all boilers.
4. Automatically cut in a boiler, making accidents due to inaccurate steam gauge impossible.
5. Positively prevent back flow of steam into a cold boiler.
6. Can be closed by hand like ordinary stop valve, and arranged with "combination feature" to open valve like regular gate or globe valve.
7. Can be tested in service from the boiler room floor.
8. Double Corliss Dash Pot that cushions in opening and closing.
9. Cannot pound, spin, stick or chatter.



Double Extra Heavy Valves

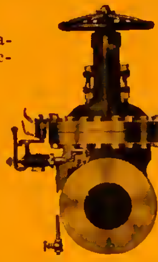
"CUSHIONING"

is of most vital importance in triple acting and non-return valves. Steam is no respecter of makers. Insist on "Double Corliss" Dash Pot Cushioned Valves.

GOLDEN-ANDERSON

Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves.

1. Operate 3 ways: Automatically, by Hand or by Electric Switch.
2. Prevent fly-wheel Explosions.
3. "Double Corliss" Cushioned— No Pounding or Sticking.
4. Contains No Tight Fitting Parts.
5. Furnished in Angle and Globe Patterns for High or Low Pressures.
6. "Always Ready for Service."



GOLDEN-ANDERSON

Pat. Automatic Cushioned Controlling Float Valve.

1. Automatically maintains uniform level in heaters, tanks, etc.
2. Air and water cushioned.
3. No metal-to-metal seats.
4. No waste of water.
5. No water hammer or shock.
6. Angle or Globe patterns to 30 in.

GOLDEN ANDERSON

Pat. Automatic Cushioned Water Float Valves.

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle — Most Satisfactory Float Valves Known.
4. No Metal-to-Metal Seats — No Water Hammer or Shock.
5. Cushioned by Water and Air.

GOLDEN-ANDERSON

Patent Automatic High and Low Pressure Steam Traps.

1. The first new departure in steam trap design, in years.
2. 50 to 100% greater capacity than other traps of similar size.
3. Full area through discharge valve.
4. Extra Heavy Throughout — Very Durable — Will last a lifetime — and Always Works.
5. Furnished Semi-Steel and Cast Steel for Superheat.

GOLDEN-ANDERSON

Pat. Cushioned Water Relief Valves.

1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water, cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 30 in.

GOLDEN-ANDERSON

Pat. Automatic Double Cushioned Check Valves.

1. Especially adapted for Water Service.
2. For High or Low Pressure.
3. Thoroughly Cushioned. No chattering, Hammering, or Sticking.
4. Globe or Angle Patterns up to 30 in.
5. Especially adapted for hydraulic elevator service.

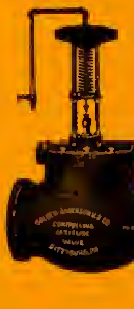
GOLDEN-ANDERSON

Pat. Automatic Cushioned Steam Pressure Reducing Valves.

1. Maintain a constant reduced pressure.
2. Thoroughly cushioned.
3. No hammering, chattering or sticking.
4. No auxiliary valves or small by-passes to clog up.
5. No wire drawing.
6. Only one adjustment from the outside.
7. Double extra heavy throughout — practically indestructible.

GOLDEN-ANDERSON

Pat. Cushioned Automatic Controlling Altitude Valves.



1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, Reservoirs, etc.
2. For High or Low Pressure. Always Dependable.
3. No Floats or Fixtures used.
4. No Water Hammer or Shocks.
5. Sizes up to 30 in.

GOLDEN-ANDERSON

Pat. Automatic Cushioned Water Pressure Regulating Valves.

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

GOLDEN-ANDERSON VALVE SPECIALTY CO., 1299 Fulton Building., Pittsburgh, Pa.

Represented by

The Arthur S. Leitch Co., Limited, Kent Building, Toronto

High Grade Power Plant Equipment

Increased Boiler Capacity—Constant Steam Pressure *With Cheap Fuel*

You can carry your heaviest peak load with the cheapest fuel available if you equip your boilers with

REGISTERED
COPPUS
U.S. PAT. OFFICE

TURBO-BLOWERS

If You Fire by Hand—

A COPPUS Type "C" Turbo Blower placed in the boiler wall will result in a marked saving in fuel and insure higher steaming capacity and steady pressure. It occupies no floor space and is designed for continuous operation under boiler room conditions. Can be controlled automatically or by hand.

Type C Undergrate Blower

Turbine Driven VANO Blower

For Mechanical Stokers and Induced Draft—

we have developed the COPPUS VANO BLOWER with either turbine or motor drive.

COPPUS VANO BLOWER
"IT'S ALL IN THE VANES"

The VANO is unquestionably the most efficient blower yet built. It combines the advantages of the centrifugal and propeller blower—is more efficient than either and admirably adapted for direct motor or turbine drive. Be sure to investigate.

Electric Driven VANO Blower

The Efficient Way To Pump Feed Water

The COPPUS Turbo Feed Pump was specially developed to bring the high efficiency and even feed pressure and other advantages, resulting from the use of centrifugal feed pumps, to the small and medium size plant.

Type TB Coppus Centrifugal Boiler Feed Pumps, multi-stage — the latest development in the feed pump design. Adapted to service with the highest modern boiler pressures.

Write us for full set of Coppus Bulletins. Consult us regarding your special requirements.

Type CCC Coppus Centrifugal Turbo Boiler Feed Pump, single stage. Insures smooth, steady feeding for moderate boiler pressure.

Copp Engineering Corp., 350 Park Ave., Worcester, Mass.

THE ARTHUR S. LEITCH COMPANY LIMITED

Kent Building, Toronto

HIGH GRADE POWER PLANT EQUIPMENT

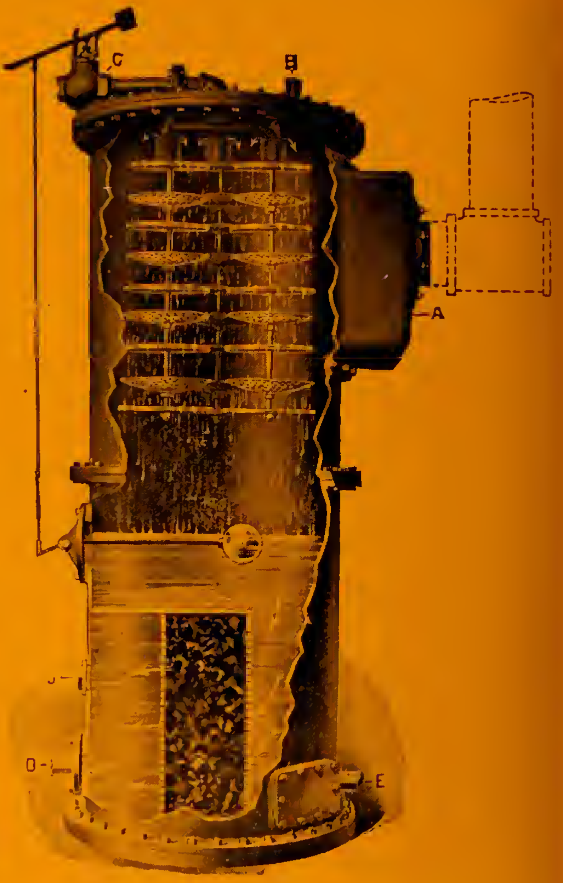
"SIMS"

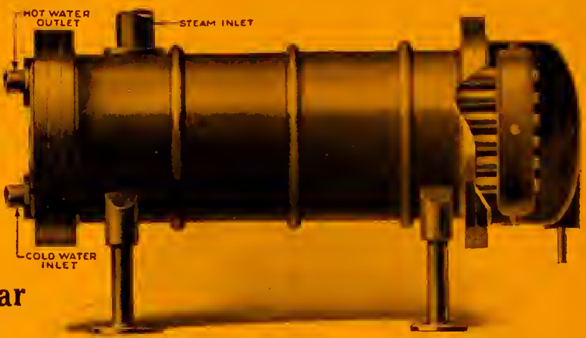
Hot Water Heaters and Generators

SIMS Heaters are designed and constructed to give service. Economy in operation is one of the outstanding features.

Tubes can be easily cleaned, due to the construction.

Straight tubes are expanded into a floating header which takes care of the necessary expansion and contraction.





"Sims" Closed Tubular Feed Water Heater

"Sims" Hot Water Generators

"Sims" Open Feed Water Heater

With the "Sims" Closed Tubular Feed Water Heater the temperature of feed water can be raised within a few degrees of boiling point with exhaust steam. All heaters are made up with straight, seamless drawn brass tubes 1½" O.D., subject to factory test of 1,000 lbs. per sq. in. The tube structure is tested at 250 lbs. hydrostatic pressure.

"Sims" Hot Water Generators and Convertors are designed for heating water for all kinds of service. They are efficient and economical. Tube covers are easily removed, exposing all the tubes so that they can be scraped and kept in good order as when new.

"Sims" Steam Storage Heaters

"Sims" Open Feed Water Heaters are round, the best for withstanding internal pressure; they are constructed of cast iron, the only material which is not subject to corrosion. The design is very simple, every part is easily accessible.

Practical Uses For B.H. Clean E-Z Storage Heaters

These heaters are adapted for use in any plant or building requiring hot water, with either high or low pressure steam. Installations are in service in factories, office buildings, Y. W. and Y. M. C. A. buildings, hotels, apartment houses, steam laundries, etc.

THE ARTHUR S. LEITCH COMPANY LIMITED

Kent Building, Toronto

HIGH GRADE POWER PLANT AND PUMPING EQUIPMENT

GOLDIE & McCULLOCH Co. LIMITED GALT ONT
THE GOLDIE & McCULLOCH LIMITED GALT ONT
CANADA STOKER

CANADA STOKERS

Effect a Remarkable Saving in Fuel

Canada Stokers applied to 150 h.p. H.R.T. boilers as shown above have made it possible for four boilers to produce same amount of steam formerly produced by six boilers when hand fired. Only two men are now required instead of four. These stokers, although in continuous service for four years, have cost nothing for repairs.

The owner of another plant says: "Shortly after Canada Stokers were installed our load demand was increased about 15 per cent., but, despite this, we have saved fully 10 per cent. in coal. Furthermore, our efficiency, evaporation and capacity have been greatly increased."

CHAIN GRATES

We have placed on the market a narrow link, non-sifting, British Standard, high grade traveling grate adaptable to natural or forced draft.

Being continuously self-feeding and self-cleaning, it does not require dump plates, there being no large masses of solidified clinker to frequently dispose of, as is the case with several other types of stokers.

This stoker is entirely automatic in all its functions and is driven by a seven-speed fully enclosed gear box, running in oil.

We also furnish pumping machinery, portable flow meters, boiler feed water regulators and pump governors, feed water heaters, crushing and pulverizing machinery, and flat suspended arches for every type of furnace.

THE CANADA STOKER COMPANY, LIMITED

GALT, ONT. General Sales Office, 2 GOULD ST., TORONTO, Phone M. 3531

REFRIGERATION DEPARTMENT

Made in Canada since 1896

LINDE

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Making Plants Large and Small

Vertical Enclosed Type Machines made for capacities from one to fifty tons.	Horizontal Frame Heavy Duty Type Machines made for plants up to 300 tons capacity.

LINDE Machines embody every improvement that adds efficiency and durability, and are the ultimate development of specialized engineering and manufacturing experience during fifty years.

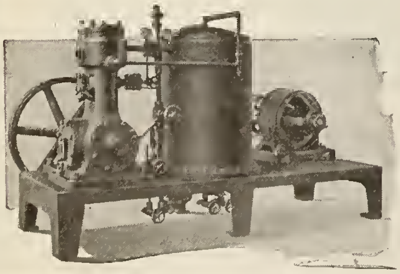
All present-day Linde Machines are fitted with our patent silent valves, giving increased efficiency and guaranteed to be mechanically silent in operation.

Linde Machines will do the most work for the least money.

The Linde Canadian Refrigeration Co., Ltd.
37 St. Peter Street, MONTREAL, Que.
TORONTO WINNIPEG VANCOUVER

VILTER

ICE MAKING AND REFRIGERATING MACHINERY

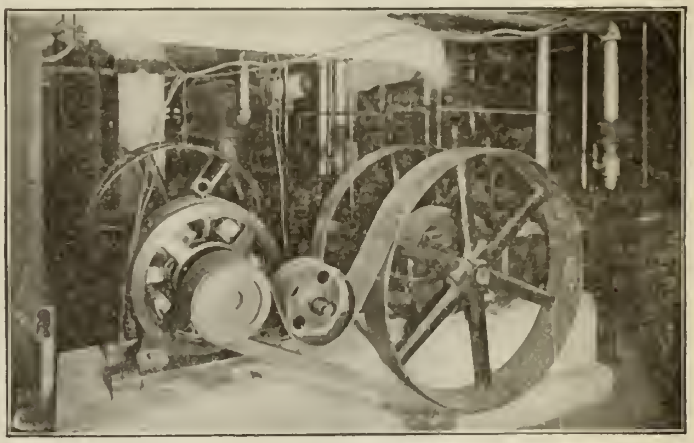


A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

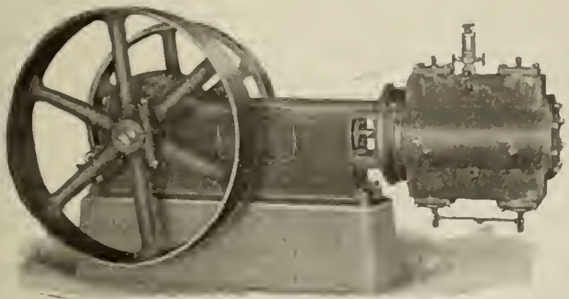
THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada

Ingersoll-Rand *Compressors* *Serve* Mount Royal Hotel

Pure, aerated water for the largest and most modernly equipped hotel in the British Empire is supplied by an "Ingersoll-Rand" Imperial Type "VA" Air Lift System.



The Compressor Installation Under Construction.

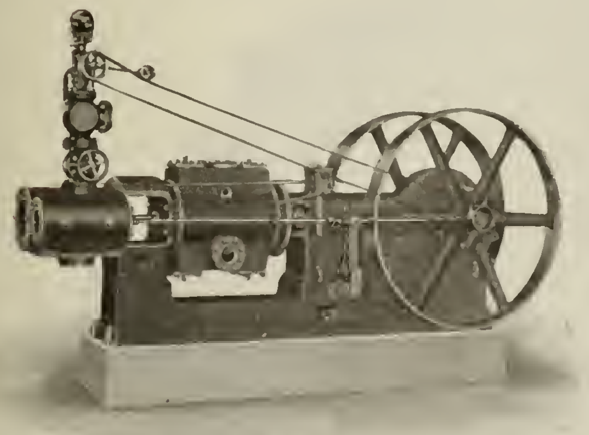


A Class "ER-1" Power Driven Compressor is used for regular service at the Mount Royal Hotel.

There is no better source of water supply than a properly designed Air Lift System. The water secured is cool and of the best quality; the supply steady and reliable, and the cost of pumping is usually lower than by any other means.

Satisfactory performance, however, is largely dependent upon the experience of the manufacturer and the efficiency of the equipment used.

This Company's experience in Air Lift Pumping is coincident with the inception of this method of elevating well water and its reputation for the production of highly efficient air compressors—**the heart of an Air Lift System**—is unchallenged.



For Stand-by Purposes the Mount Royal Hotel employs a class "FR-1" Steam Driven Compressor.

Interesting and informative bulletins sent to those interested on request.

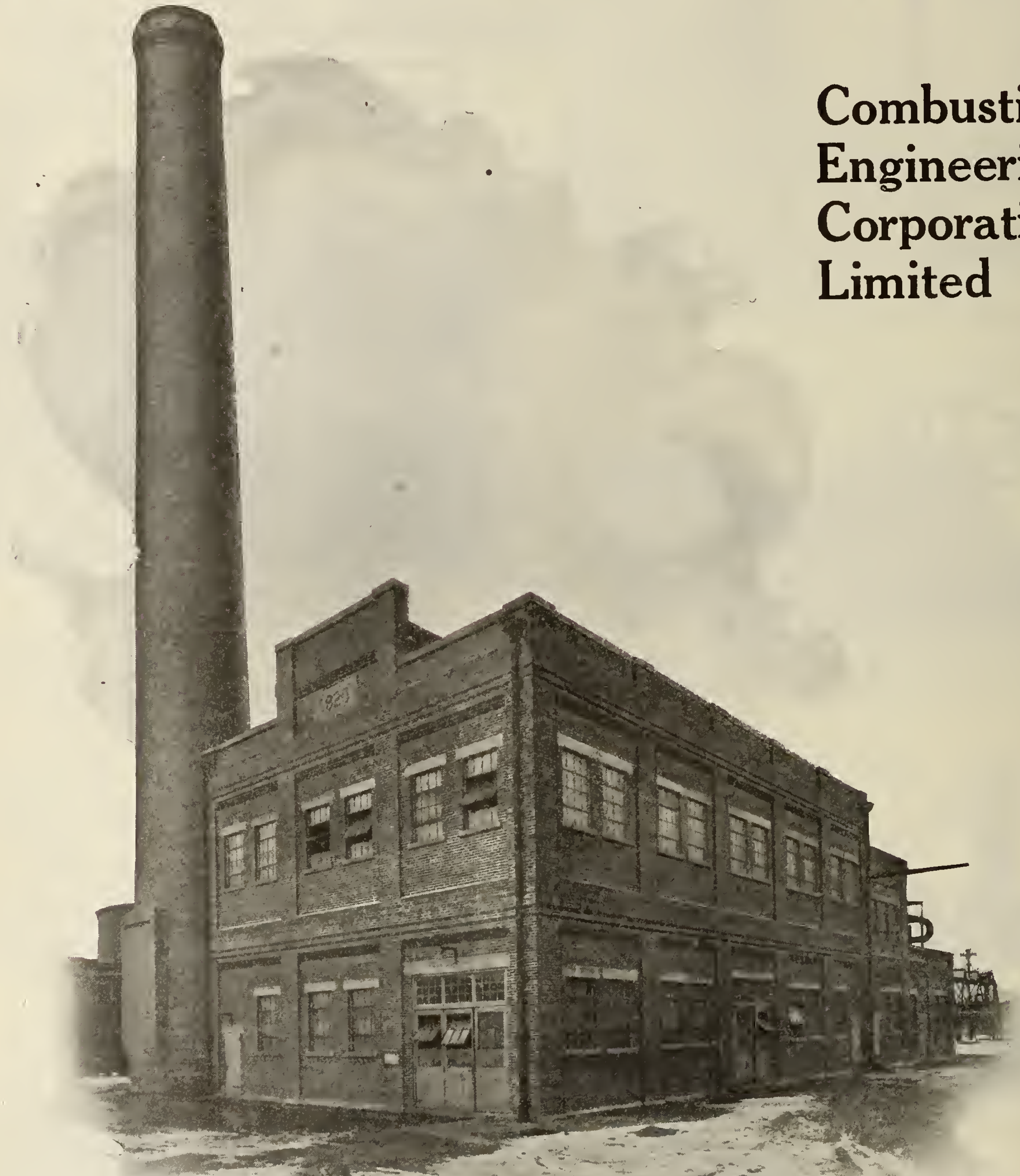
Canadian Ingersoll-Rand Co., Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

Associated Offices in all civilized countries.

Ingersoll-Rand

SERVICE *for* Power



Combustion
Engineering
Corporation
Limited

Plants of Canada

YOU will find us ready at all times to serve you with the correct equipment to meet your particular power plant requirements.

Our organization is complete and is backed by some of the best engineering brains in the world.

We serve the needs of Canadian industry wherever coal, wood or oil is burned for the generation of power.

Associated Companies

Underfeed Stoker Company, Ltd.,
London, England

Société Anonyme des Foyers Automatiques,
Paris, France

Combustion Engineering Corporation,
New York, N.Y.

Green Engineering Company
East Chicago, Ind.

International Pulverized Fuel Corporation,
New York, N.Y.

Alphons Custodis Chimney Company,
New York, N.Y.

M. H. Detrick Company, Chicago, Ill.

Uehling Instrument Company
Paterson, N.J.

Elliott Company, Pittsburgh, Pa.

James Howden & Co., Glasgow, Scotland

R. H. Beaumont Company
Philadelphia, Pa.

Raymond Bros. Impact Pulverizer Co.,
Chicago, Ill.

Apparatus Sold

Stokers of all types.
Pulverized Fuel Systems.
Steam Turbo Generators.
High Speed Steam Engines.
Air Preheaters.
Radial Brick Chimneys.
Coal Handling Equipment.
Ash Conveyors and Hoppers.
Suspended Flat Arches.
De-aerators.
Condensers of all types.
Oil Burning Equipment.
Pulverizing and Grinding Mills.
Recording Instruments.
Induced and Forced Draft Fans.

You may have our latest catalogues for the asking

COMBUSTION ENGINEERING CORPORATION

LIMITED

Head Office - Toronto

VANCOUVER MONTREAL WINNIPEG

REES RoTURBo
Self Regulating
PUMPS

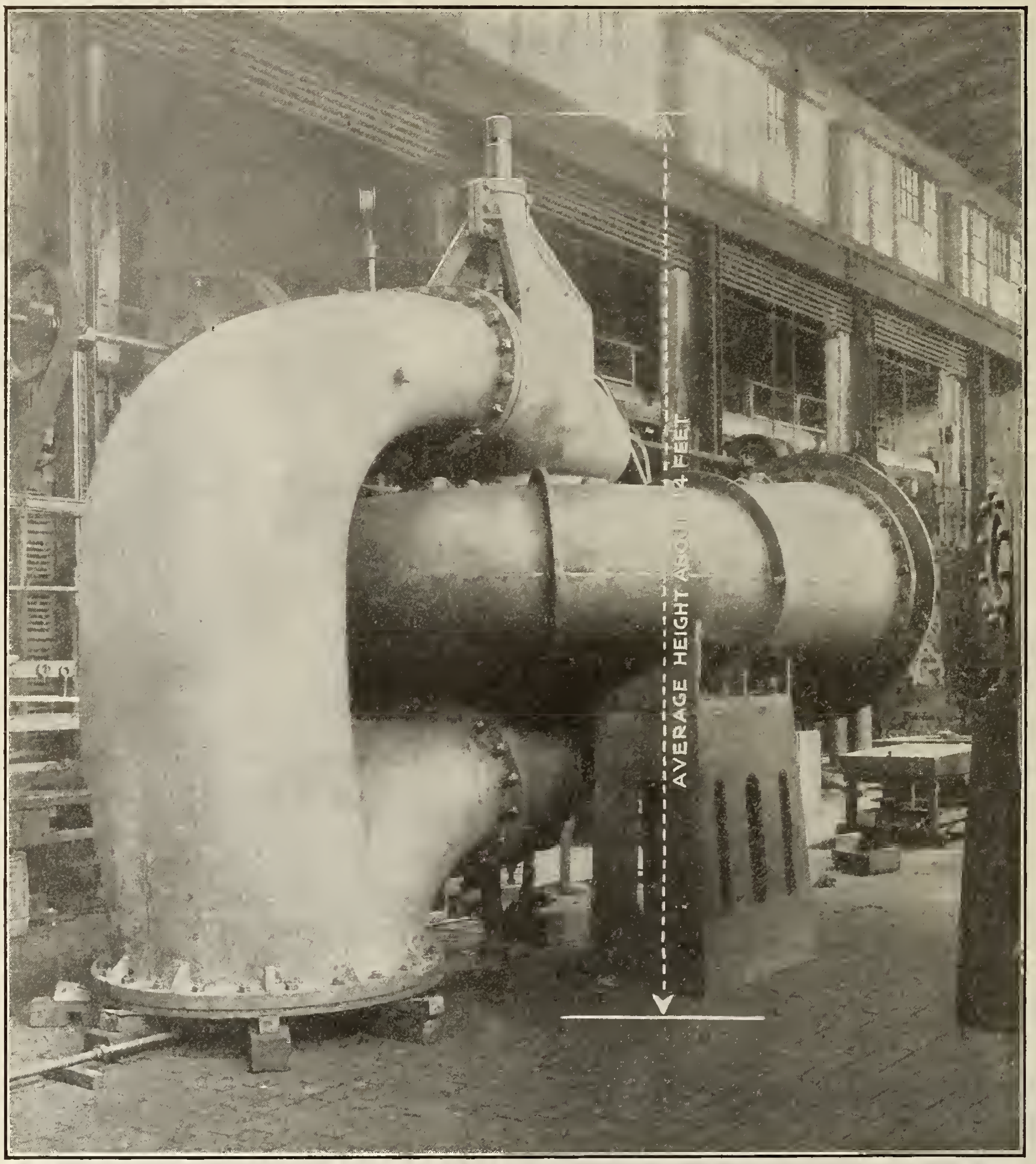


Illustration shows one of TEN REES RoTURBo PUMPS installed or on order for The St. John Drydock & Shipbuilding Co.

The three main pumps, "one of which is shown above" have an average capacity of over 250,000,000 imperial gallons per 24 hours and a maximum capacity of over 300,000,000 imperial gallons per 24 hours.

Ask for the REES Catalogue and any desired information.

THE GOLDIE & McCULLOCH CO., LIMITED

Head Office and Works, GALT, Ontario, Canada

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bldg.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig,
400 St. James St.,
Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B. C.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

N. C. SHATFORD
News Editor

Why is Money More Sacred?

EVERYONE is familiar with sales contests among road men, dealers and branches. Their regularly growing popularity is ample proof that they produce results—that they pay—and this "paying" is what we are interested in.

Rarely does it occur to an executive that a profitable contest can be staged right in his own power plant. He is alert to the value of prizes for salesmen whose expense accounts are audited with a sharp pencil, forgetting that firemen count money with scoop shovels which comes out of the same bank account.

Whether we have one boiler and one fireman or five boilers and eight-hour shifts, is immaterial. Set one lone man a mark to shoot at, or turn a number of them loose to beat each other; so long as it is a fair contest with a sound motive the executive is bound to get results. And the outcome—no matter who wins, is sure to be in his favor and to pay him in cash.

The more difficult the conditions are in the boiler room, the greater the need of directing attention to them. Men cannot, will not, and do not work well under continual handicaps and annoyances any more than money will. Yet, as a rule, money and its preferences are considered much more sacred. Be as selfish as we desire, we are bound to emerge at the identical point in every case where we are forced to realize that both factors, men and cash, are vitally necessary to have present in good order, willing and in good humor. Cashing in on either through proper use and adaptation of the other improves dividends.

All of which is but another sidelight upon the unpleasant truth that there is too great a tendency to neglect the boiler room and the kind of work done in it because it is dirty and uncomfortable—therefore we usually get the sort of returns to which poor equipment and our conduct has entitled us.

* * * *

Poor Stoker Operation

IMPROPER stoker operation is a very common cause of poor boiler results in Canada. A hand fireman often, unfortunately, makes a very poor stoker operator. He is hard to convert, and still believes there is no tool equal to the hook and slice bar—and he bravely attempts to live up to his opinion. This does give temporary relief, but it has serious after-effects, and often ruins the work of the best stokers. Overfeeding the coal is also a very prolific breeder of stoker trouble.

When the complaint regarding stoker operation is what might be termed general, a good safe rule is to shut down a stoker, go over every part of it in detail, tighten loose bolts, and do everything possible to make it as nearly new as possible. Then the blowers, flues and tubes should be inspected and everything put in first-class order before the stoker is started. This will naturally give good results, and will prove conclusively to the engineer, that by keeping everything up to concert pitch, satisfactory boiler operation will result with far greater economy than ever possible before.

Burning Oil Fuel

IN THE everyday operation of oil fuel burning plants there are certain axiomatic rules which must be adhered to at all times in order that the safety of the plant and its operators may be assured. The term "casualties" is perhaps the most appropriate to apply to accidents which might result directly from careless handling and burning of oil fuel.

Explosion may be caused by neglected leakage, accumulation of oil vapors in unfrequented places, and flarebacks within the furnace; ignition in the first two cases being caused by contact with a naked flame, flash or spark of some nature. Fire may be considered to be the result of explosion in practically every case.

Flareback as a cause of explosion is probably the most general operating casualty to guard against. It may or may not be serious, depending entirely on the extent of the explosion within the furnace, and the amount of explosive oil vapor present in the furnace. In general, it may be said to occur when lighting up, due to the accumulation of oil vapors within the combustion chamber occasioned by leakage from the burner tip.

The most general rules for safe operation may be outlined as follows:

Do not allow leakage of oil to continue at any point whatsoever in the system.

Do not allow spilled or leaked oil to accumulate; wipe up immediately.

Do not allow oil vapor to accumulate in a furnace. It is well to blow the latter through with steam or air before lighting off a burner.

Do not stand directly in front of a burner when lighting off. It is best to use a torch at least four feet long, and to stand at one side of the burner so that in case of flareback the chances of personal injury will be as slight as possible.

* * * *

Old Things in New Dress

OF COURSE you've noticed the new "masthead" on the cover this week. All of us like change—even "small change." And so every little while there is something new in Power House—we take out something old, or move things around a bit, just to add to the interest and freshen up the pages.

From month to month there will appear new things—things that will interest you, please you, help you in solving your every day problems. Then, too, old things will dress up in new dress, or will take a fresh twist or turn. You're going to like all this for there's a heap of satisfaction in watching for the unexpected. And you may look for the unexpected every time the paper arrives.

To keep up with the progress being made to-day in the power plant field in Canada there is just one thing to do. As soon as the postman hands you your copy, pull it out of its wrapper, and turn every page from cover to cover. Not to do this will be to miss something you'll be sorry you missed.

卷頭ノ辭

想ヒ起セバ早拾有壱年ノ昔トナリヌ。滞在僅カニ参週日ニシテ櫻花咲ク大和國ヲ跡ニ英國指シテ旅立チシハ。 遮莫、優ニ氣高ク麗ハシキ富士山ノ印象ハ歸未忘レントスルモ能ハズ。此新聞紙ヲ日本ノ輸入業者、并ビニ製造家ノ大方諸彦ニ紹介スルニ當ツテユクリナクモ、其英姿ヲ偲ブヤ切ナリ。

日本國民現下ノ急務ハ其傳統的勇気ト魅力ヲ振起シ速ヤカニ財政機関ノ再興ヲ計リ且ニ類無キ工業ノ輪ノ廻轉ヲ益々改善スルニアリ。

吾等ハ常ニ喜ムデ日本讀者諸君ノ需メニ應ジ此新紙ノ論説并ビニ廣告欄ニ掲載セラレ、機械器具ノ効率利益等ニ関シ紹介ノ労ヲ惜マザル可シ

言フ迄モナク、アドバタイザー紙ハ米大陸ニ於ケル最良最廉ノ材料提供者ニシテ工業ノ発展ニ必要ナル労力、貨銀ノ節約等斯業喫緊問題ノ解決ハ此新聞紙ニ依リテ始メテ達成セラル可シ。

キャンベル・ブラッドショー。

主筆記者 白。

Effecting Big Savings Through Control of CO_2

By ROBERT JUNE, A.S.M.E.[*]

In This Article the Author Emphasizes the Fact That Flue Gas Analysis Will Not Improve Boiler Room Efficiency, in and of Itself, Its Purpose Merely Being to Ascertain a Basis for Intelligent Action

THE constant regular determination of flue gas analysis will enable every Canadian engineer to accomplish the following results:

1. Improve methods of handling fire.
2. Improve draft regulation.
3. Detect air infiltration.
4. Indicate necessity, if any, to provide secondary air supply.
5. Indicate needed changes in design and construction of furnace.

In addition, the installation and regular use of flue gas analysis apparatus in a boiler room increases the morale of the entire "crew." Efficiency is infectious. Being stimulated to employ better firing methods, the men will handle every part of their work in a better and more economical manner.

No One May Know

Thin fires through which holes quickly develop insure low CO_2. The fireman cannot always tell by inspection when his fires are too thin. He may be careless, and if there is no check on CO_2 no one may be any the wiser.

There is no such thing as a fixed adjustment in the operation of a boiler. Load conditions vary and the rate of combustion must follow suit or the steam pressure will drop. This calls for variations in the thickness of the fire, and these variations cannot be made anything like as correctly without CO_2 equipment as with it.

With hand-fired boilers a continuous CO_2 record shows how often the fires were replenished, how long the fire doors were left open, when fires were cleaned, and how long it took to clean them.

In stoker fired boilers equivalent changes are indicated.

Improve Draft Regulation

Unnecessarily high drafts decrease the percentage of CO_2. On a recent test of a boiler burning No. 1 Buckwheat, a fairly uniform relation between the boiler draft and the amount of CO_2 was indicated. With a draft of 0.20" a CO_2 content of eight per cent. was found. Reducing the draft to 0.18 increased the CO_2 to nine per cent. A further drop in draft to 0.16" produced a ten per cent. CO_2. Cutting the draft still further to 0.14 an eleven per cent. CO_2 was established. With a draft of 0.12" the CO_2 content was increased to twelve per cent.

Here the improvement ceased. A further drop in draft resulting in a decrease in CO_2 showing that for the particular load demand and the particular condition of the fuel bed during the test a draft of 0.12" was most economical.

With another fuel and under other conditions a different draft would be required. The economical draft can be more readily determined with the aid of CO_2 analysis apparatus than in any other manner.

Detect Air Infiltration

The presence of leaks permitting the infiltration of air into the setting through the brick work or doors can be detected readily by means of CO_2 apparatus. If the percentage of CO_2 is not increased by better handling of fires or by adjusting the draft then it is time to examine the setting.

A lighted candle passed slowly over the brick work and door joints will indicate air infiltration as the flame is sucked in.

Each pound of fuel of a certain composition requires a certain fixed weight of air for complete combustion. In addition to this fixed amount an additional percentage of excess air must be provided so that despite faulty distribution of the air supply there will be a particle of oxygen available for each particle of carbon or other combustible to be consumed.

Whether the amount of excess air is high or low determines boiler efficiency. As the amount of excess air is measured by the percentage of CO_2, we can determine by the use of CO_2 indicators whether we have an adequate supply of air, properly distributed.

Insufficient combustion space is another direct cause of low CO_2. If we have carefully checked over our firing methods, draft regulation, condition of our settings and air supply and if we still find that we are getting low CO_2, it is time to examine furnace design and furnace volume. Hundreds of furnaces are re-constructed every year to the profit of the owners, as a result of the findings of CO_2 indicators.

The loss due to heat carried away by dry chimney gases for varying percentages of CO_2, and different temperatures of exit gases is shown in Fig. 1 and Fig. 2. Fig. 1 shows the actual loss in B.t.u. Fig. 2 shows the percentage loss of the total value of the fuel, based on a coal of 14,000 B. t. u. Table 1 gives a rough approximation of the per cent. loss up the chimney for the several major classes of fuel.

CO_2 Indicators

A great many different types of apparatus have been developed for indicating and recording CO_2. In describing and illustrating a number of these, we do not impute any lack of merit to makes of apparatus not mentioned, or only described briefly.

The orsat, Fig. 3, is employed for volumetric analysis of a single sample. The principles employed in the equipment illustrated are used in practically all of the portable appliances on the market. A measured sample of gas having been drawn from the stack, is forced successively through pipettes containing solutions of caustic potash, pyrogallic acid, and cuprous chloride in hydrochloric acid, respectively, thus absorbing the carbon dioxide, the

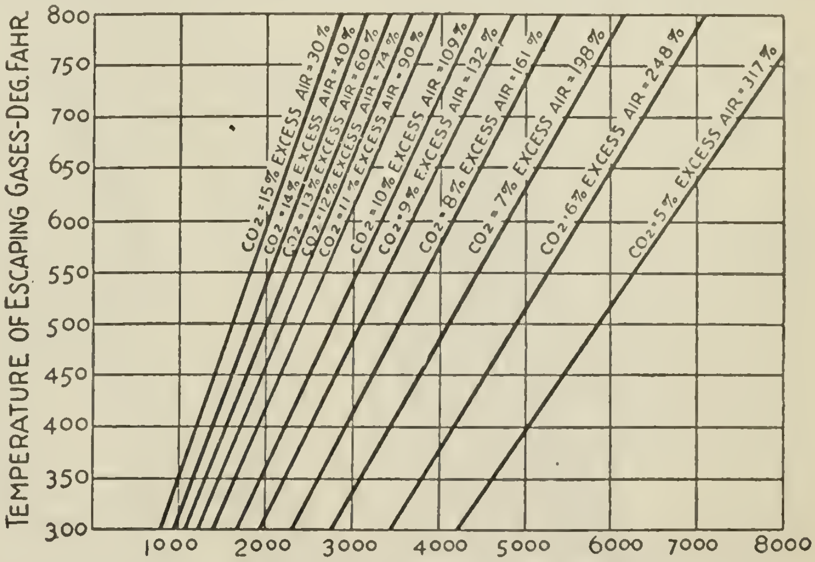


Fig. 1—Losses occurring with various percentages of CO_2

---

[*] Specially written for Power House. Copyright 1923.

oxygen and the carbon monoxide, the contraction of volume being measured in each case. The original orsat apparatus is bulky, fragile and slow, but it is accurate. Some recent modifications have considerably improved the apparatus. There is room for an orsat in every power plant for the following services:

1. To determine the maximum CO_2 which can be carried while still securing complete combustion.
2. To inspect settings for air infiltration.
3. To check up the continuous CO_2 recorders.

By itself the orsat is inadequate as a control for the firing operations of a boiler plant. It is decidedly better than nothing however and as it is not expensive it should be employed in every plant whether CO_2 recorders are installed or not.

Sarco CO_2 Recorder

One inch pipes tap the side flues or last combustion chambers of the boilers or furnaces, and a three-quarter inch main pipe from them is connected to the instrument. In order that the gas samples may be secured rapidly and continuously, the circuit is completed by another pipe of the same diameter. This is carried to the base of the chimney or, where this is not practicable, to a convenient point in the main flue, well beyond the boiler damper. Thus a continuous, rapid passage of the gas is secured, which, usually, renders it possible to read on the chart the effect of an alteration in the firing within two or three minutes of its occurrence.

The instrument, once erected, works entirely automatically, and requires little attention beyond changing of the chart every 24 hours, and renewal of the potash solution every fourteen days to three weeks.

Foxboro CO_2 Recorders

In the Foxboro recorder a solution of caustic is used for a re-agent. The motive power is obtained from a constant flow of water and the periodic operation of an automatic syphon, the amount of water required per day being approximately two barrels. There are only three moving parts—the clock movement for rotating the chart, the pen-actuating float, and the dotting mechanism.

The operation of this particular machine is as follows: The water flows through the coils into a measuring vessel and traps a definite volume of gas in a bulb, forcing it over through a tube to an absorption vessel, where it bubbles up through caustic solution, which almost instantly absorbs the CO_2 gas present. Above the caustic solution is a layer of oil, and above that is a gas chamber. A float tube terminates in a tube which extends through the oil almost to the level of the caustic solution. Pressure in the chamber causes the oil to flow through the tube into a float tube which encloses a float, to the upper end of which is fastened a pen.

The distance the pen will rise depends upon the quantity of gas forced into the gas chamber by the rising water— the gas reaching the gas chamber being residue of the original sample after CO_2 is removed. The water rising in the water-float tube raises a float which operates dotting mechanism, causing the pen to press against the chart.

The water now syphons out, and, as the syphon takes water away faster than it is delivered, the float drops, releasing the pen. As the water continues to syphon out, the pressure in the gas chamber decreases and eventually balances to atmospheric pressure through the exhaust pipe, the float in the tube dropping to normal position.

Water passing through the syphon operates an aspirator, creating suction through a water seal, and drawing flue gas through the chamber of the filter. Part of this gas is drawn through the filter into the measuring vessel through an intake pipe. When the syphon breaks, the pressure of the gases in the measuring vessel balances, and the cycle is resumed by the rising water trapping the unit quantity of gas in the bulb.

Uehling Apparatus

The principle involved in the operation of the Uehling CO_2 meter depends upon the change in pressure in a stream of gas flowing through two apertures, caused by absorption of its CO_2 content. The apparatus consists of three principal parts, namely the CO_2 meter proper, the recorder for the engineer's office and the auxiliary boiler front indicator for the fireman. The CO_2 is extracted, in the CO_2 meter proper. The CO_2 meter, in turn, actuates the recorder and indicator.

TABLE I.

Heat Loss With Various Percentages of CO_2 for Different Fuels.

Per Cent. CO_2	Carbon	Anthracite Coal	Bituminous Coal	Fuel Oil
	Loss	Loss	Loss	Loss
3	67.2%	61.8%	58.1%	49.4%
4	50.5	47.1	44.6	38.9
5	40.7	38.3	36.5	32.6
6	34.0	32.3	31.1	28.4
7	29.3	28.1	27.2	25.3
8	25.8	24.9	24.3	23.1
9	22.9	22.4	22.1	21.4
10	20.7	20.5	20.3	19.9
11	18.9	18.9	18.8	18.8
12	17.4	17.5	17.6	17.9
13	16.1	16.4	16.5	17.1
14	15.0	15.4	15.6	16.4
15	14.1	14.6	14.9	15.7
15.7				15.3
16	13.3	13.9	14.2	
17	12.6	13.2	13.6	
18	11.9	12.6	13.1	
18.6			12.8	
19	11.3	12.1		
19.5		11.8		
20	10.8			
21	10.3			

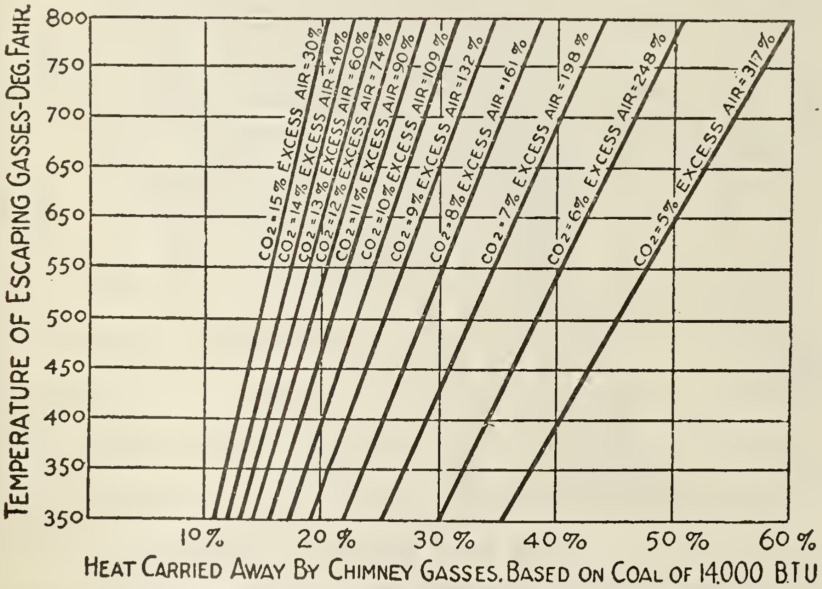


Fig. 2—Percentage of Heat Lost With Various CO_2 Percentages.

Republic CO_2 Recorder

The Republic depends upon the flow of water for its operation. It is so constructed that a variance from a minimum supply to a full open valve will not affect its proper functioning. The gas is drawn from the furnace to the instrument by means of a water jet and aspirator. It is a chemical machine.

Precision CO_2 Recorder

This instrument is likewise operated by a small stream of water. Individual gas samples are taken, analyzed with the aid of chemicals and the results recorded. After one sample has been analyzed another is taken immediately and duly recorded.

Hays CO_2 Recorder

In the operation of the Hays CO_2 recorder, a continuous stream of gas is drawn rapidly from the last pass of the furnace and at regular intervals the machine takes a measured sample of this gas, causes the CO_2 to be absorbed by means of caustic potash (KOH) solution and the pen to move on the chart to a point representing the per cent. by volume of CO_2 contained in it. Such variables as temperature and pressure of the gas sample, evaporation of water and changes in the specific gravity of the KOH solution are automatically controlled by the machine.

Water from the regular source furnishes the motive power for this type of recorder; about one gallon is required for each operation. This flows into the aspirator and thence into the overflow box. The speed of operation is governed by the amount of water admitted to the recorder through the sliding sleeve regulating valve. The range of adjustment is from one to four minutes, but a cycle every two and three-fourths minutes is recommended.

Electrical CO_2 Meter

The S. & H. CO_2 meter, (Bachrach) operates on a principle entirely different from that of the chemical CO_2 indicator; it makes use of the physical property of heat conduction of the gases. An electrical system is arranged in a Wheatstone bridge circuit, of which four branches are four platinum wires in two blocks. Across the mid points of the bridge is connected a sensitive indicating galvanometer. If desired the recording galvanometer, which may be placed at any reasonable distance from the measuring instrument, can also be connected into the circuit. The electrical energy is obtained from a small storage battery through a variable resistance which is adjusted to give constant current through an ammeter.

The flue gases consist of carbon dioxide, (CO_2), carbon monoxide, (CO), oxygen, nitrogen, and water vapor, with traces of other gases. Nitrogen, oxygen, carbon monoxide and air all have practically the same heat conductivity, but CO_2 has 40 per cent. less conductivity, and water vapor a conductivity about 30 per cent. greater than that of air.

The air in the comparison chamber is kept free from water vapor by the presence of hydroscopic chemicals, and the flue gases having passed through a cooler which also acts as a dryer, contain a very small, but practically constant, quantity of water vapor, hence the only variation occurring in the heat conductivity of the gases depends directly on the percentage of CO_2 in the flue gas.

As the electric current flows through the platinum wires, the heat which is generated in them is transmitted through the gases to the walls of the chambers.

Arndt Gas-Balance

The action of the Arndt apparatus is based upon direct measurement of the weight of the gases, CO_2 being heavier than air. In the absence of moisture, and at a fixed standard of temperature, the variations in density serve as an index of the CO_2 contents of the gases. The scale of the balance is graduated, so that the percentage of CO_2 can be read off directly. With a recording attachment of the usual type, a permanent record of the variations is obtained.

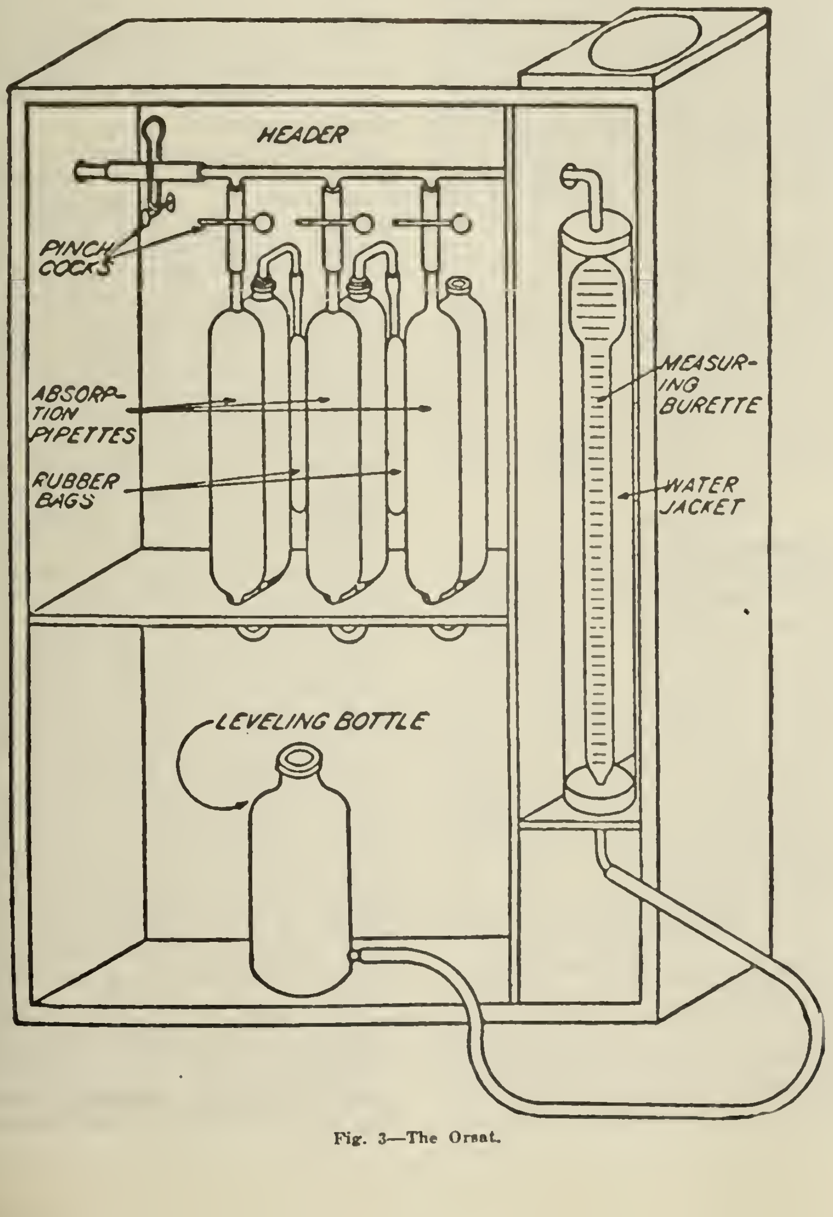


Fig. 3—The Orsat.

Krell CO_2 Recorder

This instrument is closely allied to the Arndt Gas-Balance. A very delicate differential pressure-gauge is employed to determine the difference in weight, of measured volumes of the flue-gas and air; and is attached to two columns of equal height, the one containing air and the other the sample of flue-gas.

A slightly inclined glass tube, filled with colored alcohol, is employed to record the pressure-gauge reading. The height of this thread of colored alcohol varies with the pressure, and by means of a scale marked in the percentages of CO_2, corresponding to certain pressures, the amount of this constituent of the flue-gas can be read off.

Haber-Loewe Refractometer

This instrument depends for its action upon measurements of the "refractive index" of the mixed gases. The method is thus an optical one, and resembles the optical methods for determining temperatures. The refractometer consists of the following three parts:—a prism, a telescope and a microscope.

The prism made of varnished metal, is provided with windows on opposite sides for the incident and reflected rays of light to enter and escape—and the gas to be tested flows through it, while the gas used for comparison flows through the casing. The observer sees in the field of vision when using this instrument, a scale which is partly illuminated and partly in darkness. The boundary of the dark zone will coincide with zero on the scale in pure air. In air containing nine per cent. CO_2 this boundary will coincide with 1.0 on the scale; and the line of demarcation between the light and dark zones will be still further shifted, for higher percentages of CO_2.

The instrument can be graduated, however, to yield the percentages of CO_2, or some other gas, directly by observation.

Checking Analyses

The heat balance itself is always a good check on the accuracy of the results of a boiler test. The radiation and unaccounted-for losses are always determined by difference. If this item is larger or smaller than the conditions would warrant, judging from experience, then an error has been made either in the observed or calculated data. This may be due to the gas sampling tube not being located properly or to some error in the analysis, either from a faulty instrument or technique.

In order to check out on the results of an actual test, Prof. Thomas G. Estep worked out the following concrete example based on data taken from the report of a boiler test.

(Turn to Page 55.)

Protective Gear Minimizes Transformer Faults

By S. AUSTEN STIGANT, A.M.I.E.E.

A Brief Review of Modern Methods to Protect Electrical Systems From the Effects of Faults in Static Transformers With a Description of the Principal Types

WHEN we refer to transformer protection, precisely the same interpretation is to be placed upon the phrase as when referring to alternator protection; that is, the protection is afforded to the system and the remaining plant connected to it, against faults, for the latter can only be procured through special care in design, manufacture and operation.

The faults which may arise in transformers to perturb Canadian engineers and against which protection is required are:—

1. Earth faults and faults between phases.
2. Faults between turns.

The protective gear installed must ensure the complete disconnection of the transformer from the supply immediately a fault occurs in it, while such disconnection must not interfere with the continuity of service given by any sound transformer. The damage which is likely to occur to the transformer itself and to other parts of the system must be reduced to a minimum in the one case and entirely obviated in the other. The various types of protective gear outlined in this review generally succeed in fulfilling these requirements.

Faults Between Phases

In the following discussion it will be assumed that on the primary side of the transformer either the transformer neutral is earthed or the neutral of the system to which it is connected is earthed at some point other than at the transformer; it will also be assumed that the L. T. neutral point of the transformer is earthed. It will further be assumed that the protection is applied so as to embrace the connections between the transformer windings and the busbars on both primary and secondary sides.

The principal types of protective gear used in England to-day for transformer protection are:—

(a) Core balancing system.
(b) Merz-Price circulating current system.
(c) Merz-Beard self-balancing system.
(d) McColl circulating current system.

Core Balancing System

The application of the core balancing system of protection is shown in its simplest form in Fig. 1, as applied to a single-phase transformer, from which it will be seen that the system consists essentially in taking the main leads on each side of the main transformer through the core opening of a protective current transformer, the secondary winding of which is directly connected to a relay coil. The relay contacts on primary and secondary sides of the main transformer are connected in parallel, as also are the oil switch trip-coils, while for D.C. tripping a battery is connected in between the relay and trip-coil leads as shown in the diagram.

In order that the transformer shall not be tripped out of circuit by a distributor fault, the earth connections from the transformer midpoints must also be taken through the core openings of the protective current transformers; when this is done, fault current flows in one direction only through the current transformer in the case of a transformer earth fault, thus disturbing the balance of the system and operating the protective gear. The protective gear may be operated by a fault on either side of the transformer.

As in many cases, however, particularly with poly-phase transformers, it may not be permissible to earth the neutral, while in other cases the H.T. neutral on the transformer may be not available, the application of this system to transformer protection is distinctly limited.

The system is applicable to earth fault protection only and not to protection against faults between phases. Fig. 2 shows the system applied to a three-phase transformer with star connected windings, and it will be seen that in this case also, one protective current transformer only is required on each side of the main power transformer.

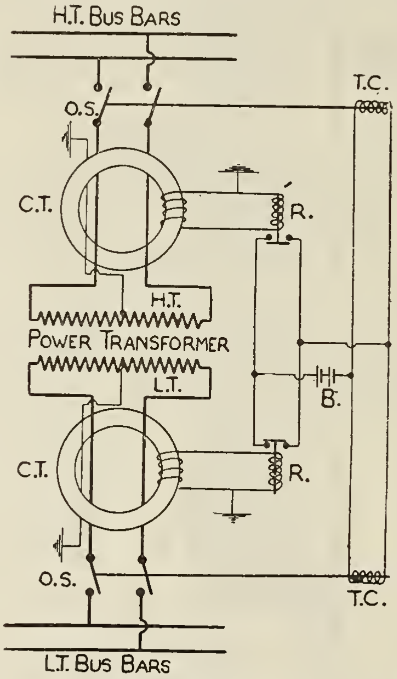


Fig. 1—Core Balancing Protection for a Single Phase Transformer.

REFERENCES TO ALL FIGURES:—

O.S.—Automatic Oil Switches.
C.T.—Protective Current Transformers.
T.C.—Trip Coils.
B.—Battery.
R.—Relays } *R C.—Restraining Coils.* { *O.C.—Operating Coils.*
O.F.—Overload Fuses.
K.F.—Kick Fuses.
B.R.—Balancing Resistances (if necessary).

Merz-Price System

The Merz-Price circulating current system has, up to the present, enjoyed by far the greatest popularity of all the transformer protective systems which aim at the automatic disconnection of a transformer upon the occurrence of either an earth fault or a short-circuit between phases. The application of the system to the protection of a single-phase transformer is shown in Fig. 3.

The principle upon which the system is based is the equality of the currents at the two ends of a sound balanced circuit. When, however, the electrical continuity of a circuit is interrupted by a static transformer for the purpose of pressure alteration, the currents on the two sides obviously are not equal in the mathematical sense, though at the same time by suitably designing the protective current transformers they may directly be compared.

In a sound balanced system the currents flowing into and out of the circuit are the same or directly comparable neglecting losses, but if an earth fault or short-circuit between phases occurs this equality is disturbed and the difference in the amounts or ratios of entering and leaving currents is utilized for tripping the faulty apparatus out of circuit. With Merz-Price circulating current protection for a three phase star/star transformer protective current transformers are inserted in series in each line on both H.T. and L. T. sides, designed so that the secondary currents of the current transformers on the H. T. side are the same as the secondary currents of those on the L.T. side.

The current transformer secondaries are connected so that the normal currents in them flow in the same direction round the secondary circuit composed of the windings and the short pilot cable connections. Relays are connected to equipotential points between the current transformer secondaries, and, with them so connected, there is no tendency for current to flow through the relays under normal operating conditions. If, however, an earth fault between phases occurs in the main transformer the currents in the current transformer secondaries will differ in magnitude or phase (or both) and this difference flows through the relay windings, thereby operating the automatic oil switches. The current transformers are of the ordinary switchboard type, and, as in practice it is difficult to obtain exact balance on heavy overloads, too fine a relay setting should not be adopted; the relays should be set to operate at a current somewhere between fifty per cent. and 100 per cent. higher than the minimum current at which they would operate.

If fuses are inserted in series in the pilot wire connections between current transformer secondaries, the protective gear will operate on overloads as operation of the fuses leaves one set of current transformers only connected to the relays, and consequently the secondary currents must flow through the particular relays, so operating the oil switch. These fuses are designed to operate at currents between five amps. and ten amps., according to individual requirements. In order to prevent operation of the relays when switching a transformer into circuit, it is usual to provide so-called "kick" fuses to shunt the relay terminals, thereby short-circuiting the magnetizing current rushes when switching in the transformer.

These fuses are set to operate at currents corresponding to about seventy-five per cent. of the full-load current, while the relays operate at currents of the order corresponding to seven and a half per cent. to ten per cent. of the full-load current. These kick fuses should be short-circuited after the transformer has been switched in, as their permanent insertion would necessitate relatively coarse settings of the relays for the actual operating conditions and so decrease the sensitiveness of the protective system.

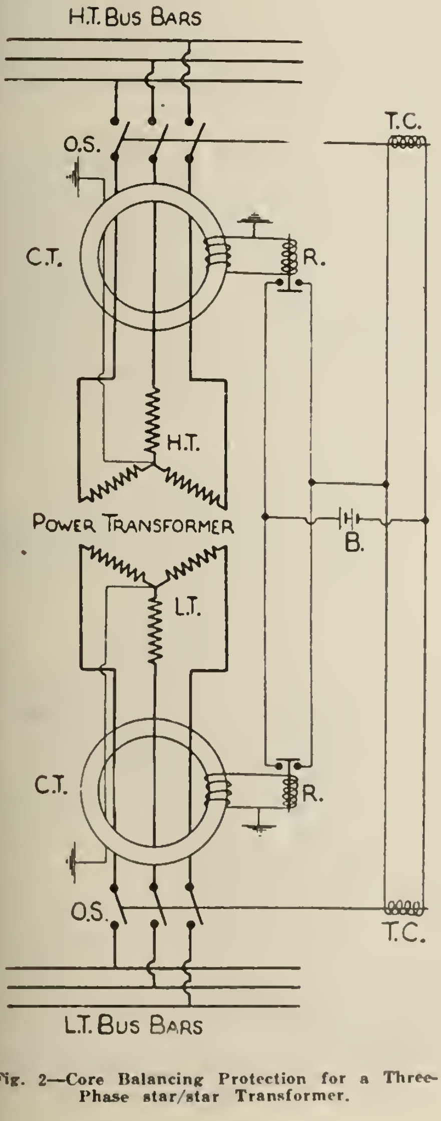


Fig. 2—Core Balancing Protection for a Three-Phase star/star Transformer.

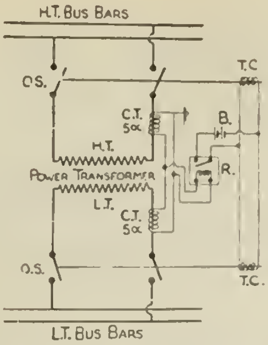


Fig. 3—Merz-Price Circulating Current Protection for a Single-Phase Transformer.

When the Merz-Price circulating current system is applied to a delta-star connected three-phase transformer the secondary connections are the same as those previously described except that the current transformer secondaries on the star-connected L.T. side of the main transformer are connected in delta in order to compensate for the phase displacement between the current in the lines on the primary and secondary sides of the main transformer.

In this case the current transformer secondaries on the L.T. side of the main transformer are designed for a secondary current of fifty-eight per cent. of that taken by the secondaries of the current transformers on the H.T. side of the main transformer, as on the L.T. side each current transformer secondary carries a delta current, while on the H.T. side the secondary of each current transformer carries a star current, and the star lines current of the two groups of current transformer secondaries must be the same.

In those cases where, due to the position of the current transformers and the run of the pilot cable, it is difficult to obtain equipotential points on the latter, balancing resistances may be inserted in series in the pilot wires between the current transformer secondaries, and equipotential points for relay connections may then be obtained at places other than midway between the current transformer secondaries, according to the location of the balancing resistances.

Self-Balancing System

The application of the Merz-Beard self-balancing system of protection to a single-phase transformer is shown in Fig. 4, and to a star/star connected three-phase transformer in Fig. 5. The principle involved is the comparison of ingoing and outgoing currents separately on each side of the main transformer. The two ends of each H.T. and L.T. phase winding are both taken through the core opening of a common protective current transformer so that, as the currents in the two leads passing through each core flow in opposite directions, there is no magnetic flux in the cores of the current transformers under normal operating conditions. If, however, an earth fault occurs in the transformer or if a breakdown between phases occurs, the current balance is destroyed and the resultant currents produce magnetic flux in the cores of one or more of the current transformers, so that a tripping current flows in the secondary circuit to energize the relays and operate the automatic oil switch.

This scheme gives a closer degree of protection than the ordinary Merz-Price circulating current system, and as there is no balancing of protective current transformers against each other, the question of ratio accuracy at heavy overloads does not arise; the current transformers can, therefore, be used over a wide range of primary currents. With this system the fault current setting of the relays is not dependent upon the actual value of the out-of-balance current for providing sufficient power to operate the relays, but it is fixed by a current difference.

The system is really an application of the split conductor system of feeder protection, and its only disadvantage lies in the fact that it is necessary to bring out both ends of all phase windings. Pilot wires between current transformers secondaries are not required, it being necessary only to interconnect the relays as shown on the diagrams.

Except for the meshing of the windings of the main power transformer the diagram in Fig. 5 is exactly the same for other combinations of three-to-three-phase (main transformer meshing that is, for delta/delta, delta/star, etc., as in all cases the ingoing and outgoing currents of each phase and on each side are directly compared with one another. The protective current transformers are designed individually to give five amps. on the secondary, and this holds good quite irrespective of the meshing of the main transformer windings.

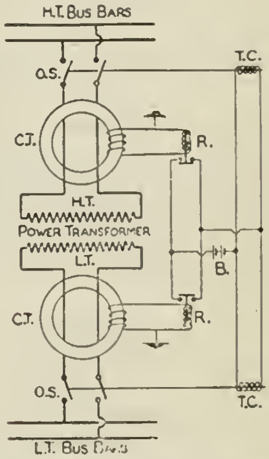


Fig. 4—Merz-Beard Self-Balancing Protection for a Single-Phase Transformer.

McColl Current System

While the Merz-Price circulating current system is inherently a sensitive protective scheme, full advantage cannot be taken of this on account of the unstable characteristics of the protective current transformers under severe overload conditions, such, for instance, as the passage of short circuit currents through healthy apparatus to remote parts of the system. In actual practice the unstable tendency may be due to a faulty choice of equipotential points and to vector unbalancing of current transformers, which becomes accentuated when the induction density in the cores reaches high values under fault conditions in other parts of the system.

As a result of these aspects the relay settings must necessarily be high, in order to ensure stability, and in practice the fault settings average about thirty per cent. or more.

A development of the circulating current system has been put forward by A. E. McColl, an English engineer, in which biased relays are employed, Fig. 6 showing the application of the system to a star/star connected three-phase transformer and Fig. 7 to a delta/star connected transformer.

The relays are of the mechanically biased beam type, one coil being traversed by the main current in the secondary system and the other coil being connected to equipotential points, one of which, in this instance, is midway along the restraining coil. If a bias corresponding to, say, a ten per cent. fault current is desired, the restraining coil would be wound with approximately ten per cent. of the number of turns in the operating coil, and under this condition the relay would definitely be held in the off position until the unbalanced currents flowing through the operating coil reach a value equal to ten per cent. of the current flowing through the restraining coil. At these values the ampere turns of the respective coils would balance one another.

With this arrangement it is possible to give a definite degree of stability under the abnormal operating conditions which should not trip the particular transformer out of commission, as ample latitude for unbalancing of the protective current transformers may be allowed. This system is operative for transformer earth faults between phases.

A further development, also due to McColl, of the biased relay circulating current protection as applied to a delta/star connected three-phase transformer is shown in Fig. 8. In this particular scheme the so-called reactive type dynamometer relay is employed having its elements shunted by a resistance. Under normal conditions the circulating current flows straight through the two coil elements of the relay and through the shunt resistance, the direction of the currents being such that the relays remain unbiased. If an earth fault occurs on one phase, the corresponding fault current in the secondary circuit will flow along the equipotential lead and through element No. 2 of the relay, and as the fault current through this local circuit increases, the main circulating current diminishes through element No. 1 of the relay, and increases through the shunt resistance.

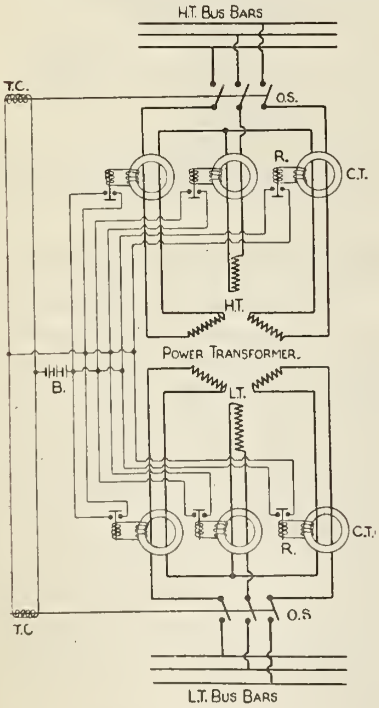


Fig. 5—Merz-Beard Self-Balancing Protection for a three-phase star/star transformer.

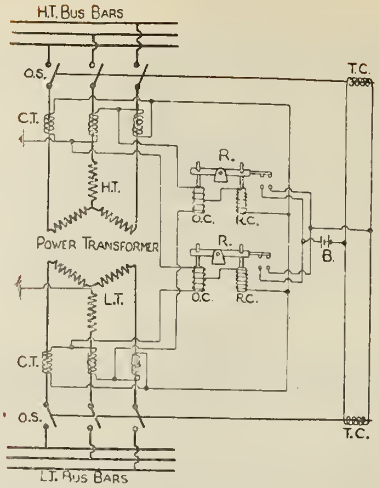


Fig. 6—McColl Circulating Current Protection using Biased Beam Relays, for a three-phase star/star transformer.

Ultimately the fault current reaches such a value that the whole of the main circulating current is forced into the shunt resistance, and no current flows in element No. 1 of the relay. Further increase of fault current causes a portion of it to flow through No. 1 element in the reverse direction and thence through the shunt resistance, reversal of current flow through one element constituting the condition necessary for operating the relay. The operation of the relay does not take place until all the main circulating current is forced into the shunt resistance, this point determining the bias of the relay.

The point at which reversal takes place through one element may be controlled by varying the ratio of the ohmic value of the relay elements and the shunt resistance. The system is similarly operative for a fault between phases of the transformer.

Faults Between Turns

Dealing next with the question of protection against the effects of faults between turns in a transformer, it can be stated that these usually occur in the H.T. windings, and, therefore, it is only necessary as a rule to instal protective gear on the H. T. side. When, however, the L.T. side of the transformer is wound for a pressure which is really a high pressure, say, 6,600 volts and above, the protection should, to be consistent, be applied to the L.T. side also. In such a case the two transformers to be protected would have to be connected in parallel. The scheme now proposed for isolating faulty transformers in the incident stages of a fault between turns is termed the midpoint protective gear. The protective gear is applied to the H. T. windings only, and for the application of the scheme it is necessary to have a second transformer or a potential transformer connected to the same H.T. busbars for the purpose of obtaining equipotential points. The protection then, of course, applies to both transformers.

The H.T. windings are provided with tappings at the midpoint of each phase, these midpoints being connected together through suitable protective current transformers, while the secondaries of the current transformers are connected to relays. Under normal conditions, the midpoints which are connected together are at the same potential, and, therefore, no currents flow in the midpoint connections. If, however, a short circuit between turns takes place in the H.T. windings of either transformer the number of turns active between the midpoint and the particular end of the phase winding concerned will be less than those normally active, and, therefore, the potential of the midpoint of the faulty phase will be different from that of the midpoint of the corresponding phase on the sound transformer. Current will, therefore, flow in the midpoint connection from the faulty phase, and the corresponding current in the secondary winding of the protective current transformer will operate the tripping relays.

This system also gives protection against faults to earth and between phases occurring in the transformer windings, but it does not protect the transformer leads unless the cables are provided each with a conducting sheath surrounding the core and insulated from the core and from the sheath for half the phase pressure. This conducting sheath should be connected to the transformer midpoints.

Location of Fault

The location of a fault between H.T. and L. T. transformer busbars is determined by methods somewhat similar to those employed for the detection of alternator faults, that is, either by megger tests or by pressure tests with a testing transformer. Usually, however, when by a process of elimination, the fault is found to be in the transformer, it will in most cases be appar-

(Turn to Page 55.)

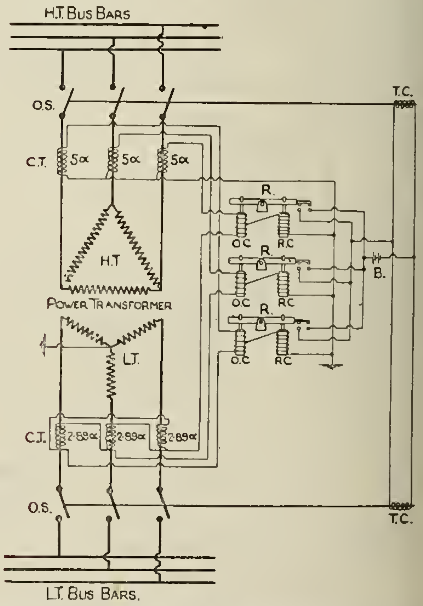


Fig. 7—McColl Circulating Current Protection of same type as Fig. 6 for a three-phase delta/star transformer.

Lubrication and Its Effect on Steam Boilers

By EDWARD L. GROSS*

The Quality of Oil Used in the Engine is Usually of Paramount Importance in the Operation of the Steam Generator or the Steam Boiler Itself

THE lubrication of steam-driven units, both of the reciprocating and steam-turbine type, has been reduced to a pretty exact science. Knowing the type of engine, load to be carried, revolutions per minute, temperature of steam, etc., the character of lubricant to be employed can be definitely determined by those versed in the art. It is not, therefore, the purpose of this article to discuss this particular phase, but to bring to your consideration the relation of the steam boiler itself to the lubrication problem.

Not only do certain phenomena occurring in the steam boiler materially affect engine lubrication, but in turn the lubricant employed in the engine itself plays an important role in the operation of the steam generator or steam boiler itself.

Exhaust Contains Oil

In studying the efficiency of the various types of steam engines, it is found that, with a very few exceptions, all of the steam that is exhausted from them contains oil that has served its useful purpose as a lubricant, and if the steam is condensed and returned as boiler feed water, considerable of this oil gets back into the boiler and is capable of doing considerable harm.

One of the advantages possessed by the steam turbine, as compared to the reciprocating type of steam engine, is that when it is operated condensing, no oil gets into the steam passages. A surface condenser can be employed in connection with the turbine and the condensate returned to the boilers practically free from lubricant, without the necessity of oil separators.

Oil in a steam engine is a mighty good thing, but oil in a steam boiler is a mighty bad thing.

Insulating Power of Oil

It has been estimated that the insulating power of a thin film of oil on the heating surface of a boiler is much more than that of a scale averaging one-sixteenth of an inch in thickness. In addition, the scale that is formed by the collecting of light floating material by the surface film of the oil and its settling on the heating surface is even worse than ordinary scale, because, in addition to causing a loss of heat, it also causes corrosion of the metal.

One would naturally infer, in view of the fact that oil is lighter than water, that it would remain on the surface, but this is not the case. As above explained, the oil comes in contact with the small particles of lime, magnesia, etc., and by sticking to them soon becomes as heavy as the water, with the result that it is carried around by the circulation, and, coming in contact with the metal, sticks to same.

This explains why the under side of the boiler tubes are just as liable to become encrusted with a mixture of encrusting salts and oil residue as the upper side.

The insulating effect of a thin film of oil on the heating surface is surprising. A recent test showed that with fire temperatures ranging from 2,190 deg. to 2,500 deg. Fahr., the temperature of metal at the bottom of an iron vessel, ½ in. thick, when the surface was clean, was 280 deg. Fahr. On mixing 5 per cent. mineral oil with the water it rose to 310 deg. Fahr., and when the bottom of the vessel had a coating of grease 3/64 in. thick, it rose to 518 deg. Fahr.

Two men with the aid of mechanical stokers can handle a boiler room that would require five men if it were hand fired. This means a marked reduction of labor costs, of course, but the saving of labor is of no greater importance than the solution of power plant labor problems by the use of mechanical stokers. The better labor conditions offered by the stoker fired plant make a strong appeal to a better class of men—men who keep their jobs and take a pride in their work. All of the distasteful boiler room duties are practically eliminated by stoker firing. The slicing of fires and cleaning of fires, are automatic functions of the mechanical stoker. Fewer men are needed; a better class of men is attracted to the plant.

Mineral oils form a coating similar in appearance to brown varnish when deposited on a boiler-plate, forming a coating which readily results in overheating of the metal and burnt and bagged sheets.

Crude Oil for Scale

It is a rather peculiar state of affairs that in spite of the fact that power plants spend a large amount of money in installing fairly efficient oil separators in the exhaust steam line, and in spite of the harmful effects of oil films on heating surfaces, engineers in certain plants still employ crude oil as a boiler scale preventive and for the purpose of stopping boiler foaming and priming.

In reference to the corrosive action of scales containing oil, it can be readily seen that the oil could only be chemically active insofar as its compounding was concerned, as the average cylinder oil contains between 2 and 10 per cent. of organic compound. Under the high temperature prevalent in steam boiler practice, these animal and vegetable oils are decomposed with resultant formation of organic acid, with consequent pitting and corrosion of the plate.

It would appear to the writer, therefore, that in compounding oils some consideration should be given as to whether or not the engine in which they are to be employed runs condensing or not, and if the former is the case the oil should be prescribed, other things taken into consideration, with the minimum compounding.

Terms Often Confused

The effect of oil in a boiler and the effect of the boiler on the oil in the engine is intimately related to that common trouble known to engineers as foaming and priming, and which terms are very often confused.

Foaming consists of the steam bubbles building up upon the surface of the water instead of breaking and releasing steam. It only becomes serious when the bubbles form so rapidly and hang together long enough to reach the point where the steam is supposed to be taken off, when a sort of syphoning action takes place and a large amount of water is carried over entrained with the steam.

Priming, on the other hand, is due to a sudden evolution of steam from the heating surface, very similar to the so-called "bumping" which takes place in laboratory apparatus during distillation, and is due either to poor design of boiler, on a sudden demand for steam.

In some instances it is caused in boilers where the heating surface is covered with a heavy scale coating due to a sudden release of the incrustation from the metal, with the result that the water strikes the overheated surface with an extremely rapid generation of steam. The result is the same, namely, a carrying over of large amounts of water.

Priming is altogether different from foaming, and can be, to a considerable extent, controlled mechanically.

While the causes producing foaming have not as yet been at all definitely

---

*Vice-president, the Perolin-Company.

Files Stokers

Hand Operated

Canada Faces a Fuel Shortage

Consider What Files Stokers Mean to You Under Such Conditions

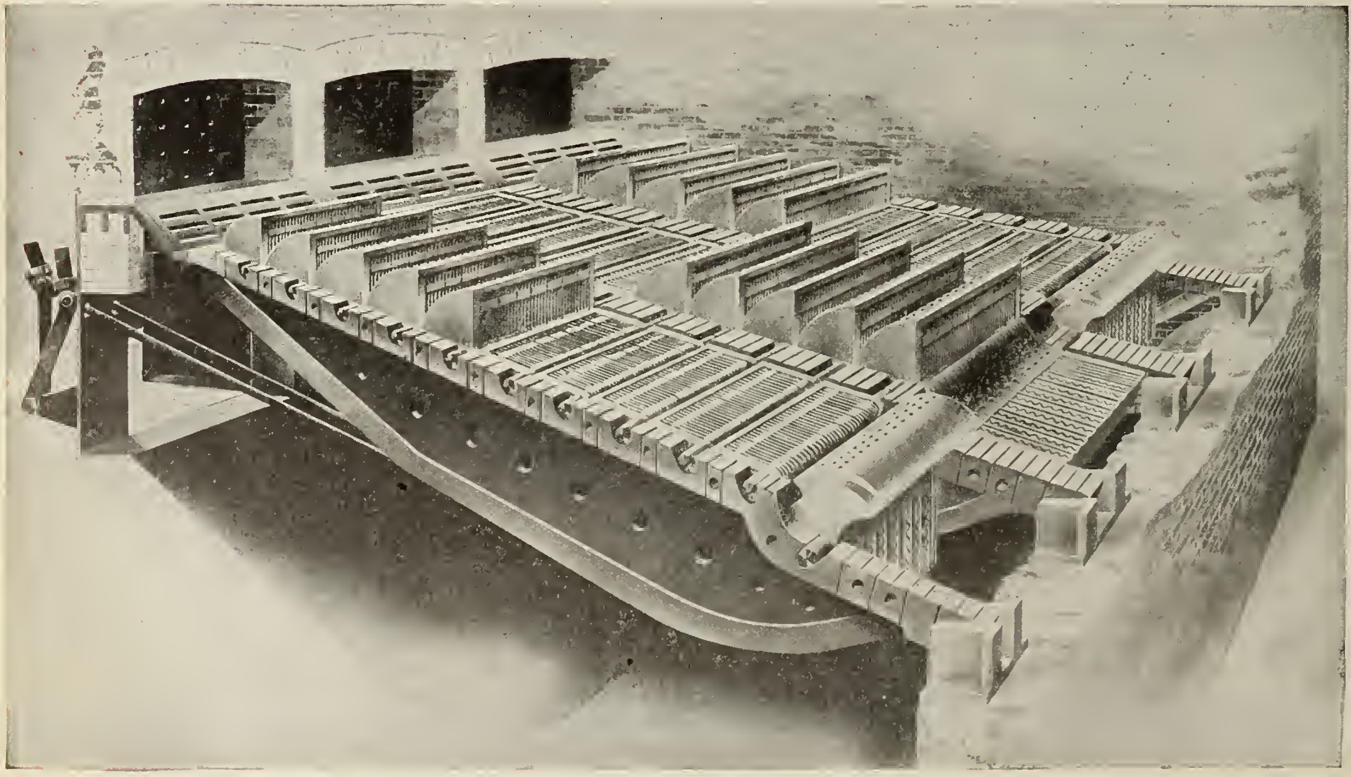
CANADA is face to face with a serious fuel shortage. This situation is not new and you know how it affects your plant. How to meet this fuel shortage is the problem that vitally concerns you. You should strive to make the most out of conditions prevailing to-day, and which will continue to prevail for some time to come.

USE FILES HAND OPERATED STOKERS. THEY PROVIDE FOR MORE EFFICIENT BURNING OF FUEL

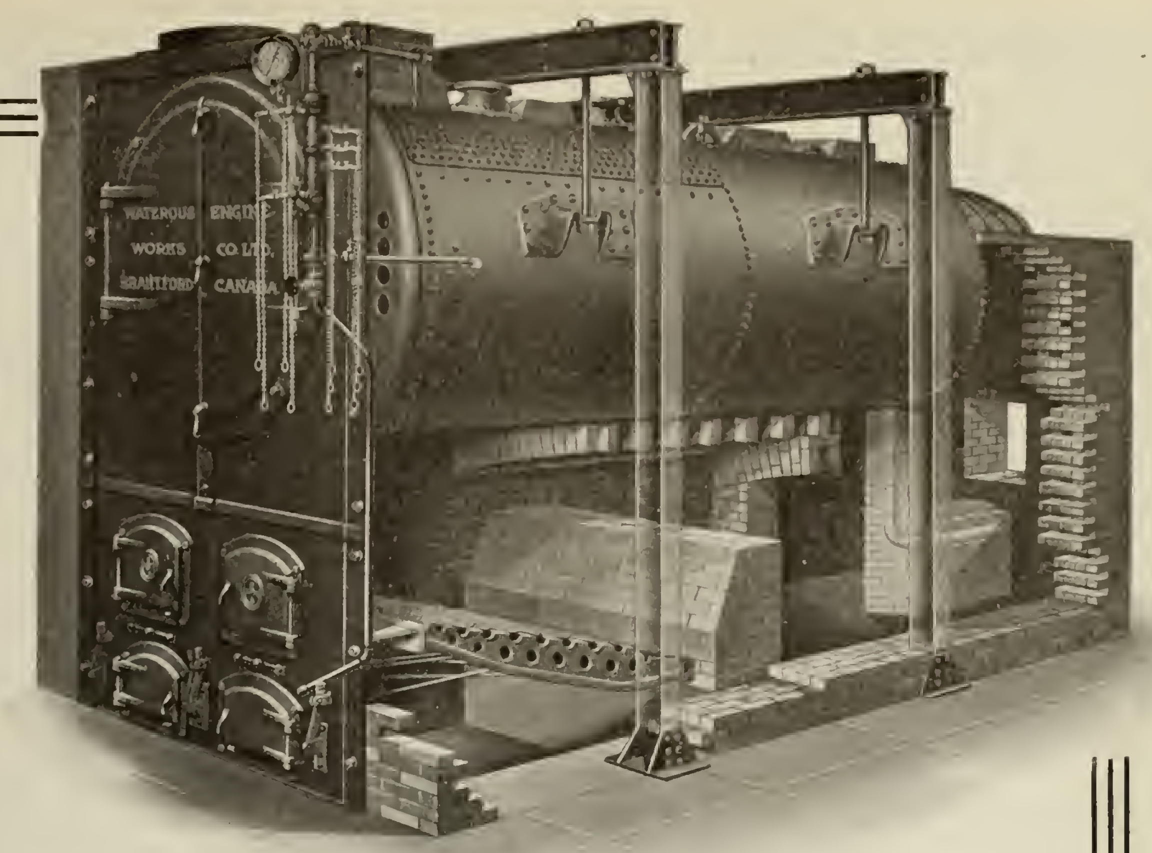
Boilers rating as high as 200 per cent. can, as a matter of fact, be carried on Files Stokers with natural draft.

Furthermore Files Stokers insure clean fires without the necessity of slicing or poking through the open fire-doors. To sift the ashes, clean the fires, break all clinkers and dump refuse into the pit, you only have to move convenient levers mounted on the boiler front.

Files Stokers save fuel and labor all the year 'round—under any conditions—fuel shortage or not. Investigate their possibilities in your plant.



Files
Stoker
Under
Waterous
Boiler



Boilers Do Not Smoke!

WHEN you hear anyone say, "the boiler is smoking," this is not really what is meant. The expression is erroneous. Certainly, boilers do not smoke. It's the fire that smokes. What causes the fire to smoke? That's the question. In most cases smoking fires are caused by improper boiler setting.

Are your boilers properly set? It requires an expert to tell. We are ready to furnish the expert. No, we do not set boilers, but our engineering staff knows how a boiler should be set to operate to the best advantage. Our engineering staff is at your service.

May We Serve You?

Waterous
BRANTFORD, ONTARIO, CANADA

established, still it is a fact that large amounts of suspended matter in the boiler water and the presence of oil are sources of trouble in this respect. One of the most active salts producing foaming, however, is sodium carbonate, commonly known as soda ash, and which is employed in many power plants either in water-softening apparatus, or in boilers themselves for the purpose of removing and preventing scale formation.

Foaming and priming of steam boilers are directly related to the lubrication of the steam engine itself. As above explained, when these two phenomena or either one occurs, large quantities of water are carried over with the steam. Boiler water runs fairly high in salts, such as calcium and magnesium carbonates and sulphates, which naturally are carried over with the water. Due to their sandy or gritty nature, they naturally seriously interfere with lubrication of the engine cylinders.

These salts tend to combine with the organic constituent of the lubricant, forming insoluble soap, which greatly interferes with the efficient working of the lubricant itself, and results in the familiar sticking or groaning taking place in steam engines when foaming or priming of the boilers occurs.

When soda ash is employed in the boiler, quantities of this are also carried over with the steam, intensifying the harmful action of the salts themselves and cutting off from the rubbing surfaces the entire oil film, with the result that the piston may freeze or stick in place, with consequent serious damage to the engine.

In turbine practice oil is always contaminated with water, which leaks through the packing glands. In cases of serious breakdowns of turbine lubrication, examination of the emulsified oil has shown the presence of these salts carried over with the boiler water.

Many of the boiler compounds or chemical treatments employed in boilers for reducing the amount of scale forming on the heating surface run rather high in soda ash, and in many cases in caustic soda, an effective ingredient in causing a quick removal of oil film.

Foaming Easy to Stop

Foaming of boilers can be alleviated or prevented by various methods, and in particular by the use of an efficient anti-foaming compound which can be prescribed after intelligent study of conditions. It is not the purpose of this paper, however, to go into methods for overcoming this difficulty, or the protection of the engine from sudden carrying over of water.

To sum up briefly, therefore, in prescribing lubricants for steam-engine practice, some consideration should be given to the fact that quantities of the oil are apt to get back into the boiler with the condensate, and an oil prescribed which will prove to be the least harmful under these conditions.

Provision should be made in those plants where condensate is employed to see that efficient oil separators are installed in the lines to remove as much of the oil as possible, previous to the entrance of the condensate into the boiler.

Avoid Excess Lubrication

In those plants where foaming and priming are prevalent, careful investigation should be made by an expert to determine the causes thereof and to prescribe an effective remedy for preventing, or at least alleviating, this trouble. Where foaming and priming are due to improper boiler design or to extremely sudden demands for steam, a protective arrangement should be inserted in the steam line to protect the engine and turbine against interruption of efficient lubrication or possible complete wreckage of the engine or turbine.

The amount of lubricant for each individual engine which will give the most efficient working should be noted, and provision made to avoid excess lubrication or flooding of the engine, with consequent introduction of a large amount of oil into the steam boiler with the harmful results above noted.

Trade Catalogs

The Under-Feed Stoker Co. of Canada have recently published two bulletins, one illustrating the Arrowood system of pulverized fuel burning, the other the lateral retort under-feed stoker.

The Arrowood or "Multi-Mix" method of burning pulverized coal was developed by the Ground Coal Engineering Corp. A rotating screw delivers the pulverized coal to a space inside the perforated screen of a mixing drum. About 25 per cent. of the total air required for combustion is blown into the coal directly as it is whipped off by the screw, then the coal and the air pass through small orifices in the screen. The wire drawing is claimed to diffuse the particles uniformly in the air. These jets impinge against the outer shell setting up a mass of eddy currents. The jets of air and coal then pass into the main mixing part of the burner, where the remaining 75 per cent. of the air required for combustion is admitted. The air and the pulverized coal again pass through a series of orifices.

The mixing device is claimed to so thoroughly mix the air and the fuel that no excess air need be used. Other advantages claimed for the burner are low velocity of the air and the fuel entering the furnace, resulting in sufficient time for complete combustion and longer life for the boiler brick work.

The Jones "Lateral Retort" under-feed stoker was designed to meet the demand for a multiple retort, side cleaning under-feed stoker.

The stoker consists essentially of two multiple retort stokers placed back to back in such a manner that there is one main retort extending from the front wall to the bridge wall with the lateral retorts branching off this central retort at right angles. Coal from the main retort is forced into each lateral retort by means of lateral pusher blocks, operated by an auxiliary steam cylinder, independent of the main steam cylinder that operates the fuel ram feeding the coal into the main retort.

The advantages claimed for the lateral retort stokers are:—proper coal and air distribution, high efficiency combined with ability to carry heavy overloads, automatic control of the fuel and the air for combustion, agitation of the fuel bed, ease of repair when necessary, the use of plate tuyere blocks, and side cleaning, combining the simplicity of the single retort stoker with the flexibility of the multiple retort.

* * * *

The Bristol Co., Waterbury, Conn., have issued a bulletin No. 317 describing recording and indicating tachometers. The tachometers are for use wherever it is desired to know the speed of revolving shafting or machinery such as turbines, engines, line shafts, fans, etc.

The pneumatic instruments are made in the recording models only with records traced by ink.

The electric tachometers are furnished in both indicating and recording types. A magneto is belted to the machine or the shaft whose speed is being taken, wires connect the magneto with the instrument, allowing the instrument to be mounted at a convenient place. The round chart models use a direct marking smoked chart system for records, the advantage claimed being that friction is reduced to a minimum, resulting in a sensitive instrument. Where continuous records for a longer time than 24 hours are required the strip chart electric recording tachometer is used. Records are made in ink.

* * * *

The Brown Instrument Co., Philadelphia, distributed a pamphlet at the Chemical Show describing a new electric CO_2 recorder. The instrument works on the principle of the difference in thermal conductivity of various gases.

A Wheatstone bridge is the means used for comparing the thermal conductivity of the gas under test with that of another gas adopted as the standard of comparison. In practice one cell is filled with air and sealed for the comparison standard. The other cell is exposed to a flow of the gas under test. Since the thermal conductivity of CO_2 differs from that of air by approximately 40 per cent., it is possible to calibrate the equipment in terms of CO_2 percentage. Other constituents of flue gas such as carbon monoxide, nitrogen and oxygen have practically the same thermal conductivity as air.

The pamphlet contains several drawings showing the principles of operation and the method of installation.

Brown CO_2 recorders are made in indicating, recording and continuous recording types as well as a combination of CO_2 recorder and flue gas pyrometer.

Savings in Proper Control of Power Production

By CHARLES L. HUBBARD*

Greater Flexibility and Important Gains, Both in Economy and Capacity, May Often be Attained by Means of Comparatively Small Changes in the Boiler Room

MOST manufacturers have been giving their whole attention to the economical production of some special line of goods. They have been able, through long experience, to foresee future possibilities for enlarging the business; the improved processes necessary for securing desired results; the difficulties involved and the best methods for overcoming them.

Plants have been designed and equipped with special reference to production problems, improvements in processes, and reduction in labor costs. Those in charge have not hesitated to provide the best in the way of machinery, both for the handling of material and the manufacture of the finished product.

All work has been so managed as to reduce manual labor to a minimum, and wastes in material have been eliminated to the greatest possible extent.

Inferior Equipment

In view of this, it may seem strange that in most cases the power plant is far inferior to the main plant in matters of equipment and efficiency of operation, although it really should be considered as an independent manufacturing plant, whose output consists of power, heat, and light, all of which are of equal importance with the products of the main plant. Under the usual operating conditions the power department sells its output to the factory, so that the company operating the entire establishment benefits from both the selling and buying ends of the contract.

The typical power station, in most cases, is simply a factory for the manufacture of electric energy, and if steam-driven, can only utilize 15 per cent. to 20 per cent. of the heat contained in the coal burned under the boilers, the remainder disappearing mainly in the water discharged from the condensers.

Utilize Exhaust

In this respect, the industrial power plant has a great advantage over the central station, as a large proportion of the heat contained in the exhaust steam can be utilized for purposes which otherwise would require the burning of additional fuel.

Among the most important of these is warming the buildings, a requirement which continues from six to eight months in the central and northern sections of the country. In many plants large quantities of steam are required for process work throughout the year, and low-pressure exhaust may be made to fulfil this purpose in most cases.

In view of the fact that water powers are being rapidly constructed in many parts of the country, and that the conditions just described apply only to steam-driven plants, it might seem, at first thought, that the development of an efficient private plant was of secondary importance, as it might, at any time, prove more advantageous to purchase power from one of the central stations than to generate it upon the premises.

Outweighs Savings

While this might be true in certain cases, it is stated upon the highest authority that the cost of power generated by the average hydraulic plant will fall but little, if any, below that produced by steam, due to their greater cost of development and consequent high overhead charges, which balance, or overbalance, the saving in cost of fuel.

Charles L. Hubbard graduated from New Hampshire State College, a Bachelor of Science in Mechanical Engineering. He received his Mechanical Engineer's degree at Cornell after a year of post-graduate work in steam engineering. For some years he was connected with Brown and Sharpe Manufacturing Company and Holly Engineering Company, where he was engaged in the design and development of a new line of steam specialties. Then for twelve years he worked with Professor S. Homer Woodbridge of Massachusetts Institute of Technology as an engineer in charge of design and installation of heating and ventilating systems. The last few years he has been engaged in private consulting work in Canada and the United States.

This brings us back again to the statement previously made, that where steam is required for heating and process work, as well as for the generation of power, the privately operated plant may, in general, be run at a higher over-all efficiency than the largest and most up-to-date central station.

When put on this basis, the plant executive and the operating engineer should realize the importance of this part of the establishment, and the possibilities of increasing dividends by putting it in the very best condition possible. In order to do this effectively it will be necessary to get back to first principles, both as regards the equipment involved, its arrangement and operation.

The series of articles, of which this is the first, will take up the more important pieces of power-plant equipment and describe briefly the fundamental principles of construction and operation.

Different types will be considered, and attention drawn to points which should be noted in making a selection for any given set of conditions. The arrangement of apparatus in the plant, with reference to other pieces of equipment, will be discussed; and later, important matters bearing upon efficient operation.

While the average engineer or purchasing agent is more or less familiar with the principles and general construction of power-plant equipment, it will not be a waste of time to go over these matters and freshen up one's memory before taking up the more practical problems of selection, arrangement and operation.

Steam Plant Complex

While oil engines and hydraulic turbines will be considered in the series, the greater part will be devoted to the steam plant, because it is the most common and also the most complex.

The subject of steam itself will bear considerable study and will be taken up in a following article. The phenomenon of evaporation is important in boiler construction and operation, while the basic principle of the engine and turbine is that of changing a portion of the contained heat into useful work.

The condensation of steam and the giving up of its latent heat is applied to practical purposes such as in the warming of buildings and in various manufacturing processes.

A knowledge of the various properties of steam, as regards the quantity of unevaporated moisture which it contains, the degree of superheat, and so on, is important in order to secure the highest efficiency from engines and turbines, and also to guard against injury to these machines in its use.

Two Common Terms

Pressure and vacuum are common terms and well understood, but with the increase in both, in power-plant practice within recent years, it may be well to consider certain practical matters in connection with their application to boilers, engines, turbines, and condensers.

Following steam, we shall take up the subject of prime movers, which will include steam engines and turbines, oil and gas engines, and hydraulic turbines.

The economical transformation of heat into work by means of the conveying medium, steam, has brought about many changes in engine and turbine construction which should be well understood in making a selection for a given plant. It should be borne in mind, however, that conditions in the industrial plant are different from those where the economical generation of power is the sole object, and in certain cases an engine with a high steam consumption will give the more satisfactory results when both the power and heat requirements are taken into consideration.

---

*Consulting Engineer on Power House Problems. Reprinted in Canada by special permission from Factory, the Magazine of Management.

With automatic mechanical stokers it is often possible to use a cheaper grade of fuel, yet one which contains practically the same quantity of heat per pound. Fuels of this kind are uneconomical under hand stoking, due to the difficulty in handling, clinkering, and the large bulk of ash to be cared for.

When coal is stored in large quantities, care must be taken in piling it to reduce to a minimum the chances of spontaneous combustion.

Can Utilize Exhaust

For example, where all, or a large proportion, of the exhaust can be utilized throughout the year, a simple, slide-valve engine with a high water-rate will answer all purposes at a low first cost. In this case it simply acts as a pressure reducing valve for the heating system, and produces power at the same time at a small additional expense.

As the proportion of exhaust steam which can be utilized during the year becomes less, the importance of steam economy becomes greater, and a more efficient type of engine should be considered. Here power is the main product and low-pressure steam the by-product. Under these conditions, a Corliss or Uniflow engine would prove more desirable, and compounding might be considered as a means of reducing the water-rate still further.

The steam economy of the turbines of medium size does not vary materially from that of the reciprocating engine, when operated under the same conditions, and other details are usually the deciding factors between the two machines, such as space required, size and weight of foundations, and so on.

A Bleeder Turbine

When large quantities of low-pressure steam are required, and it is desired to keep the fuel expenditure as low as possible throughout the year, a bleeder turbine may be employed, and steam withdrawn from the intermediate stages whenever desired and in such quantities as may be necessary. As this machine is run condensing at all times, it operates at a good efficiency from the power standpoint and also serves as a reducing valve for the low-pressure steam required for heating and process work.

The power output from a plant using a non-condensing engine may be practically doubled without the installation of additional boilers by turning the exhaust steam into a low-pressure turbine connected with a condenser.

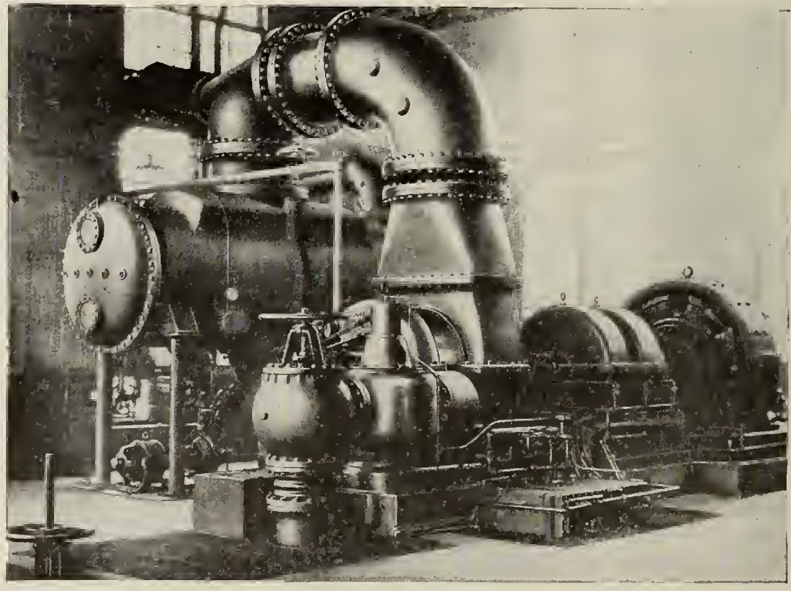
These are simple illustrations of how the economy of a plant may be increased when the requirements of the different prime movers, and the principles upon which they operate, are clearly understood.

Wasting Exhaust Steam

There are other cases where exhaust steam is produced in large quantities and where practically no requirements exist for heating and process work, as in forge shops, and so on. Here the exhaust from hammers and presses may be used to advantage either in low-pressure or mixed-pressure turbines, and the quantity may be still further increased by utilizing the hot gases from the furnaces which would otherwise be wasted. These gases may be passed through specially constructed heaters or boilers and the steam thus generated turned into the exhaust line from the hammers.

For low-pressure work of this kind, water for condensing purposes must be available at low cost in order to make the arrangement an economical one.

Waste heat from steel mills and free cement kilns has been used very successfully, and special boilers for this purpose

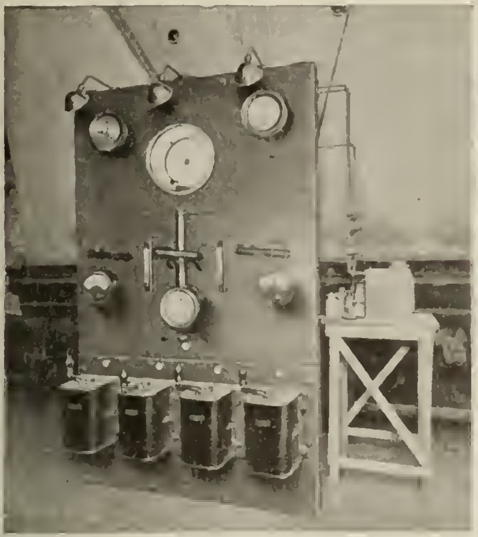


The power output from a plant using a non-condensing engine may be practically doubled without the installation of additional boilers by turning exhaust steam into a low-pressure turbine connected with a condenser.

will undoubtedly come into use much more extensively with the increasing cost of fuel.

All Needs Understood

Power and heat should always be considered together in the design of any industrial power plant, and a detailed study of all the existing conditions should first be made in each case. In this investigation the whole manufacturing plant must be included, the processes examined and the needs of all departments understood before deciding upon the power of boilers and prime movers, and the best types to be used.



No power or heating plant can be operated at its highest efficiency without indicating and recording instruments which tell just what is going on in different parts of the system.

For low-pressure work such as in the case of a low-pressure turbine, water for condensing purposes must be available at low cost in order to make the arrangement an economical one. Where the supply of condensing water is limited, the water is cooled by spraying. The sprays are mounted over and discharge into a small pond, thence the cooled water is re-used.

An important detail in this connection, which is sometimes overlooked, is the varying relation between power and heating requirements at different seasons of the year.

In planning any arrangement of equipment, the entire calendar year must be taken into consideration, and provision made for operating the prime movers more economically as the use for exhaust steam diminishes.

In some cases, satisfactory results are obtained by providing an auxiliary condensing outfit for use during the non-heating season, say from the first of May to the first of October.

Best Economy in Fall

This, however, will fall short of producing the best economy in the late spring and early fall, when the relation between power and heating requirements is gradually changing. Methods of overcoming this, and automatically maintaining a true balance between the two throughout the entire year will be described in a later article.

Going on to the boiler plant, there is great flexibility, and important gains may often be made, both in economy and capacity, by means of comparatively small changes. An illustration of this is the installation of stokers for burning a cheaper grade of fuel, but one which contains practically the same quantity of heat per pound. Fuels of this kind usually require a forced draft and are uneconomical under hand stoking due to several difficulties—among them, handling, clinkering, and the large bulk of ash to be cared for.

Another important matter to which attention may be called, is that of reconstructing the furnaces for higher rates of combustion, thus increasing the boiler capacity from 50 per cent. to 100 per cent. for continuous operation and still more for temporary peak loads.

In making changes of this kind it is very important that the principles of boiler construction and operation be clearly understood, as it can only be done safely and economically under certain specific conditions.

A practice often carried on in the building up of a power plant to meet increasing requirements, is that of purchasing new pieces of equipment upon their own merit, without due regard to the plant as a whole. While these devices may do their own particular work in a satisfactory manner, they may not be the type best adapted to the conditions existing in the given plant. A good machine in the wrong place is no better than a poor one, and in many cases it may result in actual loss.

In other cases, an expensive piece of equipment may be installed for producing a small saving which is more than offset by the fixed charges upon its cost and upkeep, while some other machine included in the plant is being operated with a waste which might easily be eliminated by simple adjustments or by the substitution of a type better adapted to the existing conditions.

Questions of Labor

The questions of labor and of the uncertainty of a continuous coal supply naturally suggest the installation of coal and ash-handling equipment, and improved facilities for the storage of large quantities of fuel.

Here, as in the power house, the engineer and the owner should be familiar with certain practical matters bearing upon installations of this kind in order to secure the most satisfactory results.

If coal is stored in large quantities, care must be taken in piling it to reduce to a minimum the chances of spontaneous combustion and provision made for detecting overheating before fire actually breaks out. All of these matters will be treated in detail in future articles, as well as the selection of fuels for different operating conditions.

To Remove Soot

Accumulations of soot and ashes on one side of the plates and tubes and scale on the other, not only shorten the life of the boiler but retard heat transmission and cause waste of fuel. In order to avoid this loss, soot blowers must be provided and the feed water purified before delivery to the boilers, both of which call for practical information on the part of those in charge.

No power and heating plant can be operated at its highest efficiency without indicating and recording instruments which tell just what is going on in different parts of the system. Steam flow meters show at once when one of the units in the boiler plant fails to do its share of the work, and CO_2 indicators and recorders enable the fireman to handle his furnaces to the best advantage and the engineer to know just what is being done in this regard at all times, thus tending to insure the best methods of hand firing and the proper adjustment of mechanical stokers.

Water meters serve as a check on wastes through leaks or carelessness and give results which are useful in checking up with the steam production. Heat wasted up the chimney is indicated by means of a pyrometer, and the strength of draft by devices constructed for this particular purpose.

Recording instruments are essential to the efficient operation of any power plant and are of great assistance in the detection of wastes of various kinds.

Enough has been said to show the importance of the power plant in its relation to the main factory, and future articles will give practical suggestions and information which should be of assistance in planning new work and improving conditions in inefficient plants already installed.

Choosing the Proper Type of Electric Motor

By C. N. JOHNSON*

Study of Intended Application Must be Made by the Engineer Before Open, Semi-Enclosed, or Enclosed Units Are Selected For the Job on Hand

FROM the standpoint of ventilation, motors may be classified as open, semi-closed, totally enclosed, and enclosed ventilated. The first is the standard motor with which we are familiar. Semi-enclosing covers are sometimes added to give mechanical protection to the motor winding, to keep out all but fine dirt or other matter and to protect operatives from possible injury where the motor is located on the machine near the floor. The totally enclosed and enclosed ventilated motors serve two main purposes. Where dust, fumes or moisture, injurious to the windings is present, the enclosing feature protects the motor.

Where gases, dust or other inflammable material are present, any fire in the motor generally will be confined to the motor, except in case of a self-ventilated motor where the air discharges directly into the room.

A study of the design, installation, and general reasons for using enclosed motors brings up a number of interesting considerations. In the design we must keep within certain prescribed limits of construction and the installation of enclosed ventilated motors must be made in such a manner that the motor may function properly within the limits for which it was designed. In the application of these more expensive types of motors, we must see that common sense is applied rather than hasty judgment.

Determine Limiting Rating

The limiting rating of any motor is determined by the amount of heat which can be dissipated from the motor and still maintain all parts at a given specified temperature. In the open motor, air circulates over the windings and iron parts and helps to dissipate the heat from these parts.

Where no ventilation is provided, the enclosed motor must depend entirely for cooling on the heat dissipated by radiation and convection from the external surface of the motor. It has been found that from 2 to 2.5 square inches of motor surface are required for each watt loss in the motor to maintain a temperature rise of 55 degrees Cent. for continuous service. The heat to be dissipated is of course a function of the efficiency of the motor and the motor rating.

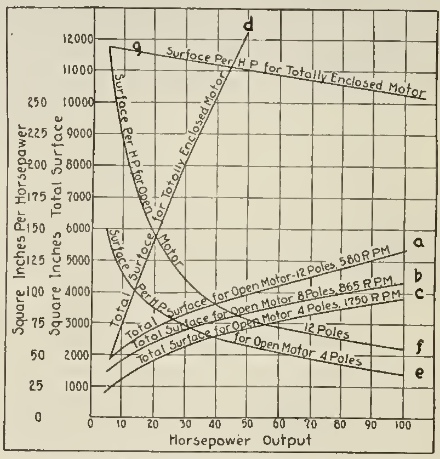
For the smaller motor ratings the external surface of the frame is comparatively large and little change is made in the rating by making the motor totally enclosed. The surface per horsepower decreases rapidly with increase in motor rating so that there is a point beyond which it is not economical to go in totally enclosed motors.

Curves Show Difference

The curves in the accompanying chart show graphically the relation between available surface for dissipating heat in open and enclosed type motors for different motor ratings. Curves *a*, *b*, and *c* show the external surface of standard open motors for different speeds and horsepower. It will be noted that the external surface for a given horsepower rating is considerably larger on a twelve-pole motor at 580 revolutions per minute than it is on the four pole motor at 1,750 revolutions per minute. The slow speed motor, therefore, lends itself more readily to enclosing.

Curve *d* shows the external surface required for totally enclosed motors for practically all speeds.

By a comparison of the curves for the open and totally enclosed motors it can be seen readily that the total surface required for enclosed motors rises so rapidly that beyond a certain rating it is not desirable or economical to build the enclosed motor. To afford a better means of determining the cause of the diversion of the above curves, curves *e*, *f*, and *g* are given to show the square inches of surface per horsepower for different ratings. Curve *g* for the totally enclosed motor would be parallel to the lower axis, except for the slight increase in efficiency as the horsepower increases. Curves *e* and *f* for the open motor fall off rapidly as the horsepower increases.



CURVES SHOWING GRAPHICALLY THE RELATIONSHIP BETWEEN AVAILABLE SURFACE FOR DISSIPATING HEAT IN OPEN AND ENCLOSED MOTORS FOR DIFFERENT RATINGS

Increasing Surface

It is possible to reduce the physical size of the totally enclosed motor by increasing its heat dissipating surface by the aid of numerous projections or ribs on the frame and brackets. Such a special frame would greatly increase the cost of manufacture and would tend to make the motor awkward for handling.

The field of the totally enclosed motor therefore, is limited to the smaller ratings, preferably below 25 horsepower.

When the enclosed feature is required on the larger ratings it is necessary to go to the ventilated type of motor. This motor is completely enclosed with the exception of an air inlet and outlet arranged for pipe attachments. Clean air is piped from an available source to the inlet of the motor, passed through the motor and exhausted into the outlet pipe which carries it again to the outside atmosphere.

In the self-ventilated type of enclosed motor the air is passed through the motor and piping by means of a blower mounted within the motor on the revolving member. In the forced-ventilated type the air is passed through the motor and piping by means of an external blower driven either by a separate motor or mechanically from the motor itself.

The ventilated type of motor when supplied with the proper amount of air affords the same conditions for taking care of the losses in the motor as obtained in the open type, so that the same size motor frame can be used as for the open motor.

It is of particular importance to see that the air supplied is pure and volume is maintained to keep the proper motor temperature. This means that the ventilating system must be considered as a vital unit of the power equipment.

Care in Piping of Air

Careful consideration must be given to piping of the air to and from the motor. The blower and piping should be of ample size. The volume of air required and the friction loss in the motor may be obtained from the motor builder.

It is advantageous to furnish the motor manufacturer with as complete data as possible as to the conditions under which the motor is to be used, an idea of the distance which air will have to be piped; information as to the temperature of the air surrounding the motor, as well as temperature of the incoming air. Often it is possible to ventilate several motors in an installation from one source of air supply.

As an example of the power required to supply ventilating air, it will be of interest to note that in tests on a 100-horsepower motor 170 watts was required to drive the blower supplying the ventilating air, which is about 0.25 per cent. of output of the motor. This will be increased where air has to be brought any considerable distance through pipes.

Limitations in Use

The writer wishes to call particular attention to the self-ventilated motor and the limitations of its use. Here the comparative ratings of the self-ventilating motor to the open motor, on a given frame, will depend entirely on the amount of air which the blowers provided on the motor will handle through the necessary piping. The space inside the motor for mounting the blower is limited.

---

*The author is associated with the General Engineering Department, Westinghouse Electric & Mfg. Co.

The higher the speed of the motor the more will be the capacity of the internal blower. Good engineering practice limits the use of motors for self-ventilation to speeds above 700 revolutions per minute so located that the total length of piping for inlets and outlets combined shall not be more than 25 feet and these pipes to be of sufficient size that the air velocity in the inlet pipe will not exceed 1,000 feet per minute.

From the foregoing it will be seen that the manufacture and installation of enclosed motors, both totally enclosed and enclosed ventilated present no serious problem.

Cost Is Higher

The important problem is the solution of the question as to when the use of the enclosed motor is justified. Naturally the cost of the enclosed motor is higher per horsepower than the open motor.

For the totally enclosed motor the physical size increases rapidly and we would expect the cost of the motor to follow closely with the physical dimensions. The totally enclosed motor can be installed as readily as the open motor and the only additional point to be remembered in this connection is the fact that the totally enclosed motor is special and is not ordinarily carried in stock so that longer shipments are required.

The totally enclosed motor is not interchangeable physically with the same rating open motor and this must also be taken into account on individually driven equipment.

The enclosed motor for forced ventilating will have a first cost of from 5 to 10 per cent. above the cost of the same rating open motor. The cost of the self-ventilated motor will depend entirely upon the conditions of application.

Blower Equipment

In the cost of the forced-ventilated enclosed motor there must be considered the cost of the blower equipment and the piping for carrying the air to and from the motor. It must be remembered also that this additional blower and piping equipment must be kept up as a part of the power system and charged to power maintenance.

The installation of the necessary piping brings in further considerations which must be kept in mind. Where cold outside air is brought through the pipes into the room, moisture will collect on the air pipes. This is often taken care of by controlling the temperature of the incoming air in some manner. Often the space into which the motor equipment is placed is limited and there is no convenient place for installing the air piping.

It has been found advantageous in most industries to divide the power supply into smaller electrical units replacing the larger sizes of former years. This has resulted in the general use of motors on individual machines, all of which has been economically advantageous to the various industries.

We must be careful, therefore, in any changes which we make in the motor equipment, that we do not unnecessarily increase the cost of installation and maintenance of these small motor units to the point that we lose the advantage which they have given us.

Protection of Motor

In the case of squirrel cage induction motors where protection of the motor is contemplated in the presence of inflammable dust or other material we should not pass hasty judgment that enclosing is the only solution of the protection problem.

With proper supervision and cleaning the squirrel cage induction motor could hardly be classed as a fire risk in most applications; for example, in woodworking plants.

A striking illustration of the change in attitude of those interested in the operation of motor drives in a large industry is that in the textile industry. When it was first suggested that individual motors be located on the various machines in the cotton mills, there was considerable agitation looking toward the total enclosing of these motors.

This was due to the possibility of setting fire to the lint from the cotton which gathered on all of the machines, and which would constitute a fire risk. The motor manufacturer contended that with proper attention, making sure that bearings were kept in proper shape and that material was not allowed to accumulate unnecessarily around the motors, there was no appreciable danger from fire.

The education of the mill men to this viewpoint has proven the manufacturer's contention and the agitation for enclosed motors has disappeared entirely.

C. A. S. E. Notes

F. S. Rutherford, honorary chairman, educational committee, C. A. S. E., in an appeal to members, asks all stationary engineers to avail themselves of the opportunities the organization offers for increasing their knowledge of engineering matters.

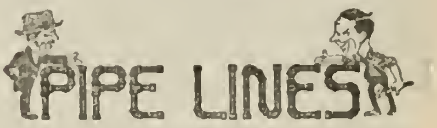
"The time is now ripe," says Mr. Rutherford, "for the local educational committee to launch a program which will induce every member of the organization to take some further training which will increase his effectiveness as an engineer.

"In many towns and cities throughout the province evening classes have been established, maintained by public funds, for the purpose of assisting employed adults to secure further training in their chosen callings. Many places have regular classes for preparing men for examinations of the Board of Stationary and Hoisting Engineers."

In towns and cities where these classes are not being conducted, Mr. Rutherford urges the local C. A. S. E. to secure the names of those desirous of taking the training, and to submit the names to the principal of the school, requesting the starting of evening classes.

Where no evening classes are being held, the C. A. S. E. should conduct the educational program, giving some time to mathematics.

A definite plan should be adopted for the coming winter months, and as many as possible should avail themselves of every opportunity through the evening classes in the technical schools, the C. A. S. E., or other suitable classes.



PIPE LINES

UNCOVERED IN ANY OLD SPOT

The power factor is always less than one except when the current is in phase with the electromotive force. Under this condition the kilovolt-amperes and the kilowatts are equal; such a condition is referred to as unity power factor.

* * *

Lives of great men oft remind us
What a lot we owe our wives;
Little women get behind us
And make something of our lives.

* * *

The effect of induction on an alternating-current circuit is to cause the current to lag behind the electromotive force, while the effect of capacity is to cause the current to lead the electromotive force.

* * *

A fireman in far off Pawtucket,
Kept all his cash in a bucket;
His daughter Nan
Ran away with a man—
As for the cash—Nantucket.

* * *

A voltmeter or ammeter when connected in an alternating-current circuit reads the mean effective value of the voltage or the current, and not the maximum value.

* * *

There was a young man from Y——,
Whose dad made his money on P——,
He went to B. C.
Got married, by gee,
And now they're expecting the St——.

* * *

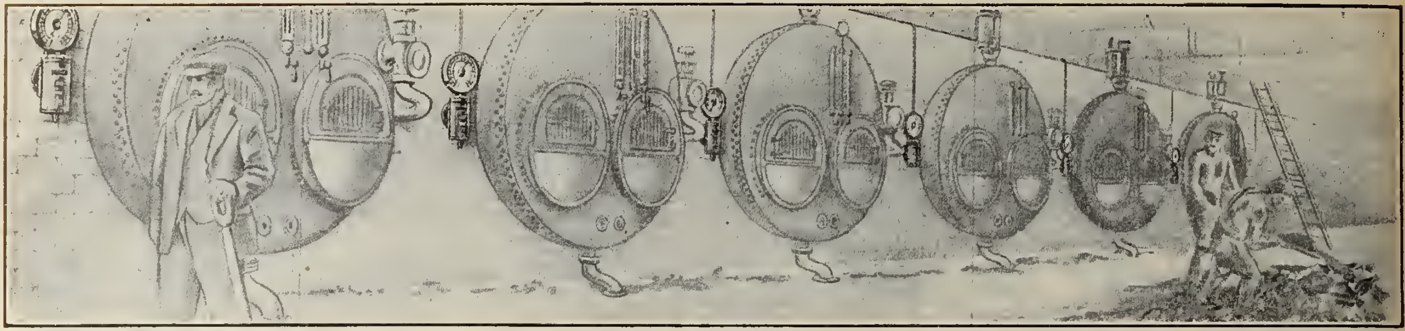
It is general practice to rate all alternating-current generators synchronous motors, synchronous condensers and transformers in kilovolt-amperes instead of kilowatts.

* * *

I hate to be a kicker,
I always long for peace,
But the wheel that does the squeaking
Is the one that gets the grease.

* * *

The pull-out torque of an induction motor is the maximum torque that will develop at normal volts after being allowed to run up to normal speed, that is, the maximum torque the motor will develop when loaded to a point where it stalls. The pull-out torque is from 2 to 3.5 times the full-load torque, depending upon the design of the motor.



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.
Director of Engineering, Central Technical School, Toronto.

FREQUENCY OF FIRING

IF THIN fires are to be maintained, only a little coal can be fired at a time. This, combined with a high rate of combustion, necessitates firing at quite frequent intervals. However, as this reduces the total amount of coal and ashes to be handled, the fireman's work is less than if heavier firings were made at less frequent intervals.

With ordinary draft two to two-and-a-half pounds of coal at a time on each square foot of grate surface is a good average firing. Thus on a grate five feet wide and six feet deep, about sixty to seventy-five pounds, or three to four shovelfuls, would be sufficient.

For best efficiency, the intervals between firings should average about five minutes, or may be shortened to three minutes for heavy loads if the draft is good. This gives from twenty to fifty pounds of coal per square foot of grate per hour, which is a good average. In no case should the intervals exceed ten minutes if the fires are to be kept clean and ready for heavy loads.

Minimum of Smoke

To keep the conditions of fire and draft as nearly constant as possible, and thus get the maximum of efficiency with the minimum of smoke, it will be found best to fire only one half of the fire at a time. This of course makes the firing twice as often, but is more than made up for by the coal and the labor of shovelling it which can be saved by this method.

This is known as the Alternate Method of Firing.

Slack coal is much harder to fire than coarse lumpy coal. It generally tends to "cake" or fuse into a hard tight crust. Very little air will get through this crust and the rate of combustion will be very low, thus cutting down the capacity of the boiler.

Some firemen like to place a fairly thick layer of this coal on one side of the fire. While this layer is fusing into a crust, the other side of the fire has to carry the load. After the crust has formed they break it by shoving the slice bar under it and raising the coal. The crust breaks of its own weight and the air passes through the cracks, allowing combustion to proceed at a high rate.

This method is all right with coals of which the ashes will not melt easily, but the majority of coals have an ash which melts at a comparatively low temperature, and in the use of the slice bar part of this ash is brought up into the hottest part of the fire, where it melts into troublesome clinkers.

Whether it is installing a boiler, calibrating a meter, testing a motor or any one of the many other routine tasks of power plant operation, the one best way of doing the work should be studied by the individual engineer and, modified by local conditions, adopted as his practice. Power House editors are continually seeking the one best way of doing work that they may record the results in the pages of the newspaper. They talk to engineers, study the relative merits of existing methods used, and then record in the printed page thorough descriptions of the best practices.

A good method of firing slack coal is to feed it in quite thin layers. The crust forms quite quickly and is thin enough to be broken by means of the prongs of the rake, thus letting the air through without disturbing the ash.

Another good method favored by many is known as the "Coking Method" of firing, in which the fresh fuel is placed on the dead plate where the radiant heat from the fire and the ignition arch fuses it, drives off the combustible gases and smoke which burn while passing over the hottest part of the fire, and changes the coal into coke. The coke can then be broken and spread over the fire with the hoe or rake. The only objection to this method is that unless carefully done, the ashes are sure to be disturbed.

Cleaning Fires

Undoubtedly the best method of cleaning hand-fired grates, whether while operating or at rest, is the side to side method. Here one side of the fire is allowed to burn down while a good bed of fresh burning fuel is built up on the other side. The clinker and ash from the burnt down side of the grate is then drawn forward into a heap on the dead plate or the front end of that side of the grate, using the hoe for this purpose.

Clinkers which have fused to the side or bridge walls should be broken off with the slice bar every time the fires are cleaned, otherwise they will become so big that they will seriously obstruct the draft over part of the grate, and in the endeavor to eventually remove such clinkers, the brick work is likely to be seriously damaged.

One should not pull the ashes directly out onto the floor in front of the ash pit doors, because while working up close to the door for cleaning the grate at the bridge wall, a heap of red-hot cinders at one's feet is not comfortable. It is better to rake the ashes into a heap just inside the fire door, then, place a wheelbarrow close under the edge of the fire door and rake the heap directly into it, after which it can be moved clear of the boiler front and will cause no obstruction to the draft nor for the operations to follow.

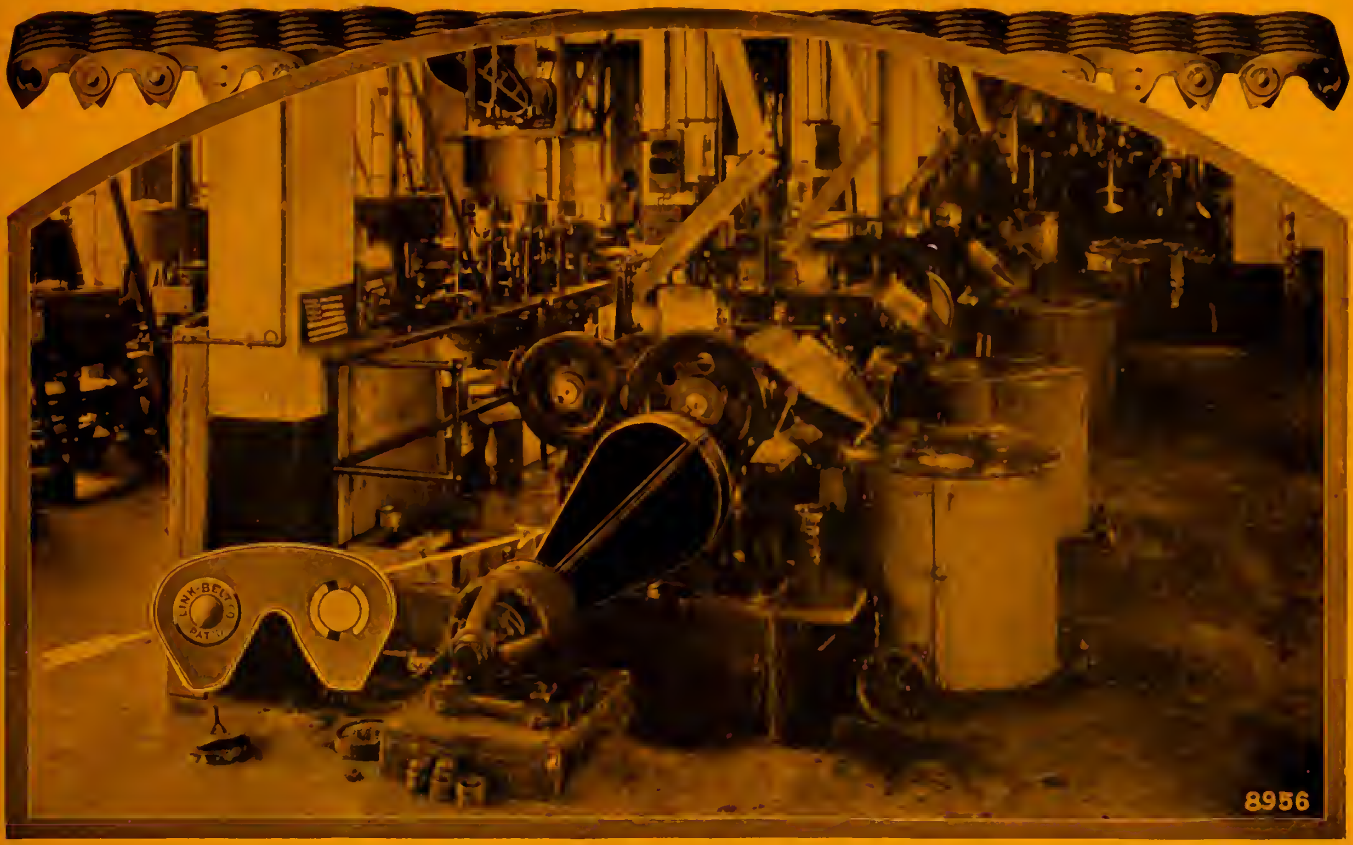
Using Slice Bar

The clean burning fuel from the other side of the grate should then be moved onto the clean grate, either by using the slice-bar with an oar-like motion or with the hoe. Care, however, must be taken not to stir up the ashes and clinkers and move them across with the clean fuel, also to see that too much of the good fuel is not left behind. The burning fuel is then spread evenly on the clean grate and covered with a good charge of fresh fuel, so there will be plenty of burning coal to cover the whole grate by the time the second half is cleaned.

After the second half of the grate is cleaned the fuel should be again spread and alternate firing carried on. The objection to the above method of cleaning grates is sometimes the inability to carry heavy loads throughout the cleaning process.

A Quick Method

A quick method of cleaning fires while carrying load is the rear to front method. In this case the clean burning fuel is pushed back against the bridge wall while the front three quarters of the grate is cleaned. It is then spread and firing is proceeded with. This method does not of



Since 1903—20 years ago—

this Link-Belt Silent Chain Drive has been operating an air compressor at the La Salle St. Station, Chicago.

This drive has required less than $5.00 repair per year. It is still good for many years economical service—even though an air compressor is a comparatively difficult thing to drive. Such is the service rendered by Link-Belt Silent Chain Drives.

Learn more about this effective, quiet drive for all kinds of machinery and lineshafting. Send for our 144 page price list data book No. 125. It is a handbook of silent chain practice. Return the coupon.

LINK-BELT LIMITED

(FORMERLY CANADIAN LINK-BELT LIMITED)

TORONTO—WELLINGTON AND PETER STS. MONTREAL—10 GAUVIN LANE

LINK-BELT LIMITED
Wellington and Peter Sts. Toronto

Please send postpaid—Link-Belt Silent Chain Data Book No. 125.

Name ____________________
Firm ____________________
Street ____________________
Town ____________________
State ____________________

RETURN THIS COUPON 1094

LINK-BELT
SILENT CHAIN DRIVES

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

Others have tried

POWER TRANSMISSION BELTING

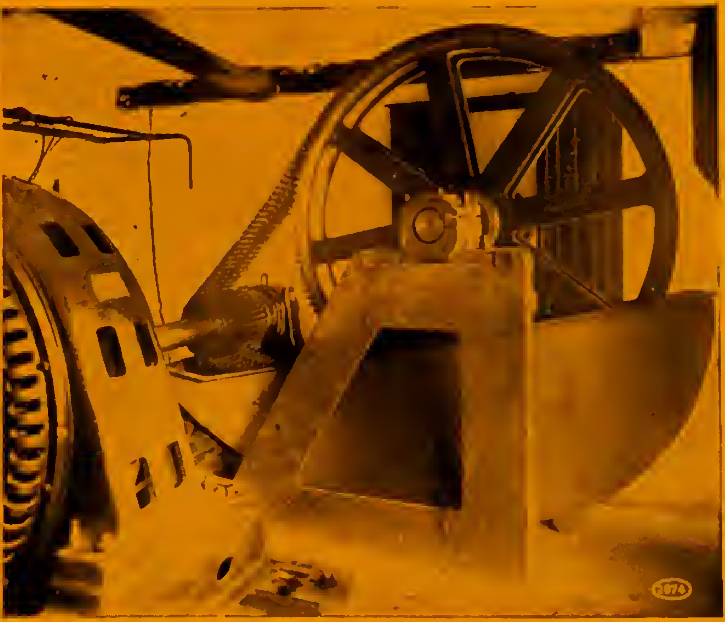
GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast

A STRIKING EXAMPLE

of the Adaptability of the

RENOLD

SILENT CHAIN DRIVES



Photograph shows two Renold Silent Chains, 1.75 in. pitch, 7.1 in. wide, transmitting 335 H.P. from line shaft at 65 R.P.M. to a 250 K.W. Alternator at 332 R.P.M. on wheels of 29 and 148T. Centre distance is 5 feet 9 inches.

The smooth, silent, regular and positive drive of Renold Silent Chains have brought power transmission to the highest point of efficiency and economy, in many Canadian plants.

Our Engineering Service is at your free disposal. WHY NOT WRITE US?

HANS RENOLD OF CANADA, LIMITED
11 St. Sacrament Street
Toronto **MONTREAL** **New York**

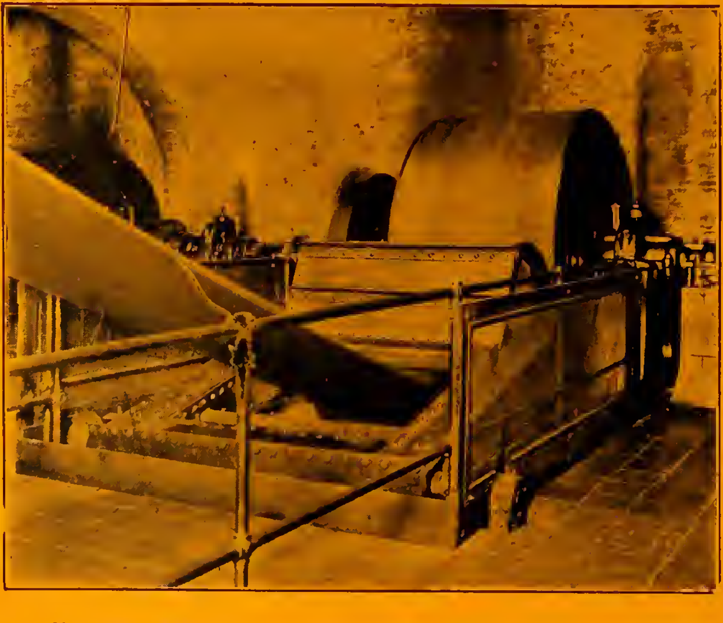
Britain's Bulwark
—Gibraltar Rock

Canadian Industries' Bulwark
—DUNLOP
GIBRALTAR
REDSPECIAL BELTING

Dunlop Tire & Rubber Goods Co., Limited
Head Office and Factory: TORONTO
BRANCHES
IN LEADING CITIES

Also makers of high-grade Fire Hose and Water Hose for all purposes

THE LENIX DRIVE



1400 H.P. Steam Engine Driven Lineshaft. Engine Pulley 216 in. Dia. 53 in. Face, 90 R.P.M. Lineshaft Pulley, 96 in. Dia., 52 in. Face, 200 R.P.M., 3 Ply leather belt 50 inches wide, 11-16 inches thick.

Increases the arc of contact between the belt and pulleys.

In the installation illustrated, the belt is wrapped by the Lenix around practically the entire circumference of the driven pulley. Belt slippage is eliminated and the full capacity of the steam engine is transmitted to the lineshaft pulley.

Booklet
"Saving Slippage and Space"
contains interesting data on belt drives.
Send for a copy.

F. L. SMIDTH & CO.
50 Church Street
Engineers
New York, N.Y.

course do any good to the back part of the grate, and if carried out repeatedly, it will result in the rear part of the grate becoming completely blocked, thus cutting off about a quarter of the capacity of the boiler. Also very large clinkers will "grow" on the bridge wall, which will be almost impossible to remove without damaging the brickwork.

If such big loads are being carried that even the time necessary for a rear to front cleaning is not available, and if the burning of the coal becomes so slow on account of dirty grates that something must be done in order to continue carrying the load, the next best remedy is to run the slice bar under the fire at intervals of about one foot apart and raise it slightly. This is sufficient to shake some of the loose ash through the grates and it cracks the larger clinkers so that air can pass through them. Care must be taken, however, not to raise the bar high enough to mix ashes with the hot part of the fire, or clinkering will continue faster than ever and conditions will soon be worse instead of better.

All the above remarks apply to the cleaning of stationary grates, and the procedure detailed is much simplified in the case of shaking or dumping grates. Even with these, however, great care must be exercised, and work with the slice bar must be done in keeping the side and bridge walls clear of clinkers. There are now on the market several types of carborundum brick to which clinkers will not stick. These although very high priced are excellent for the first few rows above the grates where the clinkers form.

Banking Fires

Many engineers have a habit of banking fires at the back of the grate, either at one end of, or completely across, the bridge wall. It will be found that banking on the front part of the grate near one of the fire doors is more advantageous for the following reasons:

When the fires are again required the back part of the grate and the bridge wall can be thoroughly cleaned before the bank is uncovered, which is much more comfortable than working through a heap of red-hot cinders.

After the dead part of the grate is thoroughly clean, the bank can be spread and the hot ashes under it removed while standing well back from the fire doors. Also if large clinkers form in the bank, as they do with some kinds of coal, it is much easier to release these clinkers from the front part of the grate and the side wall, than from the rear part of the grate and the bridge wall.

Of course slack coal, if available, should always be used for banking, as lumps will burn away too fast. However, if nothing is available but lumps, these should be broken up as small as convenient and a thin layer of ashes may be placed over the bank. Although a layer of ashes tends to form clinkers, it will keep the rate of combustion within reasonable limits. With banked fires the smoke flue damper should be almost completely closed. If the damper is a good fit and closes tightly, there should be no need of closing the ash pit doors at any time as a check on the draft.

In fact it would almost be a general advantage if boiler fronts were made without closing doors. Some engineers remove the ash pit doors from the boiler fronts so that the fireman will not be tempted to use them as a means of controlling the combustion. Naturally the ash pit should be kept clean at all times, for if it is allowed to become heaped up with ashes the draft is interfered with, grate bars may be burned, and clinkers are formed. When fuel tends to clinker badly, water in the ash pit is a help.

Summary of Hints

The foregoing lesson on Hand Firing, in which an attempt has been made to show the reasons for the various points brought out, may be summarized in the following short rules:

Keep the fires between four and eight inches thick.
Fire alternate sides, lightly and often.
Do not fire lumps of coal bigger than the fist.
Keep the fuel bed level by placing coal on the thin spots, not by raking.
Do not use the fire tools more than absolutely necessary.
Keep both the fire and the ash pit clean at all times.
Control the draft by the damper, not by the ash pit doors.

Power Notes

N. Hughson, relief engineer, at Ralph, Clarke, Stone, Ltd., praises the work of the stokers in his plant.

"As our load is purely heating, the variations in steam demand throughout the day are slight. All I have to do," Mr. Hughson said this week, "is to set my stokers in the morning, and possibly make a slight change later on in the day; of course the hopper has to be kept full of coal. I have not made any adjustments since morning and you can judge for yourself if any is needed now."

The fires were certainly clean and in good order, with the steam pressure and the water where they should be.

In telling how he kept the boilers clean inside and out, Mr. Hughson mentioned that, in his opinion, a spare boiler was the greatest aid, allowing sufficient time for a thorough and proper cleaning at the correct time and not, as is sometimes the custom, only when the fires can be drawn on week ends.

"We clean our boilers thoroughly once every six weeks," said Mr. Hughson. "Soot blowers are a great labor saver and fuel saver in our plant. We have not punched a tube in three years, and they are always cleaner than they would be even after spending hours by the old methods, to say nothing of the saving in cleanliness over the old methods."

T. H. Hope, engineer at the Phillips Mfg. Co. Toronto, in relating incidents in his long career in power plants, most of which was spent in the service of his present employers, recalled a discussion he once heard between two firemen in regard to the use of the small holes in the fire door, one claiming that the sole purpose was to enable the firemen to see the condition of the fire, the other that it served the dual purpose of admitting a slight amount of air over the fire, tending to prevent smoke and also helping to keep the fire-door reasonably cool.

"Our power plant is rather unique," said Mr. Hope. "In the summer, when no heat is required for the buildings, we buy our power from the Hydro-Electric, but in the winter power is furnished by a 250-h.p. Corliss engine, the exhaust steam being used to heat the buildings and the dry kilns. The normal load on the engine is in the neighborhood of 100 h.p., so our engine is not as economical as it might be."

Some time ago, a large feed-water heater in this plant was changed over to an oil separator. The old feed-water heater was a large cylindrical tank about 4 ft. 8 in. in diameter and about 8 ft. long, fitted with 12 troughs. It did not do the work it was intended to do, and as conditions in the plant changed so that the returns came back fairly hot, it was decided to instal a small heater and to make an oil separator out of the old heater. Four vertical baffles were fastened inside the cylinder.

"Since making the change," said Mr. Hope, "we have had practically no condensate in the exhaust steam lines, and not a trace of oil in the returns."

Harry M. Prudham, engineer in charge of the power plant of the Durant Motors of Canada, Leaside, believes the fuel situation this year is not as serious as at first expected. His firm is having no difficulty in getting plenty of coal, although at times the quality is not of the best.

"Our load is fairly constant, throughout the day," said Mr. Prudham yesterday, "and our boiler capacity is able to meet the demand, but sometimes with poor coal it means hard work cleaning and attending to the fires."

Obituary

Robert Mason Kerr, president of the Kerr Engine Company, died at his home in Walkerville, on Oct. 4. Mr. Kerr was born at Leidburn, Scotland, on July 6, 1842, and first came to Canada in 1863. With his brother he went into the foundry and machine business, in which he has been actively engaged for more than fifty years. A member of Rose Lodge, A. F. & A. M., of Windsor; a councillor and former mayor of Walkerville, Mr. Kerr will be greatly missed by a wide circle of friends.

An overhead travelling crane of 25 tons capacity, with 5-ton auxiliary, is being installed in the Winnipeg city power plant by John T. Hepburn, Ltd., Toronto. This crane has a span of 33 ft. 4 in.

Electricity in the Power House

By J. A. BURNETT, M.E.I.C., Consulting Engineer, 205 St. James St., Montreal.

CARE OF TRANSFORMERS

THE transformer, usually oil insulated and either self cooled or water cooled, is a very plain and rugged appliance. However, the designers and manufacturers have devoted considerable pains to this device and many things need to be considered by the owner.

The enemies of the transformers are moisture and overload. Moisture is insidious and must be guarded against by a test every six months; while overload can be averted by general supervision, as it is indicated by undue temperature rise. The amount of temperature rise permissible is usually 40 deg. Cent. (104 deg. Fahr.) This means that with a room temperature of 25 deg. Cent. (77 deg. Fahr.) the transformer temperature must not exceed 65 deg. Cent. (149 deg. Fahr.)

Radiates Heat

The oil and casing will radiate away considerable heat, and the amount of oil is naturally a factor, i.e., a large quantity of oil and large case will mean a cooler transformer with the same load. Many transformers are provided with water cooling coils. These add about 70% to the rating of the transformer. However, many conditions of location will preclude any supply of water being used, and so the majority of installations use self-cooled transformers.

It is sometimes found, after several years time, that the water coils become foul and rusted internally, especially where the transformer coils are iron. As there may be several hundred feet of pipe, usually 1¼" diameter, in the cooling coil, it is necessary to remove the coil nest bodily and cut it midway between ends with a hacksaw. A mixture of dilute muriatic acid is then poured into the half coil and after a period of not more than an hour, the contents are poured out. Several applications will be necessary to thoroughly clean out the pipes, and a weld will be necessary to reconnect the sections midway.

Watch Oil Level

As regards the other features of the transformer, it may be found that oil will siphon out by way of the entrance leads and thus the oil level may be lowered also, in case water gets into the case, the oil level will tend to rise. The oil gauge should be inspected once a week and any difference noted. A suitable thermometer should be provided on all transformers above 100 K.V.A. capacity.

The insulating oil should be tested every six months. A sample should be drawn from the top and bottom of the transformer and labelled separately. It should then be tested by a testing bureau, the test consisting of subjecting the oil to high voltage, between two half-inch spheres with an air gap of 0.15". When tested under these conditions, dry oil should not break down at less than 30,000 volts. In practice the oil will fail at 30 to 40,000 volts.

The corrugated metal case for transformers is not so popular as formerly, as it may not be oil tight at bottoms where imbedded in the cast iron base. Boiler plate tanks are now more in use, and with good riveting, they should be perfectly oil tight.

Authorities agree that at least fifteen per cent. of the money spent in generating power and heat for Canadian industry is wasted.

It is wasted in neglected equipment, and as a result of almost unbelievable indifference to the economy of scientific combustion and the enormous waste of old-fashioned hand-fired furnaces.

Is management blind to the fact that power cost in the average plant is one of the largest single items of operating costs?

Clears All Phases

As regards protection, the oil switch with current transformer overload trip is the ideal arrangement. In case of severe overload or a short circuit, the circuit is instantly opened and all phases are clear. The objection to fuses is that, under the National Code Rating they are marked for 80 per cent. of the current at which they flow. On this basis a 30 ampere fuse would blow at 38 amperes, but they do not protect the transformers from being roasted by continuous overload and in case one fuse should blow, the motors and the transformer left on one phase would be endangered. (This, of course, refers to three phase operation.) In case fuses are used, as in the smaller sizes of transformers, it is well to make use of the oil immersed cutout. These are rather expensive, however, costing about $27.00 each. They are safe and reliable, but, of course, may open only one phase with consequent troubles.

The transformer cases should be grounded and the connection for alternation current systems must be made at each service or near the transformer, either by direct ground connection through water piping system or artificial ground wire to which are connected the grounded conductors of secondary mains. In single phase, three wire systems, the ground must be on the neutral conductor, and in single phase, two wire systems, the ground may be on either of the conductors. The ground wire should be copper without joint or splice and protected from mechanical injury. The size of the wire must not be less than one fifth the current capacity of the wire to which it is attached except that it need not be larger than No. 0 B.S. gauge.

Locate Grounds

Artificial grounds should be located where practicable below permanent moisture level. Each ground must present not less than 4 square feet surface to exterior soil. Areas where ground water level is close to the surface should be used when available.

Where ground plates are used they should be at least No. 16 stubbs gauge copper; when driven pipes are used they should be of galvanized iron and not smaller than one inch internal diameter.

The underwriters require that where large transformers are installed in a group, an oil curb be provided three inches high to prevent the oil from spreading, in case the transformer case leaks oil. This curb is set along the floor and is usually of concrete. The doors of the transformer house are required to be metal covered. In case the bank of transformers aggregate 500 Kw. total capacity, it is well to lay out the interior so that all busbars are overhead. In case the transformers are removed the busbars will not need to be touched or disconnected. The house should be well ventilated. Means should be provided to admit air freely at the bottom and to permit air to leave house at top. Roof openings are very desirable in this connection.

In case of the burnout of a transformer, it is to be noted that the salvage value is not usually over 20% of new. This is due to the fact that to dismantle the transformer and tear down the laminations, rewind the coils and re-stack the plates, assemble and test, is a very laborious operation. It therefore behooves the user of transformers to give them due care, bearing in mind that "prevention of trouble" is the motto.

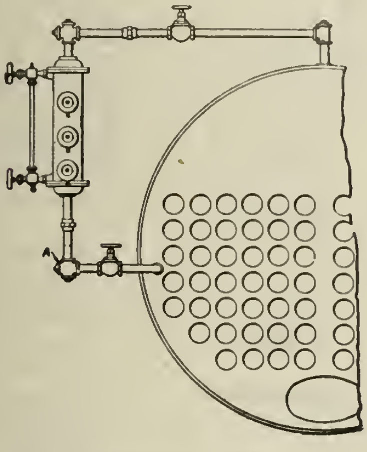
Practical Ideas From Practical Men

WATER-COLUMN VALVES

I am interested in the views of Canadian engineers on the use of valves in water-column connections on boilers. Of course it is impossible to make a steam plant absolutely foolproof, but men in charge of boilers usually do not close these valves unnecessarily when the boiler is in service. The wheel might be taken off the stem, but should be kept hanging in plain sight, near the valve. In no case should the stem be cut off.

Suppose a gauge-cock develops a bad leak; it might be days before the boiler could be let down, but with the valves in place and in order the column could be cut out for a short time, and the gauge-cock repaired or replaced.

I knew of a case where a gale of wind blew a heavy door from its fastenings. It lodged against the boiler front, breaking the cast-iron cross at the bottom of the water-column shown at A in the illustration. Only for the prompt closing of the valves much valuable paper stock, which happened to be piled in line with the pipe, would have been ruined.



Water-Column Valves.

In nearly 40 years' experience with boilers I have never yet seen any trouble caused by water-column valves being left closed. Neither have I had any trouble from scale collecting in the pipes, although I have used all kinds of water. If the boilers are blown down daily and washed out regularly, and inspected at frequent intervals, scale will not have time to accumulate in sufficient quantity to cause trouble before being discovered and corrected.

In one plant, where I was employed, the eighth floor was occupied by a bookbindery, the hot-water supply for which was taken off a branch pipe from the riser, without a valve being placed at the riser. One day, a split occurred in the branch pipe, and before word could be given to the engineer in the basement, many dollars' worth of books were damaged. A valve on this branch pipe would have saved its cost many times over.—PULP MILL ENGINEER.

COUNT THE EXPLOSIONS

By counting the explosions of a gasoline engine and doing a little simple figuring, it is possible to determine the efficiency of the hit and miss type of governing with surprising accuracy.

Subtract the number of explosions per minute made by the engine when it is pulling no load at all, from the number of explosions per minute when pulling a full load. Then divide the remainder by the number of explosions per minute when pulling full load and the quotient is the so-called "mechanical efficiency."

For a gasoline engine that explodes 95 times per minute when pulling full load, and 24 times per minute when pulling no load at all, the difference is 71. In other words, 71 of the explosions are utilized when pulling full load, whereas 24 of them are lost in overcoming the internal friction in the engine.

Going back to the rule, divide 71 by 95 and the quotient tells that the mechanical efficiency of the engine is a bit less than 75 per cent.—a rather low efficiency. It should be bettered, and it can be bettered by reducing to the minimum the number of explosions per minute when running unloaded.

It is difficult to attain a mechanical efficiency of 90 per cent. in a gasoline engine, which is common in steam engines, for steam engines are easier to lubricate and the heat problems encountered are not so complex.

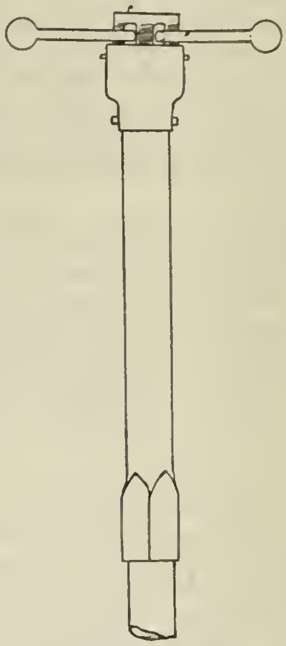
Reduction of explosions simultaneously increases the power of the engine, without consuming an ounce more of gasoline. If the number could be cut down from 24 to 10, we would have 14 "useful" explosions to add to the 71, which gives 85. Or, dividing 14 by 71, we find that the power of the engine has been increased 19.7 per cent.

It is doubtful if such an increase could be added to any engine, unless the engine were in a very sad state before the improvement began.—N. G. NEAR.

EXTENSION SHAFT

Due to a shift in our piping arrangement we found that the valve handle on one of our water supply lines came about three feet higher than could ordinarily be reached by a person on the floor. We at first placed a ladder beneath the valve but this was in the way, and usually was in some other part of the plant when it was wanted.

We, therefore, rigged up an extension shaft out of some 1½-inch pipe, along the lines shown in the attached sketch. We took one end of the pipe and put a square socket on it to fit over the original valve shaft. On the other end we put a reducing coupling, which was pinned onto the pipe, and then took a long nipple, cut five slots in it to take the original valve handle, and then screwed the nipple into place and pinned it, all as indicated on the sketch.

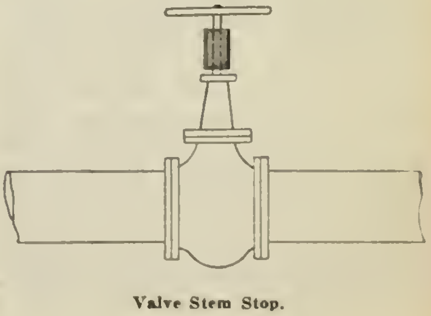


A Practical Extension.

This made a practical extension which eliminated the need for the ladder, and also saved all the red tape incident on putting through a requisition for a chain wheel or other accessory.—A. DAVIES.

VALVE CLOSING DANGER

We recently had an accident in our plant occasioned by someone completely closing the gate valve in the exhaust line beyond our open heater, with the result that the pressure accumulated, before it was noticed, to the point where it exceeded the pressure for which the apparatus was built, and the entire front section of the heater was blown out.



Valve Stem Stop.

After this was replaced, we decided to take some step against a recurrence of it, and we finally arranged to provide the rising stem of the gate valve with a collar, as shown in hatched lines on the accompanying sketch, made long enough that when the valve was closed half-way the hand-wheel was not permitted to go further down because of the distance piece formed by the collar. This half-way closed position gave us all the adjustment we needed, and the collar, which prevented any further closing, acts as a guard against anyone inadvertently closing the valve and causing a repetition of trouble from pressure accumulation.

This collar can either be made of one piece construction by sawing it from a piece of suitably sized pipe, or can be made in two parts, so that it can be readily removed. In the latter cases, in some instances it might be advisable to hold the two sections together with a padlock, where tampering is to be guarded against.—ALBERTA ENGINEER.

REDUCING VALVES

Reducing valves that are too large for the amount of steam they are to pass are usually unsatisfactory. Either they will open and close continually and chatter violently, or will stand in a position nearly closed and become steamcut and leaky. It is more satisfactory to use two small valves in parallel, one set slightly heavier than the other, so that one will supply steam up to its maximum capacity before the other opens. Another way is to use one reducing valve equal to about one-half the maximum demand, and a by-pass of about the same capacity with a hand-operated valve in it, so that when the reducing valve reaches its capacity the by-pass valve may be opened wide and the reducing valve will close down and simply make up the shortage. This, of course, required that an attendant shall observe the pressure gauge occasionally.

HOW MANY BARRELS?

Here is a chart that will be found useful for determining the number of barrels in a circular tank of almost any diameter.

Simply run a straight line across the chart connecting the height of the tank with its diameter, and the intersection with the middle column B gives the number of barrels instantly.

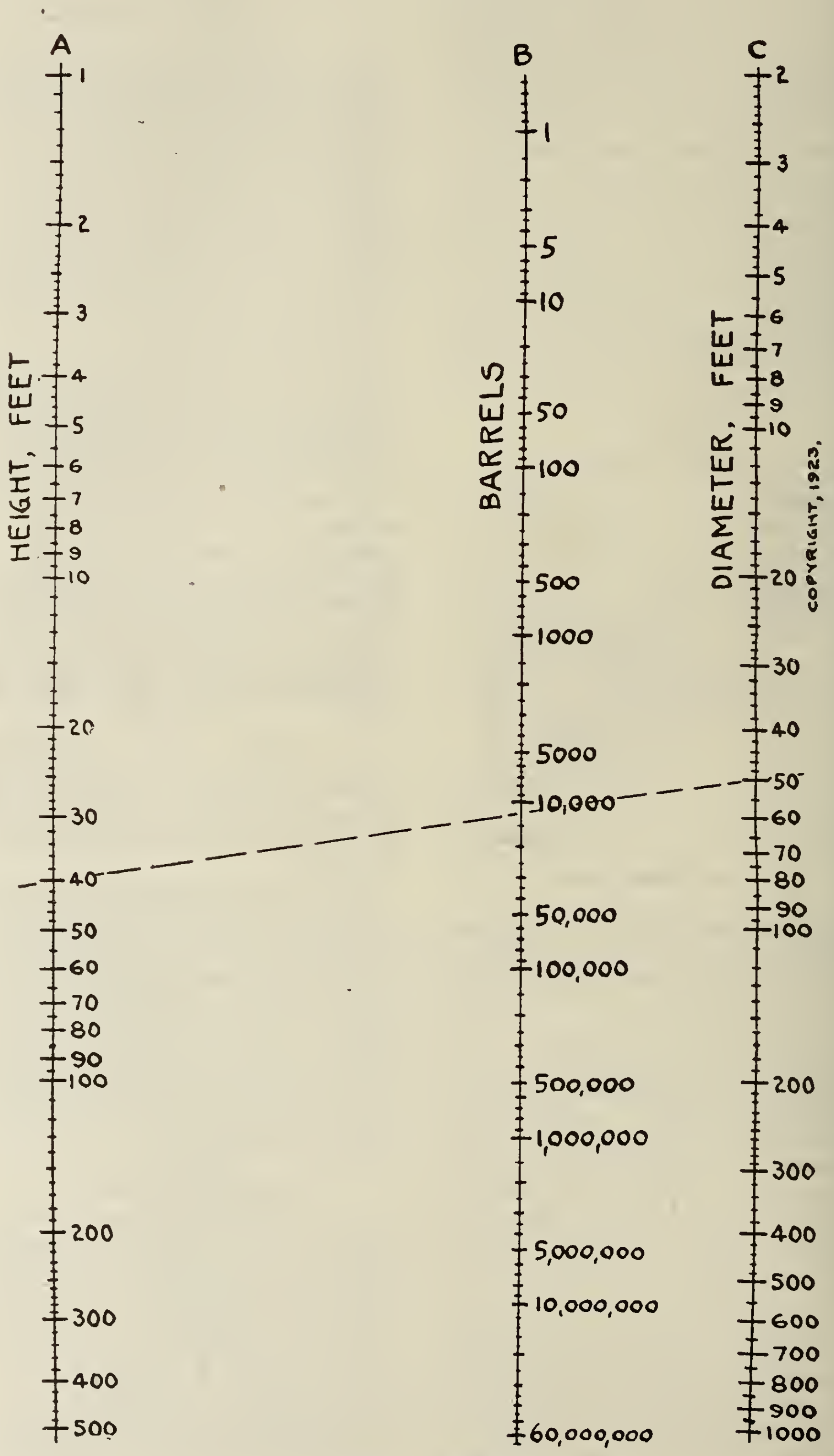
For example, if we have a tank 40 feet in height and 50 feet in diameter, what is its capacity? The dotted line drawn across the chart shows how it is done. Connect the 40, column A, with the 50 feet, column C, and the intersection with column B gives the answer as—about 12,000 barrels. Figure it out with a lead pencil and it will be found that the correct answer is 11,750 which shows that the chart gives results that are remarkably close.

In case it is desired to know how much is in a given tank at a given time, column A, represents the depth of the liquid in feet, and column C the diameter, as before. The figures in column B then represent the number of barrels in the tank.

The chart may also be used backwards for determining the height to which a given tank should be built or the diameter it should be given for a capacity of any number of barrels. Or, it may be used for determining the height to which a tank should be built where the capacity and diameter are both known. In other words, where any two of the factors are known the third is easily found by means of this chart.

The range of the chart, it will be noted, is great enough to take care of any tank ever built, the heights varying all the way from 1 foot to 500 feet and the diameters from 2 feet to 1,000 feet. The maximum capacity of the chart is 60,000,000 barrels. —W. F. SCHAPHORST, M.E.

Viscosity tests, so called, do not necessarily prove anything of the lubricating quality of an oil, since rosin or other viscous oils may constitute a large proportion of the whole and yet have no lubricating value.



How many barrels?

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

CLEANING UP AN ENGINE

What is a good method of cleaning up an engine that has stood idle for some time? —FRANK WATSON.

Answer:—Gummy deposits of oil should be softened with a paste of potash and removed by scraping with a putty knife or other flexible scraper. In places where the gum seems to be burnt into the metal, the finished surfaces can be brightened by sandpapering, being careful to do the rubbing so the marks will be in the same direction as those of the original finish.

After cleaning, the parts should be flushed clean with water, dried and oiled. The use of loose emery or of emery cloth or emery paper is objectionable as particles of the emery that may get between rubbing surfaces are likely to cause cutting that is difficult to stop.

DIRECTION OF COMPRESSOR

We have in our Montreal plant a two-stage air compressor 21 in. x 23 in.x16 in., driven 214 r.p.m. by a synchronous motor. Will this machine run as quietly "running over" as "running under"? Why are motor-driven air compressors generally run under instead of over?—F. W. RYAN.

Answer:—Quieter running of a motor-driven compressor is obtained by "running under"—that is, when the crank falls in the beginning of a stroke from the cylinder toward the crankshaft—for then the alternate thrust and pull of the connecting rod, as well as the weight of the crosshead, bring the pressure of the crosshead on the lower guide.

In a steam engine, where the power is transmitted from the crosshead to the crank, pressure is brought on the lower guide and quieter operation is obtained by "running over."

By "running under" in case of a motor-driven compressor, or "running over" in case of a steam engine, there is better opportunity for lubrication of the guide that receives the principal wear, better opportunity of adjusting and maintaining alignment of the crosshead and less tendency of the crosshead to pound on the guides.

Motor-driven compressors are run under more generally than over, so the pull of the driving belt will come on the under side of the belt and thereby better provide against slippage of the belt on the motor driving pulley.

DRAFT LOSSES

What should be the size of smoke flue for a battery of boilers containing 5,000 sq.ft. of heating surface, and what allowances should be made for loss of draft due to the length and angles in the flue?—R. SMYTH.

Answer:—A safe rule for figuring cross-sectional areas of circular iron flues is to allow 3.5 sq.ft. per 1,000 sq.ft. of boiler-heating surface, so that 5,000 sq.ft. should have a cross-section flue area of about 17.5 sq.ft., or about 56½ in. diameter.

The area at any point may be in proportion to the volume of gas that will pass that point, and when two or more branches discharge into the same duct, each junction should be provided with a baffle for turning the gases into the main flue without interfering with the passage of gases from connections that are more remote from the stack.

The retarding effect of a square flue is 12 per cent. greater than that of a circular flue of the same area, and that of a rectangular flue with sides as one to one and a half is about 15 per cent. greater than for a circular flue of the same cross-sectional area. For iron flues there is draft loss about 0.1 in. of water per 100 ft. length of flue and 0.05 in. loss for each right-angle turn. The retarding effect of brick or brick-lined flues is about one-third more.

When a turn is made by an easy-bend elbow, having a center line curved to a radius of three diameters or more, the draft loss is practically no more than for the same length of straight flue.

BOILER HORSEPOWER

What is the horsepower of a horizontal return tubular boiler, 18 ft. long, 6 feet in diameter, with 72 4-inch tubes?

What will the horsepower be if 15 sq. ft. of heating surface is allowed for each boiler horsepower?

—C. LEAK, Hamilton.

Ans.—To find the horsepower of a boiler, it is first necessary to find the total heating surface of the boiler, then allow a certain number of square feet of heating surface per boiler horsepower.

The total heating surface of a horizontal return tubular boiler consists of part of the shell exposed to the hot gases, the tubes and the tube sheets at each end of the boiler.

A Toronto manufacturer makes the following assumptions in calculating the horsepower of a return tubular boiler:

One-half the area of the shell is effective heating surface;

Two-thirds of one tube sheet as an average for the area of the tube sheets exposed to the hot gases.

The nominal diameter of the tube is used in finding the heating surface of the tubes.

The boiler is 18 feet long, 6 feet in diameter, and has 72 4-inch tubes.

Heating surface in the shell—

$\frac{1}{2}(\pi \times 6 \times 18) = 169.6$ sq. ft.

The numerical value of π is 3.1416.

Heating surface in tubes—

$72(\pi \times \frac{4}{12} \times 18) = 1{,}357.2$ sq. ft.

Heating surface in tube sheets—

$\frac{2}{3}(.7854 \times 6 \times 6) = 18.8$ sq. ft.

Total heating surface = 1,545.6 sq. ft.

The heating surface is then about 1,546 sq. ft.

If we allow 10 sq. ft. of heating surface per boiler horsepower, this boiler would be 154.5 h.p.

Allowing 15 sq. ft. per boiler horsepower, a rating used commonly for heating boilers, the horsepower is 103.

The manufacturer's rating on a boiler of this size is 150 h.p.

RESULTING TEMPERATURE

What will be the resulting temperature when 100 lbs. of water at 70 deg. F. are mixed with 15 lbs. of ice at 32 deg. F.? —S. M., Edmonton.

Ans.—Let the resulting temperature be X deg. F.

Assume that no heat is lost through radiation. The heat given out by the water in cooling from 70 deg. to X deg. is used up in melting the ice and raising the water from the ice up to a temperature of X deg.

Heat given out by water in cooling from 70 deg. to X deg. = 100(70—X) B.t.u.

The latent heat of fusion for ice = 144 B.t.u. per lb.

Heat required to melt the ice =
15 × 144 = 2,160 B.t.u.

Heat required to raise the temperature of the water from the melted ice to X deg. = 15(X — 32) B.t.u.

Now, if no heat has been lost in the process of melting and exchange of heat, the heat given out by the 100 lb. of water in cooling from 70 deg. to X deg. will be equal to heat required to melt the ice and to raise the temperature of the water to X deg. F.

Equating to find X—

$100(70 - X) = 15(X - 32) + 2{,}160.$

$7.000 - 100X = 15X - 480 + 2\,160$

$7{,}000 + 480 - 2{,}160 = 100X + 15X$

$115X = 5.320.$

$X = 46.2$ deg. F.

The resulting temperature is, therefore, 46.2 deg. F.

There will be a slight error in working a problem in this way, due to the assumption that the heat content of water at 70 deg. F. is 38 B.t.u. per lb. instead of the more accurate 38.07 B.t.u.

per lb. The difference is so slight, however, that for all practical problems it is usually neglected.

SETTING VALVE

What is the proper method of setting the valves on a single cylinder, centre crank Ideal engine, equipped with a Rites inertia governor?

—A. L. COCKING, Man.

Ans.—To find if the governor is working properly, remove the spring and try out the eccentric, from the inner to the outer stop, through the total range.

When the eccentric is tight against the outer stop, the valve must show no lead. This is the safety feature of the engine. No steam must be admitted to either end of the cylinder with the eccentric tight against the outer stop, or on light or no load the engine will run away.

Replace the spring and set to the normal tension. The eccentric will now bear against the inner stop, giving the maximum travel of the valve.

Block the governor arm solid at a position giving cut-off at approximately ⅜ stroke.

If the valve is properly set, it will now show equal opening to steam at both ends of the cylinder.

If the valve opening is greater at one end of the stroke than at the other, adjust by means of the lock nuts on the valve rod until equal opening to steam is shown at both ends.

LUBRICATING CYLINDER

What is the proper amount of cylinder oil to use on 12 x 12 steam engine, speed 277 r.p.m., working on wet steam at a pressure of 100 lb. per sq. in.?

—A. L. COCKING, Dauphin, Man.

Ans.—The correct amount of oil to use on engines of the same size and speed varies, new engines requiring more than old ones. It is also difficult to secure proper lubrication with wet steam. Engine builders recommend about one pint of good cylinder oil per 24 hours as a maximum on an engine of this size.

VELOCITY OF DISCHARGE

What would be the velocity of water discharged through a 12-in. pipe inserted at the base of a dam with the head of water 25 ft.?—ROBERT HOAG.

Answer:—The average velocity would depend on the shape of the inlet end of the pipe, the length of pipe, roughness of the pipe surface and also the pressure against which the discharge takes place. The theoretical velocity in feet per second would be 8.03 times the square root of the head 25 ft., or 40.1 ft. per second. For a straight clean pipe 2½ to 3 times as long as diameter the average velocity would be about 81 per cent. of the theoretical, or 81 per cent. of 40.1 equals 32.48 ft. per second.

This provides that the pipe is uniform in diameter for its full length, that the entrance end is cut off square, that the length of the pipe is 2½ to 3 times the diameter, and that there is no obstruction of free flow to the entrance tending to reduce the head of 25 ft. at the entrance.

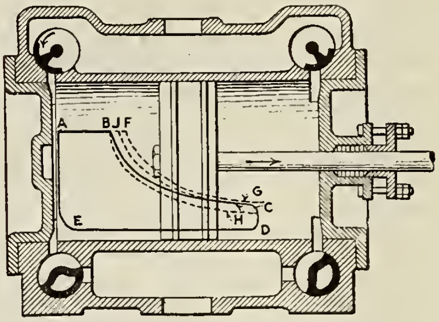
With a bell-shaped mouth at the entrance of the pipe, the velocity in a short pipe would be nearly the theoretical, and for a longer pipe than three times the diameter, the velocity and discharge would be reduced, depending on the size, length and roughness of the interior of the pipe.

CYLINDER RE-EVAPORATION

What is cylinder re-evaporation and why is its occurrence associated with poor cylinder economy?—WALTER HUDSON.

Answer:—The walls of an engine cylinder are cooled by radiation and the low temperature of the exhaust steam, and when steam is admitted from the boiler, part of it condenses.

The latent heat of that portion of the entering steam that is condensed is employed by raising the temperature of the cylinder walls nearly to the temperature corresponding to the pressure. The water formed by the process of condensation is deposited on the walls of the cylinder in the form of a thin film. This continues after cutoff takes place until the steam pressure and corresponding temperature have become reduced by expansion of the steam down to a pressure at which its temperature is about the same as the temperature of the cylinder walls.



Cylinder Re-evaporation.

Then, upon further lowering of the steam pressure from further expansion, the water in the cylinder is re-evaporated and the steam thus formed in the cylinder during the latter part of the stroke prevents the pressure from falling as low as it would without the re-evaporation. As a result the expansion line of an indicator diagram from the point where re-evaporation begins may be higher than it would be without the re-evaporation.

Referring to the figure, suppose *ABCDE* to be an actual indicator diagram with cutoff at *B*. Assuming a zero clearance volume, the volume of steam in the cylinder at cutoff is the volume displaced by the piston in movement from *A* to *B*.

But on account of cylinder condensation during admission, the actual volume of steam admitted from the boiler is greater. Suppose this additional volume to be a cylinder volume represented by the additional piston displacement from *B* to *F*. Then by adiabatic expansion—that is, with neither gain nor loss of heat excepting the heat converted into work—an expansion curve like *FG* would be realized, whose average pressure would be more than that of *BC*.

If there had been no re-evaporation to raise the average pressure after cutoff at *B*, adiabatic expansion from *B* would have proceeded along a lower curve like *BH* of less average pressure than the curve of the actual diagram; but the fact that *BC* is higher than *BH* shows that heat for re-evaporation of water in the cylinder must have been received. By passing an adiabatic *CJ* through *C*, it will be found that without gain or loss of heat an expansion curve like *JC* would have been necessary to pass through *C* and would have required a volume of steam to be admitted from the boiler at least equal to the piston displacement *A* to *J*.

But the average pressure of the actual diagram *BC* that is obtained for the quantity of steam represented by the displacement *AJ* is less than the theoretical average that should have been obtained, going to show that the work realized from re-evaporation is less than would have been developed without cylinder cooling and the incident re-evaporation.

In this connection it is to be noted that an average pressure higher than the average pressure of an adiabatic through *B*, or an average pressure lower than that of an adiabatic through *C* is indicative of a loss from cylinder cooling which is not replaced by a gain from re-evaporation.

Convention Notes

The 14th annual convention of the National Association of Practical Refrigerating Engineers will be held in Memphis, December 12, 13, 14 and 15, 1923. The convention sessions will take place in the Scottish Rites Temple on Union Ave. Plan of the exhibit space can be had from Wm. F. Davis, 630 Jackson Ave., Memphis, Tenn.

Announcements

In a recent issue of Power House there appeared an advertisement by the Celite Products Co. on Sil-O-Cel Insulation, in which the statement was made that Sil-O-Cel insulating brick possessed a crushing strength of more than 400 lbs. per sq. ft. Sil-O-Cel insulating brick possesses a much greater crushing strength and the statement should have read: "400 lbs. per sq. in., the equivalent of about 28 tons per sq. ft."

Richard & Abra, Home Bank Bldg., Ottawa, are the architects for a garage, machine shop and power house for the Ottawa Electric Railway Co. A booster generator, costing about $50,000, will be required for the power house. John Sutherland is the superintendent in charge.

The Canada Stoker Co., 2 Gould St., Toronto, have been awarded, by the department of public works of the province of Manitoba, the contract for supplying and erecting one 80 sq. ft. chain grate stoker for the new power house of the Hospital for Mental Diseases, Selkirk.

BIG CO_2 SAVINGS

(Continued from page 31)

Ultimate Analysis of Dry Coal

Carbon.....	77.00 per cent. by weight
Hydrogen...	5.00 per cent. by weight
Oxygen.....	8.00 per cent. by weight
Ash........	10.00 per cent. by weight

Dry Flue Gas Analysis

Carbon dioxide	12.00 per cent. by volume
Oxygen.......	4.50 per cent. by volume
Carbon monoxide .	1.50 per cent. by volume
Nitrogen......	82.00 per cent. by volume

The weight of the dry products of combustion per pound of dry coal is given by the equation,

$$\text{Weight dry products} = \frac{4\ CO_2\ O_2\ 700}{3(CO_2\ CO)} \times C$$

Weight of dry products =

$$\frac{4 \times 12\ 4.5\ 700}{3(12\ 1.5)} \times .77 = 14.31 \text{ pounds}$$

per pound of coal.

In order to find the theoretical weight of air required to burn one pound of fuel it will be necessary to find the weight of carbon that is burned to carbon dioxide and to carbon monoxide. The assumed flue gas analysis can be converted to per cent. by weight with the following result.

Carbon dioxide	17.51 per cent. by weight
Oxygen.......	4.78 per cent. by weight
Carbon monoxide .	1.40 per cent. by weight
Nitrogen......	76.31 per cent. by weight

Of the total weight of the dry products of combustion of one pound of dry coal, 1.4 per cent. is carbon monoxide. Therefore, the weight of carbon monoxide per pound of fuel is 14.31 × .014 = 0.2 pounds. Since carbon is 12 ÷ 28 of the weight of carbon monoxide, the weight of carbon burned to carbon monoxide is $0.2 \times \frac{12}{28} = .086$ pounds per pound of fuel The carbon burned to carbon dioxide is .77 — .086 = .684 pounds per pound of fuel. The weight of air required theoretically to burn one pound of the coal under the assumed conditions is as follows: Weight of air =

$$11.58C\ 34.8\ (H - \frac{0}{8})\ 5.78C = 11.58 \times .684\ 34.8\ (.05 - \frac{.08}{8})\ 5.78 \times .086 = 9.81$$

pounds per pound of coal.

The air actually used under the assumed conditions is the weight of the dry products of combustion minus the weight of the carbon in the fuel plus the weight of the oxygen supplied to burn the hydrogen. Hence, actual weight of air =

$$14.31 - .77\ 8(.05 - \frac{.08}{8}) = 13.86 \text{ pounds}$$

per pound of coal

The apparent excess air is 13.86 — 9.81 = 4.05 pounds.

Now, if the assumed flue gas analysis is correct for the given coal analysis, it should check with the flue gas analysis calculated from the above excess air. To calculate this flue gas analysis, per cent. by volume, the following results:

Volume of	Cubic Feet
Carbon dioxide = $.684 \times 3.67 \times 8.15 =$	20.45
Carbon monoxide = $.086 \times 2.33 \times 12.80 =$	2.57
Oxygen = $4.05 \times .23 \times 11.21 =$	10.46
Nitrogen = $13.86 \times .77 \times 12.77 =$	136.00
	169.48

Carbon dioxide $\frac{20.45}{169.48} = 12.08$ per cent. by volume.

Oxygen $= \frac{10.47}{169.48} = 6.17$ per cent. by volume.

Carbon monoxide $= \frac{2.57}{169.48} = 1.52$ per cent. by volume.

Nitrogen $= \frac{136.00}{169.48} = 80.23$ per cent. by volume.

Since this analysis does not agree with the assumed analysis, it is evident that the latter is not correct or at least it cannot be used with the given coal analysis

PROTECTING TRANSFORMERS

(Continued from page 34)

ent when lifting the transformer core and windings from the tank for inspection.

By far the greatest number of faults occur between turns of the H. T. windings, and while with modern protective gear such as described in this article, the fault becomes confined over a relatively small area, even then the resulting damage gives ample visual evidence for the purpose of location.

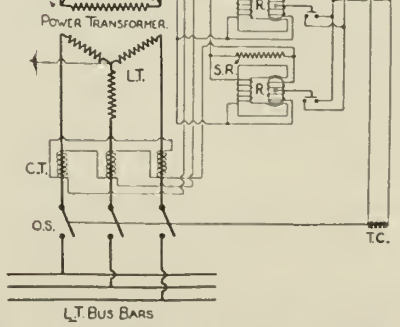


Fig. 8—McColl Circulating Current Protection, using Biased Reactive Dynamometer type relays for a three phase delta/star transformer.

The foregoing review has been confined to those types of protective gear having discriminative action, and the various kinds of overload and earth leakage protection have not been considered, as their application and characteristics are more widely known. The particular kind of protective gear to be installed will largely depend upon the importance of the continuity of supply as compared with the cost of the protective scheme, but in all cases where transformers form a link in the transmission or distribution scheme, they should certainly be protected by some form or other of the systems described in this article.

Construction

The Ottawa River Power Co., Ltd., 145 St. James St., Montreal, is in the market for transmission and power machinery to be used in connection with a proposed 60,000 h.p. scheme in Quebec.

The Sinclair Construction Co., Ltd., Excelsior Life Building, Toronto, has the general contract for the construction of a power house, foundations, and tailrace at dam No. 1, Trent River, in connection with the $250,000 development at Campbellford, Ont., for the Hydro-Electric Power Commission of Ontario, University Ave., Toronto.

Frank M. Campbell, William E. Hunt, and John L. Comfort, Fort Erie, Ont., have incorporated a company to be known as the Campbell-Aladdin Gas Maker, Ltd. Capital $250,000.

Plans are being prepared for the construction of an ice arena, 85 x 185 feet, at Niagara Falls, Ont., by the Niagara Falls Arena, Ltd. Estimated cost $150,000. The owner is in the market for an artificial ice plant. F. Barber & Associates, Ltd., 45 Jarvis St., Toronto, Engineers.

Burmeister & Wain, of Copenhagen, recently received an order for the construction of two Diesel engines, developing 1,000 H.P. per cylinder. A single cylinder engine unit has been in operation for over four months on test, including a non-stop run of about a month, which was made with very satisfactory results.

The engine is of the double-acting, four-cylinder type. The successful operation of an engine developing 1,000 H.P. per cylinder will do much to encourage other builders to make engines of large size suitable for central stations.

The Ottawa & Hull Power Co. will begin construction on their power plant at Bryson, Quebec, immediately. This plant will develop 60,000 h.p. and supply power to the communities along the Ottawa River as well as in the cities of Ottawa and Hull.

Selecting the Proper Pulley for Fans or Pumps

By A. E. HEWITT

Correct Proportioning of Sizes on Belt Driven Apparatus of Importance to Engineer—A Difference of an Inch in Diameter May Have Vital Effect on Operation

THE proper proportioning of pulley sizes on belt-driven apparatus such as fans, power pumps, etc., is very important. A difference of an inch in diameter of either pulley may have a pronounced effect on the operation of the devices, and if the error results in a pulley on the motor which is too large, the result will be an overloaded and burnt out motor sooner or later. If the proportion is the other way, the apparatus that is being driven will be operating at a lowered capacity.

In our calculations we deal so much with areas, and so little with circumferences, that in attempting to proportion pulley sizes we are apt to be misled by the fixed idea that doubling the diameter results in an area four times as great, and therefore, confuse ourselves when dealing with circumferences. Doubling the diameter of a circle increases the circumference in the same proportion, and likewise 1½ times or any other increase or decrease.

Radius Immaterial

This is illustrated graphically by the six circles in the accompanying illustration, three being 20 in. and three 10 in.; the upper 20 and 10 in. circles illustrate relative diameters only, with the radius of each marked in the circles; with radius, however, we have no concern.

The two in the centre illustrate the relative areas, which, as will be noted, are four times as great for the 20 in. as for the 10 in. The two lower circles illustrate the circumference, which, as will be seen, increases with the diameter, the circumference of the 20 in. circle is just twice that of the 10 in.

Therefore, in calculations affecting pulley sizes, circumferences, with the attendant decimal calculations, may be dispensed with and diameter only used in figuring the required sizes.

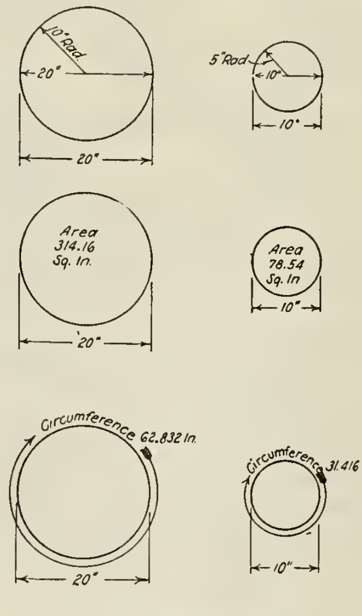
The small motors used in heating work for operating pumps, etc., are usually of 1,800 revolutions per minute, although 1,200 and even 900 are used to some extent. For operating fans 1,200 and 900, and sometimes lower, are met with more often than the 1,800 r.p.m.

Speed of Pumps

The speed of power pumps of the reciprocating type is fixed by the service, and by the length of each stroke, and is held to a given number of feet per minute travel of the piston.

Manifestly a pump with a short piston will have a greater number of revolutions per minute in order to attain the same speed as one with a longer piston. But as the length of piston increases, the speed per minute may be increased, so that the long piston will attain a higher speed with the same number of revolutions.

As an example, pump with a 6 in. stroke making 100 revolutions per minute will have a piston speed of 100 ft. per minute, while one with a 9 in. stroke would only have 66 2-3 revolutions per minute to attain the 100 ft. per minute piston speed of the smaller stroke. The proper speed is always indicated by the manufacturer.



Proper Pulley Sizes.

Speed in Fan Work

In fan work the number of revolutions per minute is related to the required tip speed of the fan, and this will of course depend on the diameter of the fan wheel. A wheel of 36 in. diameter, revolving at the rate of 300 r.p.m. will have a tip speed of 2,827 ft. p. m., while a wheel of 72 in. diameter would attain this same tip speed at 150 r. p. m.—just one-half the number of revolutions per minute.

Both fans and pumps, as well as other such devices, have a fixed number of r. p. m. recommended by the manufacturers with usually some recommendations as to percentage of variation from the given speed; ordinarily about 10 per cent. They usually also, catalog a given pulley size, which can, however, be varied. Motors also have a fixed speed, and usually a catalog size of pulley which may also be varied.

Dividing the Speed

Having a fan of a given speed and a motor of given speed, and knowing the size of pulley on the fan, the pulley size of the motor may be arrived at by dividing the motor speed by the fan speed, and then the fan pulley diameter by this quotient. Example:

Fan speed 400 r. p. m.
Motor speed 1,800 r. p. m.
Fan pulley 27 in. diameter; then:
1,800 ÷ 400 = 4.5
27 ÷ 4.5 = 6,

which is the proper diameter for motor pulley.

If the speed of both fan and motor are given, as above, and the pulley diameter of the motor is 8 in., proceed as before:

1,800 ÷ 400 = 4.5

then 4.5 × 8 = 36, which would be the proper pulley diameter for the fan with the motor pulley 8 in.

A study of the illustration will help to make this matter clearer.

Personals

The University of British Columbia is calling for tenders for the heating and ventilating of the new science building now being constructed at Point Grey. Patrick Philip is the general contractor.

The Ottawa River Power Co., a subsidiary of the Ottawa and Hull Power Co., have completed plans for development at Bryson, 50 miles above Ottawa. The first installation is to be one unit of 25,000 horse power.

E. N. Saunderson, N. Y., president of the New Brunswick Power Co., met Premier Venict at Fredericton, Oct. 5, to discuss improvements to the highway at East St. John, where the New Brunswick Power Co.'s tracks run.

The Hydro Electric Power Commission, North Bay, have purchased from the Canadian Ingersoll-Rand Company a 3¼ and 1¼ x 4 type 14, 1,000 lb. pressure air compressor for Hydro No. 2 generating station, at North Bay.

Julian C. Smith, of Montreal, president of the Quebec Light, Heat and Power Co., and supervising engineer for the Manitoba Power Co., in company with A. W. McLimont, visited the Great Falls development this month to inspect the work.

Duty of a Power Plant Engineer As I See It!

By C. J. MATHEWS, M. Inst. C. E.*

Operators Must Become as Efficient as Possible in Order to Eliminate Waste and Win Substantial Recognition of Savings Effected in Boiler Room

KEEP the water in the boiler at a uniform level; a varying water level tends to uneconomical results. Water gauges should be tested every morning before starting, or after any stoppage. They should also be frequently tested while boiler is at work. Every cock should be used at each testing. If water rises slowly in the glass, passages should be cleaned out with a piece of wire.

Pumps and feed valves should have constant attention so that there may be no risk of water shortage. Pumps should be kept going slowly all the time so as to keep the water at a uniform level.

If from any cause it is suspected that the water has become so seriously low that there is danger of furnace crown plates being bared, close dampers and smother fire with sand, damp ashes, earth, or even slack. Ascertain, if possible, the exact water level, and if furnace plates are not bared, turn on feed until the normal water level is restored. If it is almost certain that plates are bared, and have become overheated, draw fires after they have been completely smothered, and allow boiler to cool before turning on feed.

Renew Yearly

Fusible plugs must be kept clean from soot on fire side and scale on water side. The fusible metal should be renewed if at any time it appears to be getting brittle when scraped with a knife. It is generally good practice to renew the metal yearly.

See that all fittings are kept in good and efficient working order. Care should be taken to see that blow off cocks are properly closed after using them, and are not leaking. All fittings should be taken apart and thoroughly overhauled twice a year, when connecting bolts, studs, etc., should be carefully examined and renewed if corroded or otherwise defective.

Manhole and mudhole joints should be kept scrupulously tight. Very slight leakages from these doors can cause serious corrosion of the surrounding plates.

The interior of all boilers should be kept as free from scale and deposit as possible, and the plates in external flues and flue tubes kept free from soot. A dirty boiler is a wasteful boiler, and is always more difficult to fire than a clean one.

Clean Thoroughly

It is important that cleaning should be very thorough when preparing a boiler for inspection. It is impossible to detect defects through thick scale or a layer of soot. The principal fittings, such as safety valves, should, if required, be taken to pieces for inspection, and should be thoroughly overhauled, when found necessary, before restarting the boiler.

The boiler should not be emptied under steam pressure. Whenever possible the water should be allowed to remain in the boiler till everything, including the brickwork setting, is cool. This prevents the comparatively soft scale being baked hard on the plate and makes it much more easily removable.

Never close a boiler until satisfied that no bags, tools, etc., are left in it, and always see that all openings such as blow off, safety valve, stop valve, check valve, and passages to glass water gauges are clear.

When once the safety valves have been properly adjusted to relieve at the authorized working pressure, no extra weights must be hung on levers, nor must a direct spring loaded valve be screwed down. If the valve leaks it should be ground in or otherwise repaired.

Avoid Holes in Fire

The fuel should be evenly spread, special care being taken to avoid "holes in the fire," i.e., bare patches of grate bars. Any cracks in the brickwork or other casing material should be luted up with fireclay or otherwise stopped. Such cracks allow cold air to enter, and tend to destroy the draught and greatly interfere with economical firing. Larger charges of fuel are not so effective as smaller quantities introduced more frequently.

Grate-bars should be kept clear of clinkers or they will quickly burn out. The clinker also prevents proper supply of air to that part of the grate it forms on. Every engineer should remember that his fuel bill runs into thousands of dollars a year, and that careless stoking may increase the amount very considerably, and is perfectly certain to throw a lot of extra work on himself.

The actual firing should be done as rapidly as possible, and of course judiciously, and the firedoor kept open for the shortest possible periods.

Use Damper

Fires should be regulated by the damper, and not by opening the firedoor. Dense smoke is always a sign of uneconomical firing. Entire absence of smoke may, on the other hand, mean that too much air is being admitted through the grids in doors. The best results with the least labor are obtained when the boiler is discharging a light smoke.

Most fuels require some extra air through the grids after firing. This, however, should be reduced as soon as the fresh charge is properly alight.

Grease of any kind should be carefully excluded from boilers. Serious overheating of furnace plates is likely to occur if even a very little grease finds its way into the boiler.

The proper place to treat feed water is before it enters the boiler, but if there be no means of doing this, great care should be used in the choice of a boiler compound. Where feed water is very sedimentary or corrosive, efforts should be made to procure a purer supply, or, failing this, the water should be analyzed, with a view of finding the best way of treating it. Generally speaking it is quite safe to introduce a few handfuls of common washing soda (or a lesser quantity of soda ash) per day, with a view of softening the scale and neutralizing any acidity in the water. The effect of any given quantity should be noted and the supply regulated accordingly.

Drain Water

Opening steam valves should be done carefully, otherwise serious damage may occur through "water hammer." All drain cocks on cylinders and any drain cocks on low-lying parts of the steam pipes or at stop valves should be opened, and when all water has ceased running from them the stop valve on the boiler may be slowly opened a little, gradually increasing the opening as cylinders and pipes become warm enough to prevent excessive condensation.

If a stop valve is suddenly opened to a range of pipes containing a lot of condensed water, a series of violent explosive knocks is heard, and these frequently result in the destruction of joints and sometimes split the pipes.

All steam pipe lines should be efficiently drained, and it should be remembered that "steam traps," though quite efficient for this purpose when pipes are in use and full of steam, are entirely inoperative when the pipes are closed and have a lot of water in them.

A boiler operator has many opportunities to either waste or save considerable sums in the course of a year for his employer, and it should be his aim to take an intelligent interest in his work and become as efficient as possible, and having done so he will find that his work is less arduous than if he performed in a careless or indifferent manner, and in addition to this, his services will be fully appreciated.

---

*Chief Inspector of Power Plant Operation, Western Australia.

The Victoria Lumber and Mfg. Co., Chemainus, B. C., is having plans prepared for a boiler house to house seven boilers, generating 4,600 h.p., and to cost $30,000.

The town council of Jonquiere, Que., is erecting a hydro-electric power development plant at a cost of $75,000 and will instal 1,500 and 1,800 h.p. turbines. J. M. Lacroix is clerk. J. F. Grenon, Cincinnati, Que., is engineer.

Halting Depreciation in Refrigerating Plants

By I. N. HULL

Practical Considerations the Operating Engineer Should Heed in Overhauling the Apparatus in Order to Retard Natural Wear and Tear

THE purpose of overhauling and repairing all parts of the mechanical equipment in ice making and refrigerating plants is twofold. In the first place, the various parts of the mechanical equipment may be operated at their highest efficiency only when they are in perfect mechanical condition. In the second place, the natural depreciation of the apparatus, that is, the natural wear and tear, will be retarded appreciably when all parts of the equipment are functioning properly.

In order that the operating engineer may ascertain accurately the operating efficiencies, defects in operation, etc., of all parts of the plant, it is necessary to study the plant thoroughly during the operating season, and at the same time keep an accurate record of the pressures, temperatures, etc., in all parts of the system.

By means of an accurate record of the temperatures, pressures, etc., of all parts of the system, the engineer will be able to determine such items as follows: The correct condenser pressure, the difference between the condenser pressure in his plant and the correct pressure, the most economical suction pressure, the difference between the most economical suction pressure and the one which he is carrying in the plant, the correct horsepower required for compressing the refrigerant, and the difference between this and the amount which he is actually expending in the plant, etc. By this method of procedure, he will be able to determine whether or not the conditions in his plant are normal or abnormal.

Must Keep Log

Also, during the operating season, he should study thoroughly the functioning of each and every part of the mechanical equipment. Any defects in the operation of the equipment should be noted and marked on the engine room log, or some suitable notation made. By keeping these permanent records of the operation of the different parts of the plant, the engineer will not only be in a more intelligent position to discover the defects of operation, but will be in a better position to eliminate or remedy them.

In reference to the type of engine room log to be used for any particular plant, it is to be observed that it is probably true that each particular plant should have its own individual engine room log. Although the plants may be used for the same purpose, this is useful in determining any defects in the mechanical equipment or working temperatures and pressures of the system. Therefore, the operating engineer should develop and maintain his own engine room log for his particular plant.

The engine room log should not contain too many items which tend to make the log not only complicated, but also would require too much labor to secure a proper record. The reading of the different gauges, thermometers, etc., should be taken every three or four hours, since the load on ice making and refrigerating plants is fairly constant during the period of a day.

To Tabulate Defects

After the operating engineer has secured and maintained his engine room log, and made all suitable notations relative to defects in the various parts of the plant, it is advisable for him to tabulate in some suitable manner those things which he deemed advisable to overhaul and repair during the slack season of the year. By going about his work in a systematic manner, according to a definite program, the engineer will find that his work will be lessened and at the same time none of the important items will be overlooked.

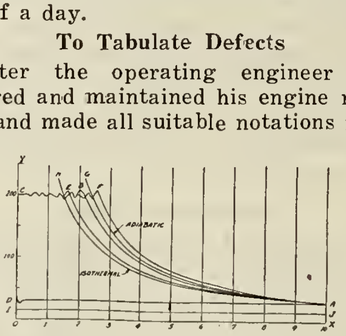


FIG. 1

A list of the mechanical equipment in any particular plant will be individual with the plant. On the other hand, the following items may be found helpful in making up a list for any particular plant:

High Pressure Side—Compressor; crank shaft; flywheel; ammonia condenser; ammonia condenser pan; oil interceptor; ammonia receiver; ammonia connections.

Low Pressure Side—Tank and partitions; brine coolers; tank coils; cans and can covers; brine agitators; can filler and hose; core suction pump; air piping; air connections; air blowers; filters; storage tank; water connections; water pump; can hoist; ice dump; brine pumps; brine piping and connections; direct expansion piping and connections; distilling apparatus.

Power Plant Equipment — Steam engines; boilers; boiler feed pumps; feed water heaters; steam exhaust connections; water connections; electric motors; internal combustion engines.

Miscellaneous—Ammonia; brine; insulation, etc.

Since the main compressor is probably the most important part of the compression refrigerating system, considerations relative to the inspection and overhauling of this unit will be given first. Also it is evident that the compression refrigerating system contains the majority of the moving parts of the system, so that it is reasonable to expect defects in the different parts of the compressor relatively sooner than in any other part of the system.

Indicating the Compressor

The action of the valves, packing, piston rod, connection rod, and main bearings should be observed closely while the machine is in operation, so that any irregularities may be carefully noted. One of the best methods of studying the action of the inside parts of the compressors is that afforded by the pressure indicator. The action of the valves and piston rings may be studied by this means.

If the compression of the vapor occurred in a cylinder which is composed of a non-conducting envelope, so that the refrigerant could neither absorb nor reject heat as such during compression, the compression curve on the indicator card would follow the adiabatic line, AG, shown by Fig. 1.

Under practical conditions, however, there are temperature differences between the vapor of the refrigerant and the metallic parts of the cylinder. Therefore, there will be some heat transmission between the parts, which, together with some other factors, tend to affect the relation of the actual compression curve to that secured under adiabatic compression. In general, it will be observed that when the compressor is in perfect mechanical condition, and when it is operated on the dry compression system, the actual compression curve will be only slightly below the true adiabatic curve.

This compression under actual conditions is represented by the line, AB, on Fig. 1, which lies near the adiabatic compression curve. The other reference curve is known as the isothermal curve, and is the curve which would show the relation of the pressures and volumes during compression at a constant temperature. The isothermal curve is shown on Fig. 1 by line AH.

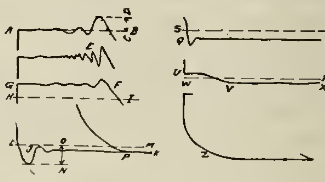


FIG. 2

With Clearance Reduced

All of the diagrams shown by Fig. 1 are assumed to have been taken from a compressor which has clearance reduced to the minimum. An indicator card such as shown by AFCD of Fig. 1 may be secured under some conditions of operation. By an inspection of the compression curve, AF, it will be noted that the pressures build up in the compressor cylinder faster than they should as the piston proceeds through the stroke. This condition could evidently be caused by the leakage of high pressure gas from the condenser back into the compressor cylinder during the first part of the discharge stroke. Also, practically the same effect would be noted should the gas leak past the piston from the opposite end of the cylinder.

Again, a diagram similar to the figure AECD might be obtained. By comparison to the theoretical adiabatic compression curve, it will be noted that the pressures do not build up as fast as they should, as the piston progresses through the stroke. It is evident that this condition may be produced by the leakage of the high pressure gas from the cylinder. This leakage may occur through the suction valve into the suction line, or through some other joint into the region of low pressure. The foregoing relate to defects that may be discovered by a study of the compression curve on the indicator diagram.

Discharge of Gas

It is interesting to note the defects which may be discovered by observing the line on the diagram which represents the discharge of the gas from the cylinder. In Fig. 2, the average condenser pressure is shown by line AB. The distance CD indicates the relative increase of the pressure in the cylinder above that in the condenser which is necessary to open the discharge valve. This condition may be produced by a sluggish or slow action of the valve, due to binding or sticking.

A tendency for the discharge valve, or other parts of the mechanism to vibrate is shown by E in Fig. 2. The same effect also may be produced by defects in the indicator mechanism. In some compressors, the gas may encounter too much resistance as it is being forced out of the cylinder.

The velocity of the gases through the passages in the cylinder may be exceedingly high, the valve spring may be too strong, or the valve may be too heavy, etc. Under these conditions, the pressure inside the cylinder must be considerably above that in the condenser during the entire discharge stroke. This condition is shown by line FG as compared to line HI of Fig. 2, line HI representing the average condenser pressure.

Study Suction Line

In a similar manner, the suction line may be studied in order to determine defects in the operation of the suction valve. If the suction valve sticks, or binds, the pressure in the cylinder may have to be reduced considerably below that of the suction line before the valve will open and the vapors of the refrigerant will flow into the cylinder.

The line ON of Fig. 2 shows a reduction of the pressure at the beginning of the suction stroke, while line JK shows the pressure during the remainder of the stroke under these conditions. Also, the suction valve may stick or bind so that it does not close until the piston has started on the compression stroke for a considerable distance. This is shown by the line KP.

If the suction valve spring is too strong, the pressures as shown by the lines OR and ST will be obtained, line ST representing the suction pressure in the suction main, and OR the pressure in the cylinder. If there is considerable leakage of the gas past the piston, or through the discharge valve from the condenser the pressure in the cylinder will not be reduced enough to allow the suction valve to open, until the piston has traversed a considerable portion of the stroke. This condition is shown by line UVX of Fig. 2.

Sometimes the leakage of the gas past the piston or from the discharge valve will not allow the pressures in the cylinder to be reduced as rapidly as they should. This gives a rounded expansion curve which is shown at Z in Fig. 2.

In the ultimate analysis, it will be noted that the engineer must not only be able to get a card which gives a picture of the conditions in the cylinder, but also be able to study and analyze all of the lines shown by the diagram.

Overhauling the Compressor

After having observed the functioning of the parts of the compressor in the foregoing manner, the compressor may be shut down at any convenient time for overhauling. The packing, piston and piston rod should be removed and subjected to close inspection. The relative condition of the packing is shown not only by the condition of the packing itself but also by whether or not the piston rod is worn and has shoulders. If the piston rod presents a highly polished surface, and is not worn appreciably, it is generally an indication that the packing is functioning in the proper manner.

If Rod Is True

In the event that the rod is true and not worn, a good form of metallic packing may be used to advantage. On the other hand, if the rod is worn considerably or is out of line with the centre of the machine, it may be advisable to pack the rod with eccentric fibrous packing rings in order to compensate for the misalignment and the wear on the rod. Of course, if it is considerably worn, it should be refinished and a new set of packing installed.

The proper functioning of any packing for the stuffing box on the compressor piston rod depends upon the presence of an oil film. The oil film under this condition serves really two purposes: first, to prevent the leakage of the medium under pressure, and second, to reduce the friction between the two solid surfaces. Therefore, in selecting and using packing for the compressor piston rods, one should bear in mind the true principle of any good packing for the compressor piston rods, and remember that it is not consistent to use a frictional material which depends upon the pressure between the two surfaces for prevention of the leakage of the medium under pressure.

Selection of Packing

Another consideration to be taken into account in the selection and use of packing is that of the temperature of the rod and compressor. In actual operation the compressors are subjected to different temperatures, due to operation on wet, dry or superheated vapor. The packing should have sufficient resiliency to maintain a tight joint under the foregoing conditions of temperature.

There are many types of ammonia packing which may be used to pack the stuffing box of compressors, pumps, valves, etc., in refrigerating plants. Among the types which are available at present, the following are the most important: collapsible tube metallic, flexible metallic, elastic metallic, fibrous or soft, and combination types.

The suction and discharge valves should be inspected closely. Generally, it will be necessary to grind them to a perfect seat and adjust the spring for quiet operation. The seat between the valve case and cylinder head must also be examined and, if found not perfect, it should be ground to a perfect seat. The piston rings should be inspected, and if they are found to be worn considerably and are loose in the grooves on the piston, they should be replaced by new rings. The inside walls of the cylinder should be examined for wear. If the surface has a high metallic polish, it is an indication that the cylinder is being lubricated properly and that the piston rings are mechanically perfect.

Have Cylinders Re-bored

In some cases, which is especially true of the larger types of horizontal machines, the cylinder will tend to wear out of round, under which condition, at suitable intervals, it is advisable to have the cylinders re-bored and re-finished. The condition of the bearings between the frame and the crosshead should be observed. As the wear goes on at these points it is sometimes necessary to re-babbitt the crosshead shoes, or to move the crosshead shoes so as to compensate for the wear. The main bearings should be inspected. In the event that these are considerably worn, they should be re-babbitted and re-finished. In the case where they are only slightly worn, it is generally possible to make adjustments, to make the bearings smooth, and to re-cut the oil grooves. Keys, wedges, bolts, etc., should be placed in such condition that they may be used for making the proper adjustment during the coming working season.

In the main, the work of overhauling the compressor consists of examining thoroughly and putting into serviceable condition each and every part of the compressor which may be subjected to wear.

Progress in New Power Equipment

ELECTRICAL EQUIPMENT

A MARKED advance in the elaboration and design of interior wiring and electrical equipment is presented in the recent completion of the Buckingham apartment house in Toronto.

This building contains thirty-four suites, and a very complete electrical installation throughout has been planned, with electric ranges, fixtures, and refrigeration supplied to all tenants.

The fixtures supplied in the suites are of the candelabra type and are a very attractive feature. Each suite has the following outlets: living room, four brackets, one switch and two base plugs; first bedroom, two brackets, one switch and two base plugs; second bedroom, two brackets, one switch and two base plugs; bathroom, one bracket, one switch and one outlet for electric heater; kitchen, one centre light, one switch, one outlet for electric iron and one outlet for stove.

The wiring throughout the entire building is installed in iron conduits, a one inch conduit containing three No. 6 double braid cable being distributed from the main board in the basement to an iron cut-out cabinet in each suite.

The electrical distributing board is an exceptionally fine installation. It consists of an iron gutter box 18 feet long by 14 inches high and 10 inches deep. In this cabinet, an illustration of which is shown, are mounted two 2 inch by ¼ inch buss bars in parallel for each leg of main feeders. These buss bars are held in place by ⅜ inch sheet fibre 14 inches by 10 inches, with slots cut for the buss bars to pass through. Switch connections are made with No. 6 cable, both ends of which are soldered into 60 ampere lugs.

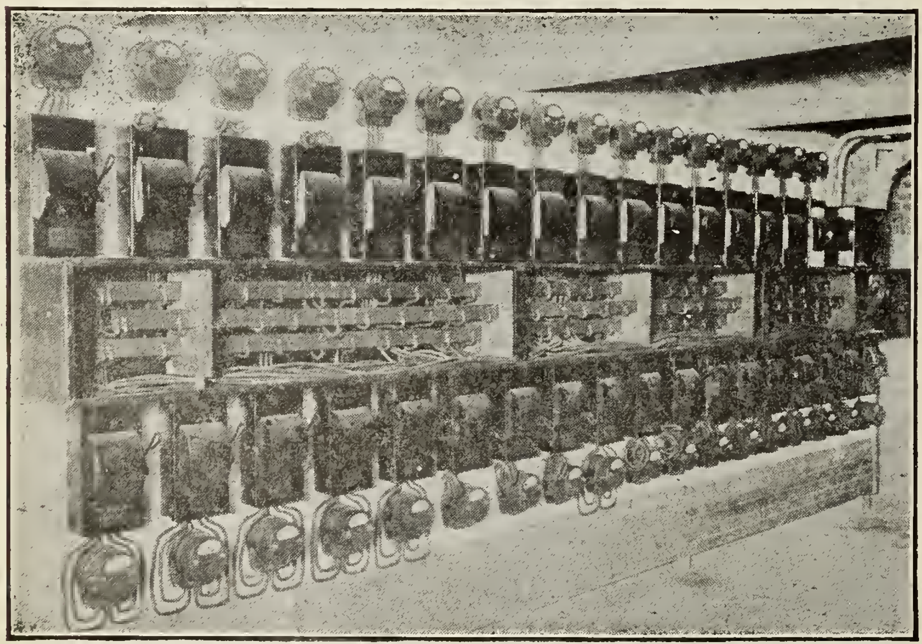
A slot is provided in the gutter box to provide ready access to the wires from the gutter box through the service switches to the meters and return. A metal bushing with flanged end forms a connecting link through this slot between service switch and gutter box. A strip of fibre with holes for the wires of the meter loop is mounted on the service switch.

This box and service equipment was designed and supplied by the Canadian Drill and Electric Switch Box Company, 1402 Queen St., East, Toronto. The service switches are of 60 ampere capacity and the main service switch is of 1,000 ampere capacity.

The main feeder leading from main service switch to the distributing board, a distance of approximately 50 feet, consists of three 1,000,000 single conductor rubber covered lead cable in a four inch conduit pipe.

Approximately 20,000 feet of conduit, 50,000 feet of wire, 1,038 outlets, 250 switches and 175 receptacles were used in the equipping of this building.

The suites are each served with a Bell telephone outlet as well as a private telephone to the main entrance, the Bell service of an underground 100 pr. lead cable from Queen Street connected to a distributing cabinet 36 inches by 36 inches by 5 inches and ¾ inch conduit runs from this cabinet to the various suites.



Distributing board recently constructed by the Canadian Drill and Electric Box Company, for installation in the Buckingham Apartment House, Toronto, marks a considerable advance in electrical equipment

The power wiring for 550 v., 3ph., 25 cycles supplies power for ice machine and the circulating pump for heating system.

The oil burning equipment has two ½ h.p. motors using 220 volts.

The complete installation was made by the Roxborough-Dean Ltd., 36 Front St., East, Toronto.

DAMPER REGULATORS

One of the later developments in the science of combustion control is the automatic control of the damper by means of the Craig damper regulator. This regulator, as applied to furnaces using forced draft, will maintain a constant pre-determined suction over the fire within two one-hundredths of an inch of water, regardless of load variations on the boiler or changing furnace conditions.

Although sensitive in operation, the Craig regulator requires little attention. By keeping a low constant draft over the fire not only is high CO_2 obtained and excess air cut down to a minimum, but the brickwork is protected against destruction due to sudden temperature changes.

The operation of the regulator is briefly as follows: From the furnace a two inch pipe leads under a zinc bell immersed in water. This bell is connected to a control piston and the two counterbalanced and compensated for buoyancy by suitable weights. The bell is of such size that the slightest variation in furnace draft results in a corresponding change in the position of the bell. The bell transmits its change of position to the control piston, which controls the water which operates the main damper piston. This piston is connected to the damper by cable. Thus the damper is opened or closed accordingly. The construction of the regulator results in the quick opening of the damper and slow closing. Any sudden pressure in the furnace results in the damper flying wide open. This gives protection in case of tube failure. The slow closing action eliminates the possibility of a pressure building up in the furnace.

RAPID PRESSURE FILTERS

There has been during the past year an increasing demand for small, easily operated, rapid pressure filters in small industries located where the water supply is taken from a creek or river, which is at times muddy. To meet this demand the Refinite Co. of Canada have designed and marketed a small steel

POWER PLANT EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA
TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK & WILCOX, LIMITED

Toronto Office
Bank of Hamilton Building

ST. HENRY—MONTREAL

shell filter with a single control valve.

The shell is made entirely of steel with electric welded joints, insuring a strong and durable container. The sand and gravel rests upon a steel diaphragm plate in the bottom, containing Refinite, two-piece, crown-head, brass sand valves, which are strong and durable. The usual depth of sand bed is used.

The single control valve permits easy operation of the unit, and no confusion can exist when performing the required operations during washing periods. The valve is controlled by one lever with a pointer attached operating in connection with a dial on which is plainly marked the various operations. This valve is constructed upon the cock principle, and is very durable and simple in construction.

These filters are also equipped with a sight glass to observe the condition of the water, and a coagulant feeder for mixing with the raw water the necessary aluminum sulphate, which insures more efficient filtration.

Larger units are constructed similar to these smaller ones for large industries. They do not contain the single control, however, because from experience it has been proven that this type of valve is not efficient in the larger sizes.

MECHANICAL STOKERS

During the past year the Under-Feed Stoker Co. of Canada have perfected an entirely new type of electrical drive for underfeed stokers. This drive replaces the devices heretofore in use and is so designed as to retain all the best features of stoker practice. It allows of entirely automatic, individual control of each retort, and in cases where exhaust steam is undesirable, or in low pressure and heating plants where boiler pressure is insufficient to operate the stoker rams, it provides an entirely satisfactory and desirable drive.

A small one h.p. reversible motor is mounted on top of the outer end of the stoker, and, by means of roller chain, drives a large screw threaded shaft on which rides a nut fixed to the ram. The motor is operated in one direction to pull the ram out and is reversed to drive the ram in. A release device is provided which prevents the ram from overrunning.

The forward and reverse movement of the motor is governed by a special revolving contactor which is usually driven from the forced draft fan shaft, but may be operated by a small separate motor if desired.

The contactor is operated by means of an adjustable ratchet device so that the amount of coal may be adjusted by hand if desired, and where the fan is driven by a constant speed motor the stoker can be automatically controlled.

Where the fan is driven by a variable speed motor or a steam engine the coal feed varies with the amount of air delivered, as the contactor is driven directly from the fan shaft and keeps step with the fan at all times.

This electric drive provides for the necessary quick inthrust of the coal and consequent breaking of the fire, so essential in good firing, and uses less than 1-3 h.p. per hour, due to the fact that the motor stands idle for a great part of the time.

There are four moving parts to the stoker—ram, nut, screw and chain drive. All these parts are completely enclosed and are self-lubricating.

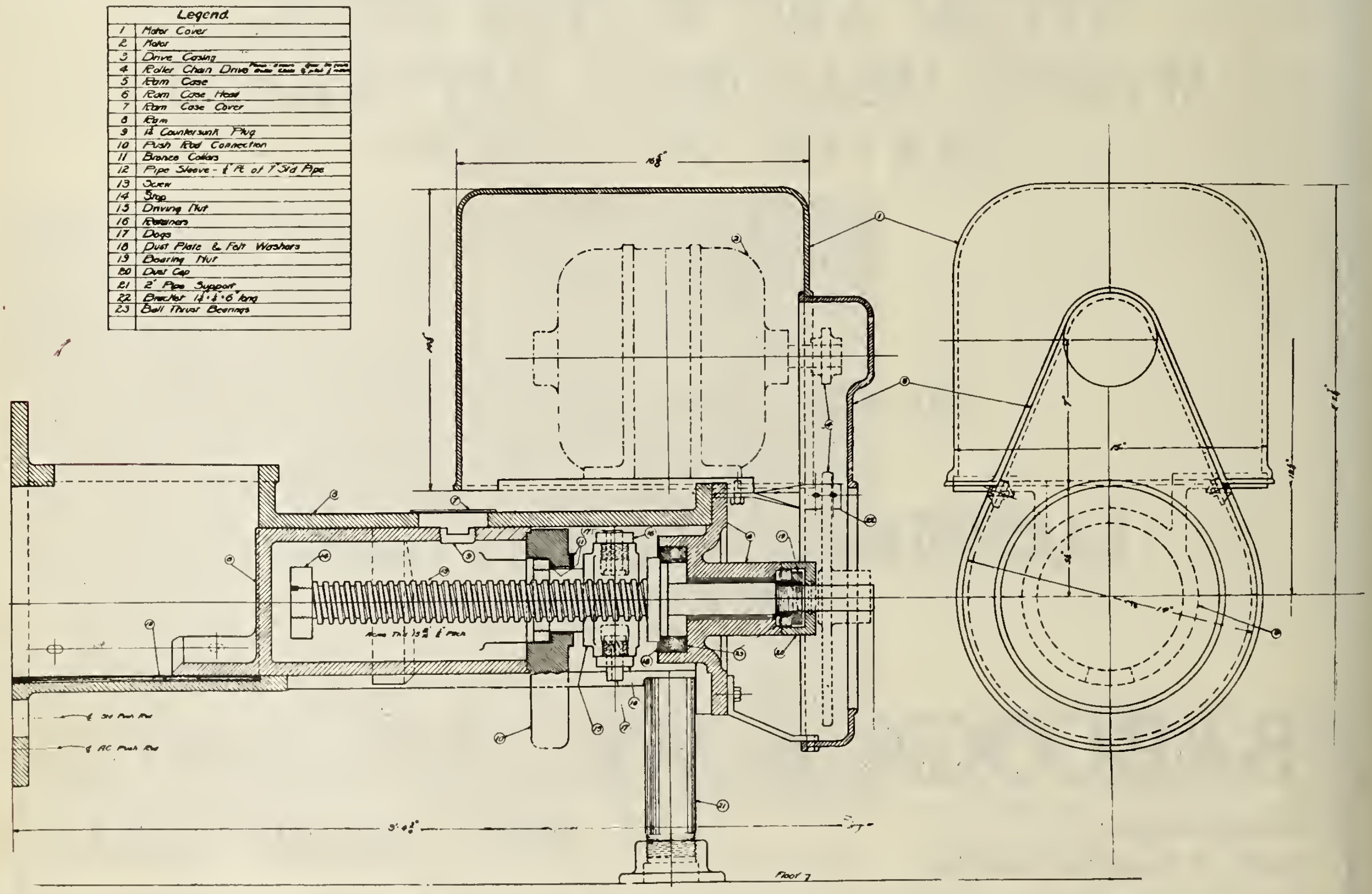
The contractor switch is of the oil-immersed type and is very simple and rugged in construction.

WATER SOFTENERS

Many improvements have been made on Refinite Zeolite water softeners during the past year, with the result that the units now have a larger capacity, with the space required for installation reduced to a minimum. The efficiency has also been increased due to a change in the direction of the flow of the water through the softener.

The direction of flow was changed from a downward to an upward flow after making laboratory and practical experiments. The latter method of operation was found to be superior to the former for the following reasons:

The pressure of the raw water in flowing up through the refinite mineral bed separates the mineral grains from each other, thereby allowing the water to come in contact with the entire sur-



Electrical Drive For Underfeed Stoker.

CLASSIFIED ADVERTISEMENT

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the c

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see thu books. No obligation to pay unless you are satisfied. Send coupou now--today and get this new master set for engineers. Pay only $1 a mouth.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you , 1 monthly until $12 is paid.

Signature ____________________

Occupation ____________________

Employed by ____________________

Rasidauce ____________________

Referenca ____________________

POSITIONS WANTED

FACTORY SUPERINTENDENT—OR CHIEF Engineer is open for engagement. Have had wide experience in operating power plants and handling help in Canada. Apply Box 107, Power House.

EQUIPMENT FOR SALE

NEW AND USED MACHINERY AND SUPplies; get our prices for machinery on monthly rental. Apply Box 113, Power House.

PIPE THREADING TOOLS—"TOLEDO" AND "Jardine" are the best; catalogue P-3 tells you; all sizes up to 12-inch at one cut by one man. A. B. Jardine and Company, Limited, Hespeler, Ontario.

PIPE AND BOILER COVERINGS—ENGINE packings. Apply Box 114, Power House.

SAWMILL MACHINERY MANUFACTURED by sawmill machinery specialists. Apply Box 115, Power House.

SAWMILLS—PORTABLE—DOUBLE EDGERS; also all kinds of sawmill machinery. Apply Box 116, Power House.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—with house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

POWER PLANT FOR VILLAGE OF TIGNISH About 18 kil. hour capacity 110 to 220 volting alternating current. Apply to John A. Hackett, Box 67, Tignish, P. E. I.

PISTON RINGS

EVER-TYTE and ZELCO Piston Rings with Patented Zelco Process Save Gasoline, Oil, Increase Capacity, Prevent Cylinder from Wearing Out of Round, Lessen Carbon; after using, make arrangement with us to sell them; made up to 80-inch; used in Locomotives, Boats, Engines, Compressors, Ice Machines, Autos, Trucks, Tractors, etc.; are looking for distributors with mechanical knowledge; all or part time; real opportunity. Ever-Tyte, St. Louis, Mo.

M.BARRY WATSON

B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer

Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W

J. A. BURNETT,

M.E.I.C., P.E.Q.

CONSULTING
& APPRAISAL
ENGINEER

Room 301—205 St. James St.
Telephone Main 6737. Montreal.

Buyers Guide Pages 78 - 80 - 82

WATER TUBE TILES

Special Firebrick Shapes, Slabs, Furnace Arch Brick, Stoker Bricks, Etc.

Made to withstand Highest Temperatures

BELL FIREBRICK CO.

1347-51 DUFFERIN ST.
KENWOOD 4335 TORONTO

BOILER SETTINGS

SPECIALISTS IN

FIREBRICK AND ARCHWORK

FOR EVERY TYPE OF STEAM BOILER

A. E. RULE CO.

122 Garden Av. TORONTO Lakeside 1274

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

face of each grain, insuring maximum softening efficiency.

The raw water first flows through the strainer system which is in the bottom of the softener container, and any dirt or foreign matter which might be in the raw water is caught before it enters the mineral bed.

The possibility of channeling is entirely eliminated, because the raw water is uniformly distributed through the strainer system, which equalizes the pressure throughout the mineral bed, reducing the packing tendency to a minimum.

The raw water coming in contact with the lower portion of the mineral bed first would contaminate this portion the most. The brine solution enters the softener container near the bottom and purifies this portion of the mineral bed first before continuing through the mineral bed and purifying the remainder of the mineral. This feature is very important, because maximum regenerating efficiency is thus obtained.

Flanged valves and fittings are now used exclusively for the valve nest on softeners. This type of fitting permits an easy assembly of fittings, and allows any part which might become damaged to be removed without dissembling the entire nest.

The steel containers are equipped with a steel diaphragm plate in the bottom, containing Refinite two-piece, crownhead, brass sand valves, which are strong and durable. The mineral bed rests directly on this plate. All concrete fill which was formerly necessary when the old manifold pipe system was used for water distribution has been discarded entirely.

CANADA STOKER SALES

"Business during the past year has been good, although it could be better in some localities," stated W. M. McRobert, sales manager of the Canada Stoker Co., recently.

The Canada Stoker is simple in operation and readily adaptable to boilers, especially of the horizontal return tubular type.

In operation, fuel is fed to a hopper of about 450-lb. capacity, usually two hoppers to a boiler. Directly under each hopper is a simple reciprocating feed plate actuated by an eccentric and curved vertical arm. Power is supplied from a shaft driven by a roller chain.

The to-and-fro motion of the feed plate causes the fuel in the hopper to slowly work down on a flat table surface, formed integral with the stoker. The fuel is then gradually pushed along by the action of the feed plate until it reaches the revolving blades of the stoker.

These blades, revolving at about 270 r.p.m., strike the fuel as it is fed and deliver it continuously to the furnace in a manner which might be likened to a light shower of rain. The different curvature of each blade distributes the fuel over the full grate area.

The blades operate at a constant speed, and are independent of the feed plate and control device.

The rate at which the fuel is supplied to the distributing blades is governed entirely by the fuel control hand-wheel, varying from nothing to a ton or more per hour. A simple feed latch may be instantly disengaged, stopping all feeding at once.

The advantages claimed over hand firing are as follows:

Even and constant supply of fuel to the furnace with the doors closed.

Uniform supply of air to the fuel bed with the fire doors closed.

The absence of black smoke.

Ability to use low-grade fuels which cannot be burned when fired by hand.

A constant steam pressure.

Ability to maintain a thin fire not over 4 inches in thickness, giving the best possible combustion.

In the chain grate stoker, made by the Canada Stoker Co., many improvements have been incorporated.

The stoker is designed with special air seals both at the sides and rear of the grate, hence all the air required for combustion must pass through the stoker links.

The links can be readily renewed while the stoker is in operation.

Either natural or forced draft may be used with the stoker.

A special feature of the stoker is the continuous drive. A totally enclosed removable gear case with 7 changes of speed, varying from 1½ to 12 inches of grate travel per minute is provided. This feature is of particular value in power plants having large variations in load.

The grate links are narrow and deep, giving maximum air space, evenly divided. The diagonal ribs give rapid combustion with minimum sifting of fine fuel.

Miscellaneous

The John T. Hepburn, Ltd., Toronto, propose an extension of their foundry by taking in a section of their plant formerly used for storage. A large new tumbler was recently installed in this foundry, and a new molding machine for which the company has secured the Canadian manufacturing rights, will shortly be brought into service. The Hepburn foundry has been running continuously since the war, chiefly on engineering work. A notable job going through at present calls for the production of 1,164 chain pieces, each weighing 250 lbs. For the Toronto incinerating plant 250 tons of castings are being molded and machined.

John T. Hepburn, Ltd., are erecting the steel work for the Northern Canada Power Co.'s new sub-station at Shumacher, Ont.

Orders for Canada stokers have recently been received from Lever Bros., Toronto; St. Croix Soap Co., St. Stephen, N. B.; J. H. Dunlop & Son, Co., Richmond Hill, Ont.; Canadian Industrial Co., Corbyville, Ont.; C. Turnbull Co., Galt; Western University, London; H. J. Mills Co., Richmond Hill.

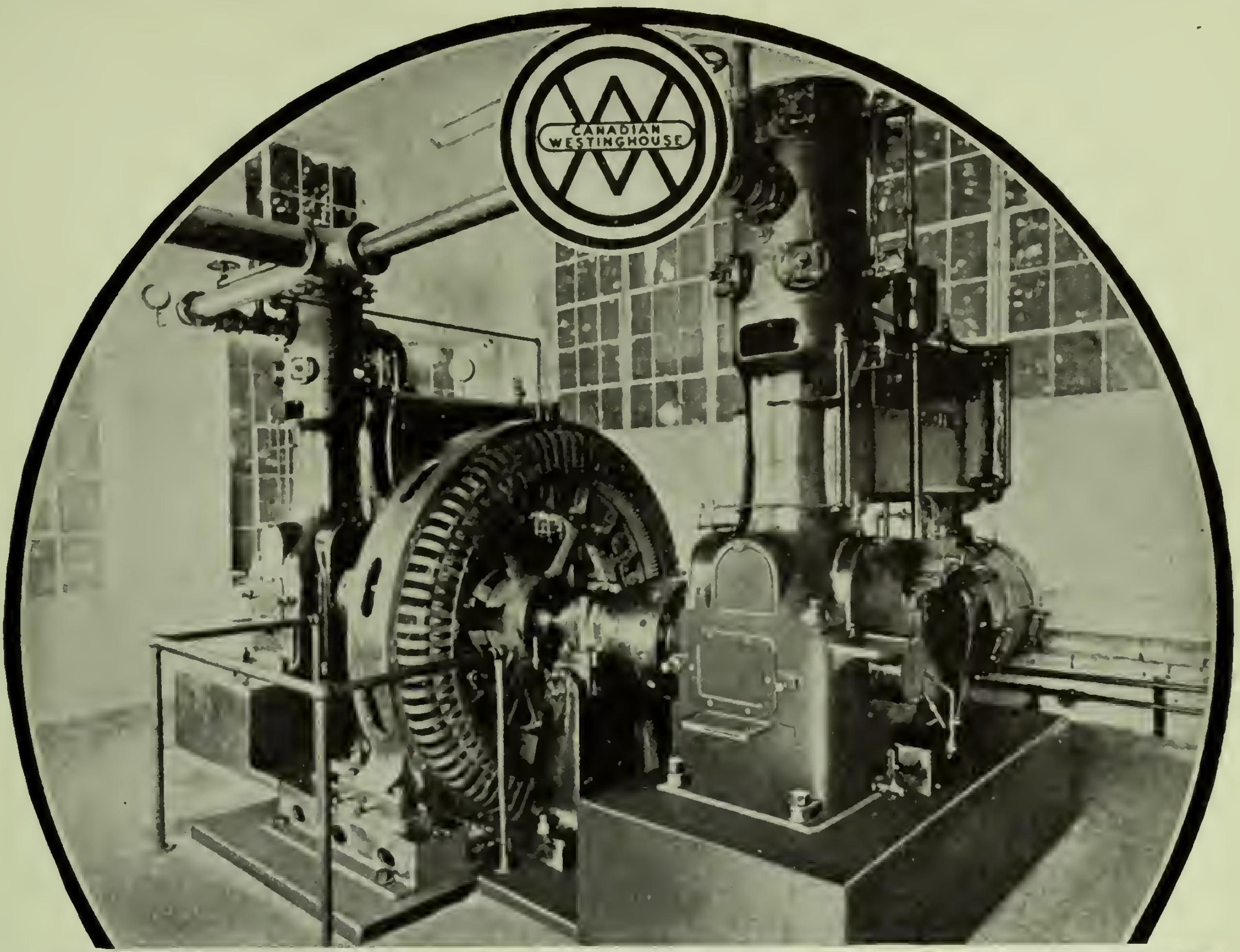
S. B. Nichol, John St., Blenheim, is in the market for electric motors for planing mill.

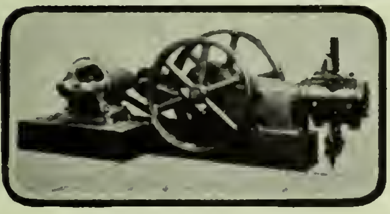
A. Milne, Blythe, is in the market for complete equipment for a hydro-electric lighting and power distribution system for the council. The work will be under the direction of the Ontario Hydro Commission, London, and the estimated cost is $28,000.

The Council, Cayuga, A. Coulter, Reeve, contemplates the installation of a hydro-electric system at an estimated cost of $30,000.

In This Issue

Editorial Point of View 27
By Campbell Bradshaw
Japanese Foreword 28
Big CO_2 Savings 29
By Robert June, A.S.M.E.
Transformer Gear Protection 32
By S. Austen Stigart, A.M.I.E.E.
Lubrication and Its Effects 35
By Edward L. Gross.
Trade Catalogs 38
Power Production Control 39
By Charles L. Hubbard.
Choosing Electric Motors 42
By C. N. Johnson.
C.A.S.E. Notes 43
Pipe Lines 43
Easy Engineering Lessons 44
By M. Barry Watson, B.A.Sc., M. E.
Power Notes 49
Obituary 49
Care of Transformers 50
By J. A. Burnett, M.E.I.C.
Practical Ideas 51
Water Column Valves
Count The Explosions
An Extension Shaft
Valve Closing Dangers
Reducing Valves
How Many Barrels?
Answers to Problems 53
Cleaning Up An Engine
Direction of Compressor
Draft Losses.
Boiler Horsepower.
Resulting Temperature
Setting Valves
Lubricating Cylinders
Velocity of Discharge
Cylinder Re-evaporation.
Convention Notes 54
Fan and Pump Pulleys 56
By A. E. Hewitt.
Duties of an Engineer 57
By C. J. Mathews, M. Inst., C. E.
Refrigerating Plant Depreciation ..58
By I. N. Hull.
New Power Equipment 60
Distributing Boards
Damper Regulators
Rapid Pressure Filters
Mechanical Stokers
Water Softeners
Canada Stoker Sales





MOTORS with Experience

The question you ask of a man whom you expect to place in a responsible position is—"What is your experience?" So you should ask about motors. Experience—over thirty years of it—ten million horse-power of it—is a big item in Westinghouse motors. The instinct for technical rightness, the know-how, the beauty of mechanical and electrical competence—these things, that experience only can provide, are the fundamental superiorities in motors that bear the Westinghouse mark.

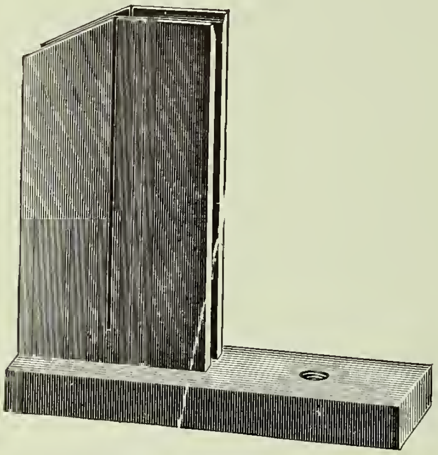
Canadian Westinghouse Company, Limited, Hamilton, Ontario

TORONTO, Bank of Hamilton Bldg.
HALIFAX, 105 Hollis St.
CALGARY, Canada Life Bldg.
MONTREAL, 285 Beaver Hall Hill.
FT. WILLIAM, Cuthbertson Block.
VANCOUVER, Bank of Ottawa Building.
OTTAWA, Ahearn & Soper, Ltd.
WINNIPEG, 158 Portage Ave., E.
EDMONTON, 211 McLeod Bldg.

Westinghouse

Use "Canadian Made" Not "Canadian Assembled"—"Keep Your Money in Canada"

Milled Type.



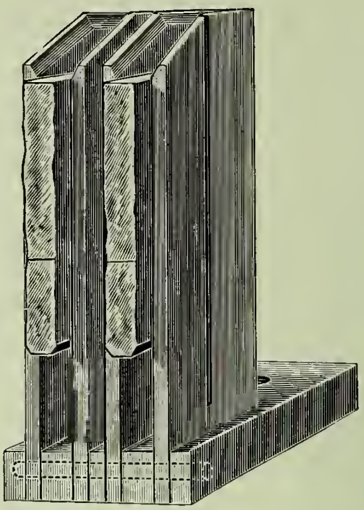
200-400 Amps.

Manufacturers of

Lighting Cabinets
Service Boxes
Cutout Boxes
Pull Boxes

STEEL BOXES & CABINETS FOR ALL ELECTRIC INSTALLATIONS

Milled Type.



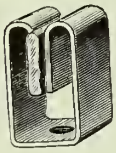
600 Amp. and over.

DISTRIBUTING BOARDS for Apartment Houses and Office Buildings. SPECIAL STEEL CABINETS with Knife Switches and Outside Control for Power and Heavy Duty Lighting Panels.

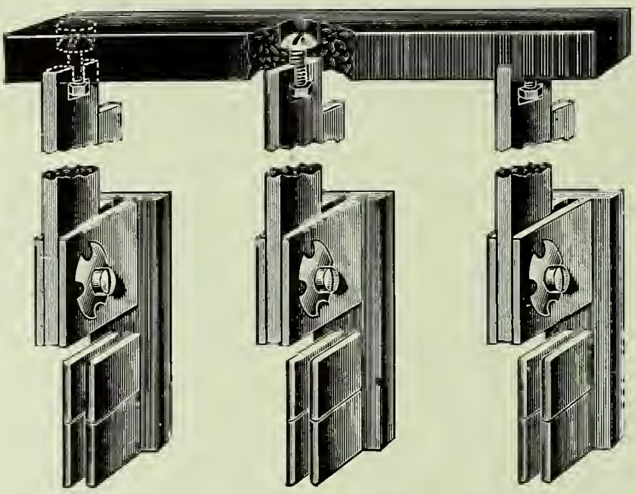
Switches of 200 Ampere capacity and over are made with Milled Type Break Jaws and Fuse Clips, the same type as used on all high class work such as Power Switch Boards. This type of jaw insures proper contact for heavy loads.

Switches of 100 Ampere capacity and under are made with Punch Clip or Formed Type Break Jaws and Fuse Clips. Same type as used by some of our competitors for all switches. This type of jaw and clip do not give proper contact for loads of 200 Ampere and over and frequently break down under their rated load.

Formed Type.

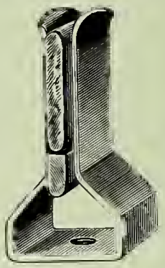


30-60 Amps.



200 Amp. and Over.

Formed Type.



100 Amp.

All our Switches are equipped with heavy one-piece Fibre Knife Blade Cross Bars which are strong both mechanically and electrically.

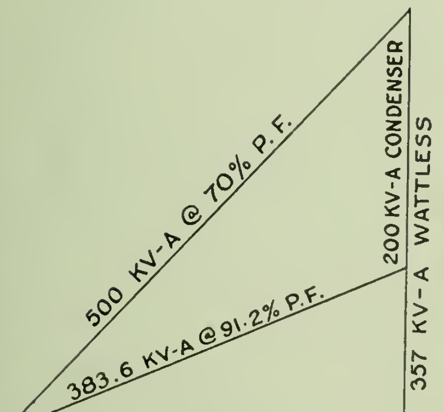
Canadian Drill & Electric Box Co., Limited

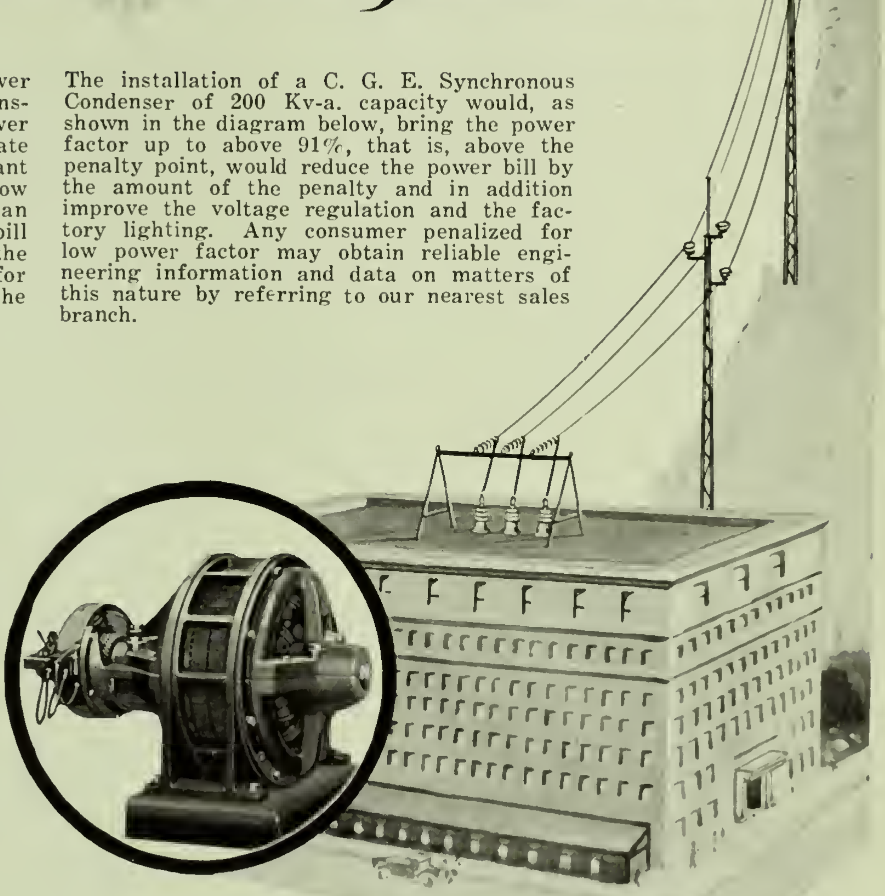
1402 Queen St. East, Toronto, Ontario

Why Is Low Power Factor Penalized?

A factory load of 350 Kw. at 70% power factor requires station equipment and transmission line capacity, that at 100% power factor would deliver 500 Kw. To compensate the Central Station for the 150 Kw. of plant rendered unavailable for revenue by the low power factor the consumer is charged an amount, and properly so, in excess of his bill for energy used. This charge in excess of the power bill is in the nature of a penalty for low power factor and is a 100% loss to the consumer.

The installation of a C. G. E. Synchronous Condenser of 200 Kv-a. capacity would, as shown in the diagram below, bring the power factor up to above 91%, that is, above the penalty point, would reduce the power bill by the amount of the penalty and in addition improve the voltage regulation and the factory lighting. Any consumer penalized for low power factor may obtain reliable engineering information and data on matters of this nature by referring to our nearest sales branch.



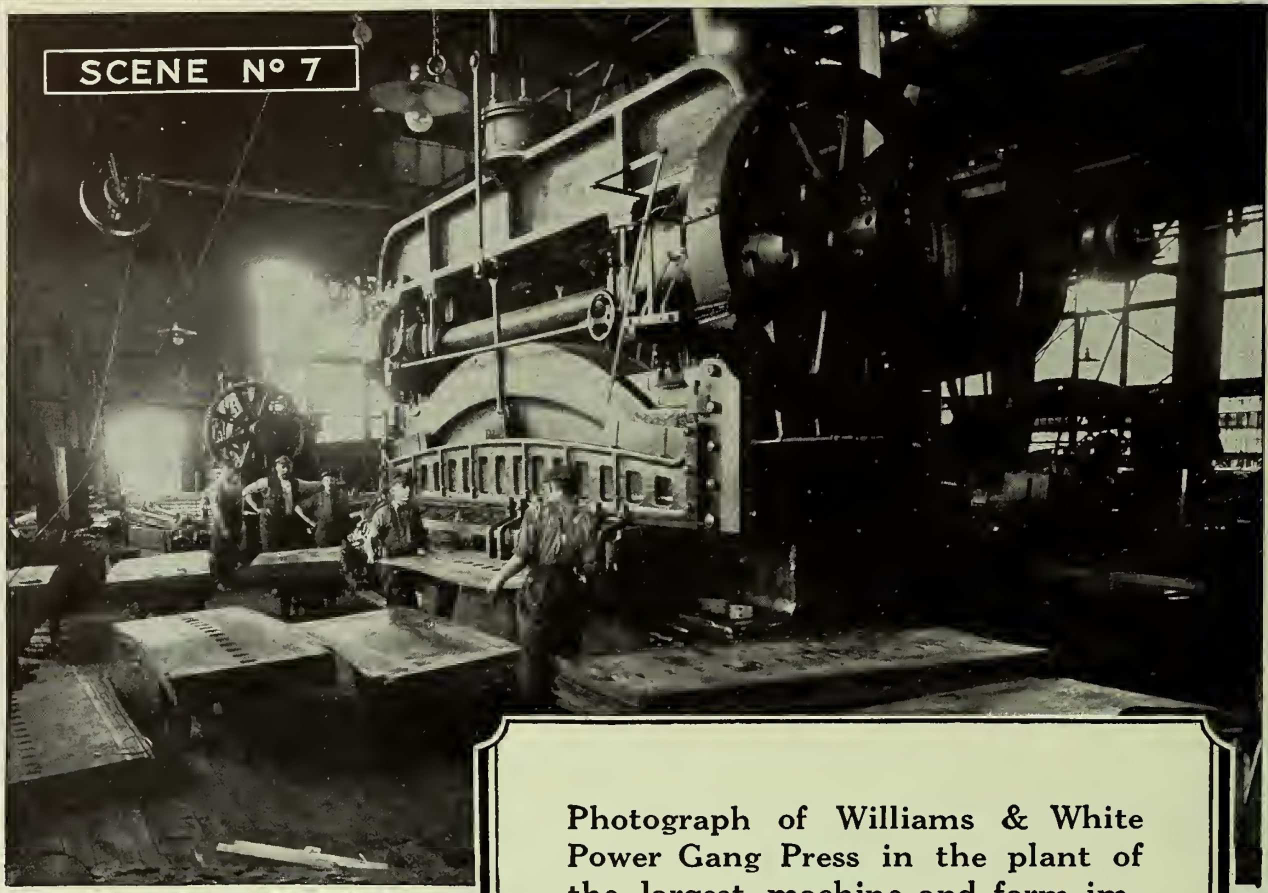


"Made in Canada" by

Canadian General Electric Co., Limited

HEAD OFFICE TORONTO

Branch Offices: Halifax, Sydney, St. John, Montreal, Quebec, Cobalt, Ottawa, Hamilton, London, Windsor, South Porcupine, Winnipeg, Calgary, Edmonton, Vancouver, Nelson and Victoria.



Photograph of Williams & White Power Gang Press in the plant of the largest machine and farm implement manufacturers in Canada.

Imperial Lubricant used:
Imperial Engine Oil.

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

The care and skill which goes into the manufacture of Imperial Lubricants justifies the confidence with which these specialized oils and greases are used in leading Canadian plants.

The right grade of Imperial Lubricants will meet the lubricating requirements of every type of machinery unit, large or small.

A letter to our nearest branch will bring the advice or services of our expert lubrication engineers.

IMPERIAL OIL LIMITED

*Better
Quality
Fittings*

**INTERNATIONAL
MALLEABLE
IRON**

Fittings Made from the Best Quality of Air Furnace Refined Malleable Iron

English and American Standard, made in flat band and plain patterns. Equipped for quality and prompt service. Special fittings made on short notice. Prices quoted on receipt of blueprints or samples.

International Malleable Iron Co., Limited
Guelph, Ontario

Making front door arch of Plibrico.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman & Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Building Products & Fuel, Ltd., Saskatoon; Dominion Lime & Coal Co., Regina, Sask.

Why fire brick can never rival Plibrico—

SUPPOSE you could weld all of the bricks in your furnace together in one solid mass—wouldn't it be a far better furnace? Wouldn't it last far longer with the joints as good as the brick?

Plibrico eliminates those weak spots—the joints. No furnace—regardless of the quality of fire brick used—can be better than its weakest joint. And therefore fire brick can never be made good enough to even rival jointless Plibrico.

It is pounded into any shape desired with a mallet, then troweled smooth. Heat vitrifies it into a rock-like, air-tight, gas-tight lining that resists temperatures to 3,100° F. Use it wherever fire brick can be used.

Plibrico is delivered only in steel containers of distinctive appearance, as shown opposite.

PLIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO
CLAY ST CHICAGO

Ask for "Refractories and Furnace Design"—the new book, 32 pages, 8½ in. x 11 in.

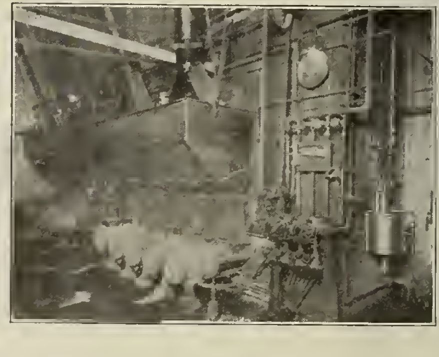
They improve any power plant

Cash Reducing and Regulating Valves

Cash Standard Regulators range from simple reducing valves to auxiliary controlled regulators, engine governors and similar reducing and regulating specialties. All embody principles that have been proved unsurpassed by years of extensive use. The catalog tells why they can't stick or bind — why wire drawing is greatly reduced—why regulation is dependable and service life longer. Write for it.

The Craig Damper Regulator

By keeping the damper automatically adjusted to the point of highest combustion efficiency, Craig Damper Regulators pay enormous dividends. The Craig employs the proper regulating medium — velocity over the fire. The installation increased average CO_2 two per cent., effecting a coal saving that quickly paid for the equipment — and this was in a plant where the dampers had always been intelligently and carefully regulated. Ask for the catalog.



RILEY JONES
The UNDER-FEED STOKER COMPANY OF CANADA LTD.
MURPHY

The Under-Feed Stoker Co., of Canada, Ltd.
146 King Street, West, Toronto

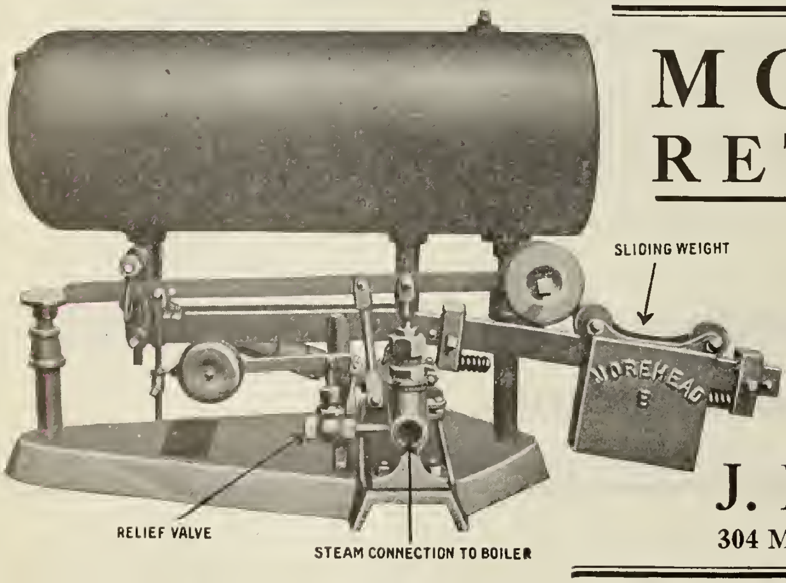
Sales Agents for: Jones Stokers, Riley Stokers, and Murphy Automatic Furnaces

Alta. & West. Sask.:
Mr. J. Twomey, Camrose, Alberta.

Man. & East Sask.:
W. W. Hicks & Co., Winnipeg.

British Columbia:
E. A. Earle, Ltd., Vancouver, B.C.

Quebec:
The Cleaton Co., (Can.) Ltd., Montreal, Que.



MOREHEAD RETURN TRAP

Will Rectify and Raise the Efficiency of Any Steam Service

THOUSANDS OF TONS of coal are saved annually in the plants which are MOREHEAD equipped

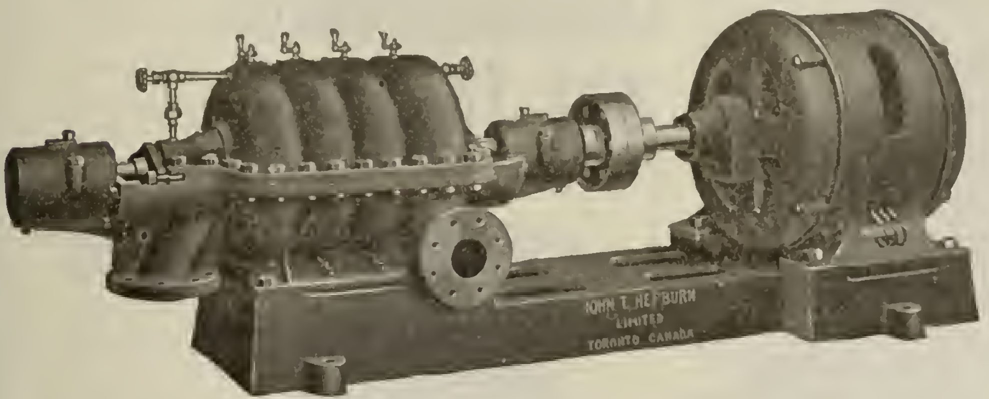
34 Years on the Market—Known the World Over

J. E. FARRELL DIRECTOR OF SALES
304 Manning Chambers, TORONTO, ONT.

On the Job Fifty-two Weeks Each Year

HEPBURN products have merited in the past and are now maintaining their enviable reputation for high efficiency and long, unfailing service.

Illustrations are typical of the lines in which we specialize.

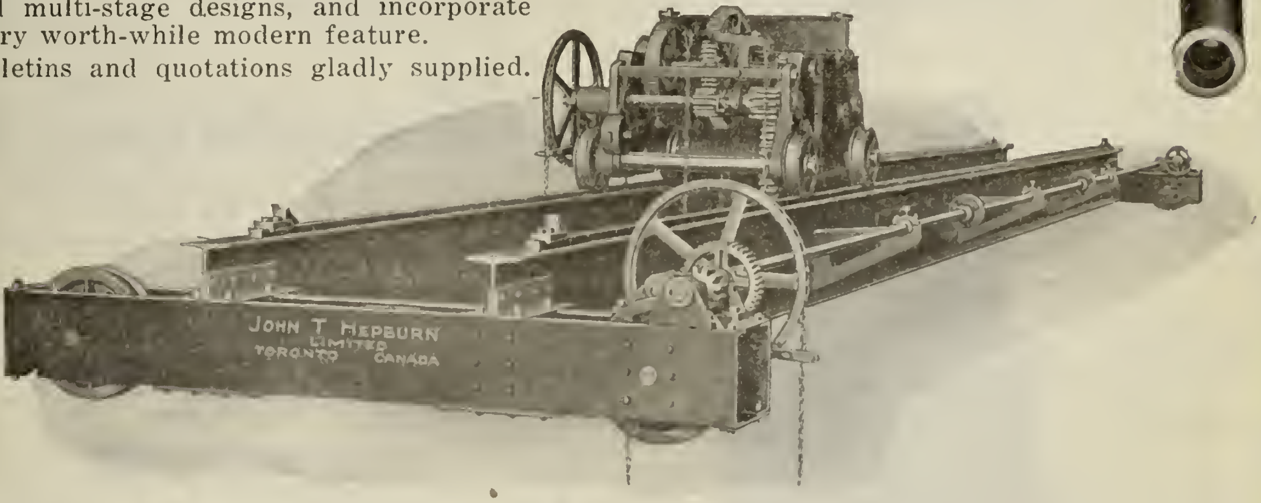


Hepburn Fire Hydrants are widely recommended as standard equipment for all services.

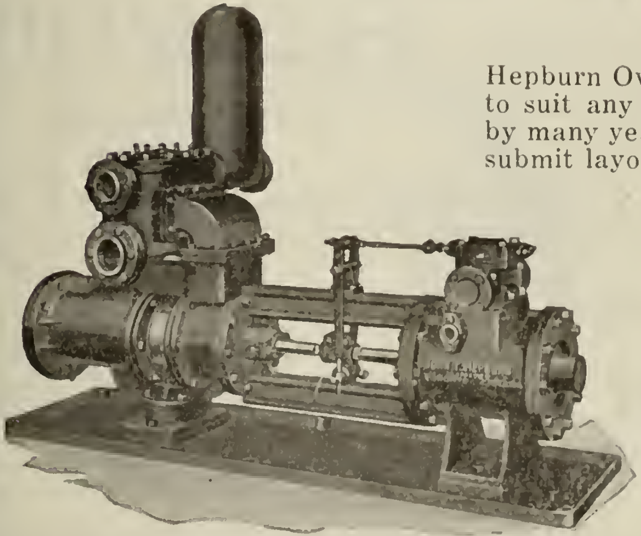
We can give you attractive prices on any quantity.

Hepburn Centrifugal Pumps are made in single stage, single and double-suction and multi-stage designs, and incorporate every worth-while modern feature.

Bulletins and quotations gladly supplied.



Hepburn Overhead Cranes and Heavy Duty Derricks are built to suit any condition of service. Our engineers are backed by many years of experience in these lines and we will gladly submit layouts and estimates.



Hepburn's Reciprocating Steam Pumps are built for boiler feed, vacuum and general service, in a variety of types and in all sizes.

These are illustrated and described in our general catalogue, which we will mail promptly on request.

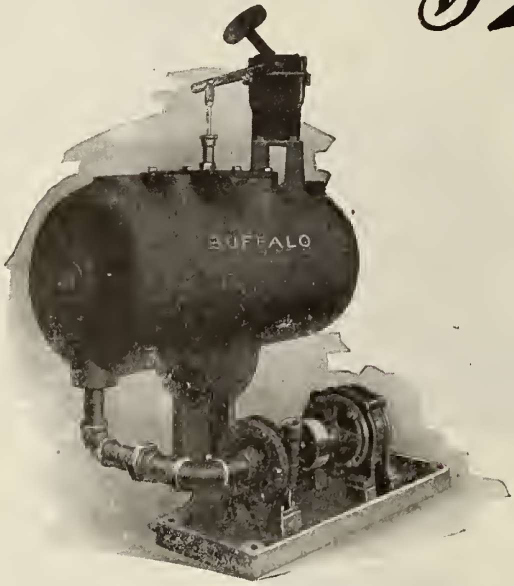
JOHN T. HEPBURN, LIMITED

18-40 Van Horne Street, Toronto, Canada

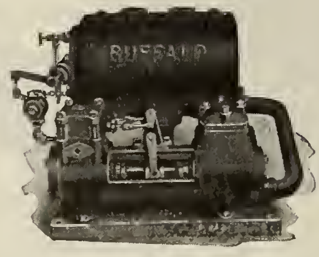
"Buffalo"

MADE-IN-CANADA

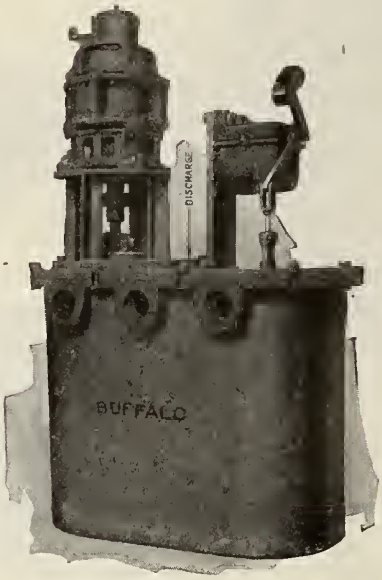
PUMPS



Horizontal



Duplex Steam Pump and Receiver



Vertical

Condensation Return Pumps and Receivers

If it's a **Buffalo** design you can rest assured of its up-to-the-minute construction and serviceable qualities. Herewith are illustrated **Buffalo** Automatic Outfits for returning condensation from heating systems and steam coils on low pressure systems.

Your attention is drawn to the vertical outfit—it eliminates the necessity of setting the pump in a pit.

Buffalo steam-driven condensation pumps are made for both high and low boiler pressures. They are self-contained and entirely automatic. There's a **Buffalo** to meet your requirements. Send for bulletin.

The same high standard of design and construction is maintained in these Canadian-made "Buffalo" Pumps as has characterized the product of the parent company for the past 25 years.

Made in Canada by

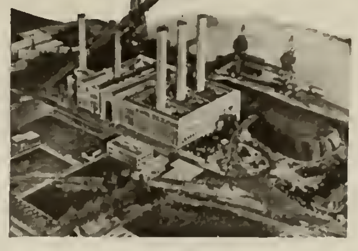
Canadian Blower & Forge Co.

Kitchener, Ontario

Fewer Shutdowns

when you have

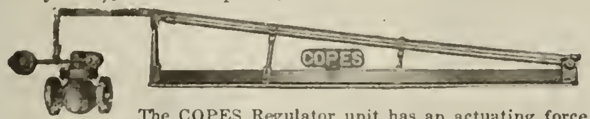
COPES



One of the many well-known COPES users—Consolidated Gas, Electric Light & Power Co., Baltimore, Md. They have 70 COPES.

No important power plant, large or small, can afford to risk "shutdowns." That's why nearly all important plants use the COPES System of Boiler Feed Water Regulation.

Being the simplest and most rugged regulator, COPES gives boiler feeding that is continuous — practically 100% "trouble-proof."

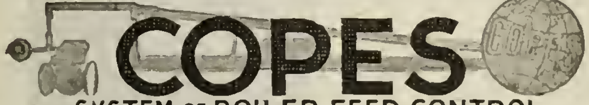


The COPES Regulator unit has an actuating force 100 times greater than the valve resistance— COPES is entirely free from lag. Every COPES Regulator is guaranteed to pass the required amount of water at a given pressure drop.

Savings of 2% to 8% in fuel are reported after installing the COPES— also savings in labor, and increased boiler efficiency.

By fuel savings alone, the COPES will quickly pay for its installation in your plant. Let us estimate the savings that you can make. Write today for Catalog D.

NORTHERN EQUIPMENT CO., 112 West 11th St., Erie, Pa.
Branch Plants: Hamilton, Ontario, Canada; London, England; Paris, France; Merseburg, Germany; Vienna, Austria; Milan, Italy.

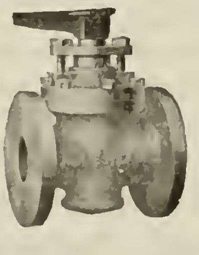

COPES
COPES
SYSTEM OF BOILER FEED CONTROL

For Real Plug Cock Valve Service

Standardize on

HOMESTEAD

Quarter-Turn Valves



After all plug cock valves are the real thing for every service. Their superiority over Globe, Gate and elaborate designs is as well known as their age. And of all in use to-day, Homestead Quarter Turn Valves are the most outstanding.

In Homestead Valves the plug cock provides a straightway opening, very important in high pressure service. They are easy to operate, the plug cock closing by a quarter turn. Made in two, three and fourway types.

There are many other features fully described in our catalogue. Write for a copy today.

Homestead Valve Mfg. Co.

Homestead, Pa., U. S. A.

SIL-O-CEL
TRADE MARK REGISTERED U.S. PAT. OFFICE
A CELITE PRODUCT

162 Tons of Coal Saved per Year

QUANTITIES of fuel consumed in combustion never become productive. Heat is generated, but all of it is not utilized. From every surface there is constant heat radiation,—a source of unnecessary waste.

Sil-O-Cel Insulation forms a barrier to heat leakage, and in stopping this loss saves fuel. Take for example, an ordinary 500 H. P. Boiler. The fuel savings accomplished by installing a course of Sil-O-Cel Insulating Brick through the walls and over the tops of such a boiler will average 162 tons of coal saved per year. Savings are proportionate with other fuels—and in kilns, ovens, furnaces, oil stills, etc., the savings are even greater.

The facts regarding Sil-O-Cel show it to possess lower conductivity than any other insulation and adapted to all types of equipment without change in design:

Insulating Value — Powder 0.30; Brick 0.58 B. t. u. per sq. ft. per hr. per inch thickness per degree F. difference in temperature (U. S. Bureau of Standards), or one-tenth as conductive as firebrick inch for inch.

Resistance to Direct Heat—Brick and Powder 1600° F. *without shrinkage.* Brick 2200° F. *without shrinkage.*

Melting Point—2930° F. (1610° C.) U. S. Bureau of Standards.

Weight—Powder 15 lbs. per cu. ft. packed in place; Brick 1¾ lbs. each, equivalent to about 30 lbs. per cu. ft.

Crushing Strength—28 tons per sq. ft.

Forms—Brick, Block, Powder, Cement.

C-22

A request will bring Bulletin CW-6 *containing complete information. Use the coupon or write nearest office.*

CELITE PRODUCTS LIMITED

New Birks Building
Montreal, Que.

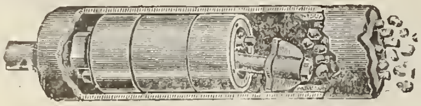
CELITE PRODUCTS, LIMITED.
Gentlemen:
We are interested in stopping heat waste. Send Bulletin W-6-C describing the application of Sil-O-Cel insulation, and tell us what it has saved in the following equipment: Type of Equipment............................

NAME ....

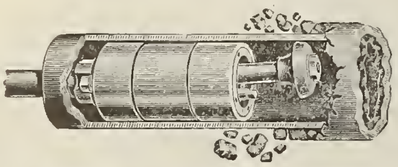
COMPANY ....

ADDRESS ....

It Will Cost You Nothing—



For removing scale from Water Tube Boilers.
For removing scale from Return Tubular Boilers.



and won't obligate you in any way to have us send an engineer to demonstrate at your own plant the fact that the DEAN BOILER TUBE CLEANER settles the boiler scale question once and for all.

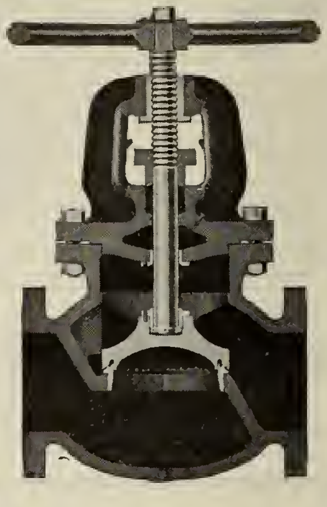
The "DEAN" method is recommended by the highest authorities in boilers in the province. Let us either ship you a Dean Boiler Tube Cleaner on trial, give you a free demonstration in your own plant, or Clean Your Boilers by Contract (distance no object).

**Wr'te or phone us for a list of satisfied users.
We have over 100 references in Toronto alone.**

GEO. FARROW & SON 17-19 Victoria Blvd. Mount Dennis **TORONTO**

NIGHT, SUNDAY AND HOLIDAY SERVICE

EDWARD *Extra Heavy* Cast Steel Stop Valves



Superior Valves for Exacting Duty

Designed to offer the least resistance to the flow, with full sized opening through seat, with body, bonnet and gland made of Electric Steel and flanges drilled in accordance with American Extra Heavy Standard of 1914, these EDWARD Stop Valves will give satisfaction under the most severe service.

THE EDWARD PROTECTED SEAT AND DISC

This positive protection of the most vital organ of the valve—the seating surface — is used only in Edward Valves. It prevents cutting from wire drawing, especially under high pressures and temperatures where very small leaks rapidly grow owing to the terrific erosion action.

Send for descriptive catalogue of the Edward line.

The Edward Valve & Manufacturing Co.

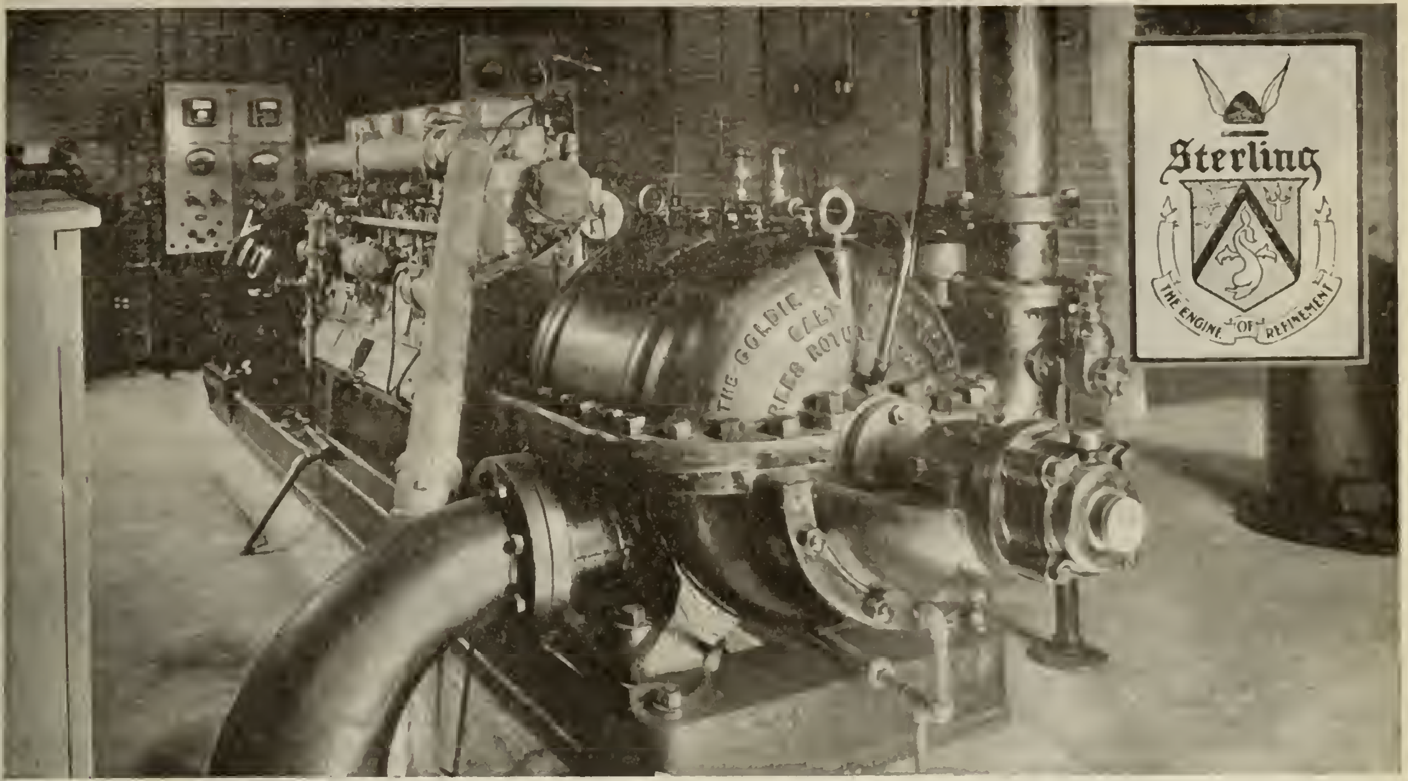
General Office & Works: East Chicago, Ind.

CANADIAN AGENTS: Lytle Engineering Co., Limited, Montreal; Valve Engineering Company, Toronto.

Don't clog your mind wheels up with unreliable, out-of-date reading. Get the latest technical information on Power House Equipment by reading POWER HOUSE, Canada's only Power Plant paper devoted entirely to the practical engineer's interests.

$2.00** SUBSCRIPTION PRICE Send in yours TO-DAY **$2.00

THE MACLEAN PUBLISHING COMPANY, LIMITED, 143 University Avenue, TORONTO



60 Towns in Ontario Protected!

OAKVILLE, Ontario, like 60 other Ontario towns, has no fear of water shortage. The town pumping station has been equipped with a STERLING internal combustion engine. Should the regular pumping system fail, or be shut down for overhauling or repairs, or in case of fire, a STERLING engine is standing by ready for immediate duty.

The illustration shows a STERLING Engine driving alternately either a lighting generator or a Goldie & McCulloch Co., Ltd., Rees RoTurbo pump of 1,200 G.P.M. capacity in the pumping station at Oakville. Speed is 1,200 R.P.M.

STERLING Internal Combustion Engines, direct drives for generators, and centrifugal pumps, when employed for peak load and standby, can save in the cost of power.

Fire your boilers economically, according to the normal load and use STERLING engines on peak load. Operate the STERLING steadily when overhauling the boilers or repairing machinery. Use the STERLING on the fire pump.

In Emergency

Oakville is finding the STERLING an indispensable standby power plant.

The Consulting Engineers, Messrs. Chipman & Power, of Toronto, wrote:

"We understand that the fire was first noticed about 6.30 a.m., and when the alarm was rung in, the electric energy from the main power line was not in service, having been cut off the main transmission line somewhere outside of the town. The engine was started immediately with the pump connected and gave excellent service throughout."

The Chairman of the Commission said:

"A few minutes after alarm the new pump was delivering 1.150 gallons per minute at 110 pounds pressure. This supplied all the water the six lines of hose could handle.

"The pump ran continuously for two hours, and its performance fully justified the installation of the type of motor and pump."

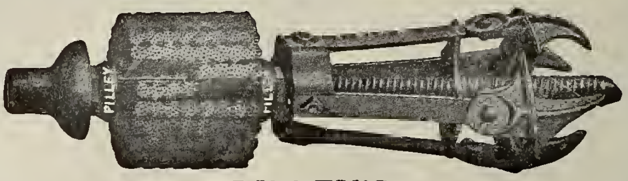
Costs About $20 a Horsepower **No Maintenance Cost**

Sterling Engine Co. (Dept. C4) **Buffalo, N.Y., U.S.A.**

HINTS TO BUYERS

ENGINEERS!

Remember to Order
GENUINE
"V." PILOT
PACKING FOR ALL PURPOSES
KIRBY & COMPANY
50 LAKE ST. TORONTO MAIN 4443
SPECIALIZING IN
Engine and Boiler Room Supplies of Every Description.
Adamant Gauge Glasses Ideal Tube Cleaners
Kirbyco Boiler Scale Remover
QUALITY SERVICE



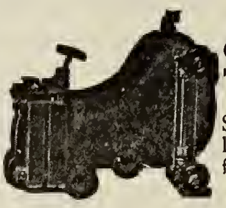
The Simplest and best cleaner on the market is

PILLEY'S
Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Thomson-Gordon Limited

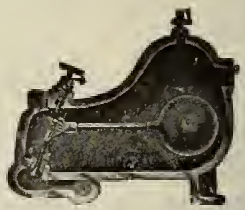
Engine Packings

Hamilton, Ontario

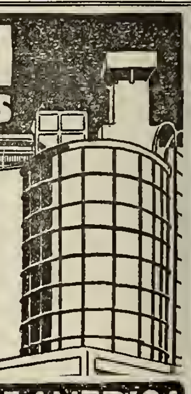


McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.
Send for Catalogue
THE GARTH COMPANY
Craig Street-MONTREAL, CAN.
WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.



FUEL OIL BURNING
for
HEATING and POWER PLANTS
Correspondence Invited
ENGINEERING & CONTRACTING
The T.J. CUNERTY Company
9 Richmond St E. Toronto



AMERICAN
STEAM ASH CONVEYORS

75% of all steam jet ash conveyors in Canada are American. Satisfactory and economical performance guaranteed. Ask for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Edmonton, Calgary.
WM. A. GOOLD. Winnipeg.
T. M. GRINDLEY Co., Vancouver.

CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

YORK Ice Making & Refrigerating MACHINERY

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO, LIMITED

Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

OIL BURNING SYSTEMS.

INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.

LAURIE ENGINE CO.

(The Service Engineering Company of Canada).

601 NEW BIRKS BLDG., MONTREAL, QUE.

INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE OF

OF POWER HOUSE

I HAVE been treating FEEDWATER for steam boilers for 24 years and am in a position to investigate your feedwater problems.

I WILL give you a formula for your special plant and thus save you 10% to 20% of your fuel.

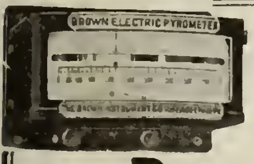
Send in Your S.O.S. to:—
H. P. STEPHENS
Feedwater Specialist.
Junc. 5642 2004 Dundas St. W. Toronto

WHEN YOU REQUIRE

Industrial Electric Control Apparatus
Consult "Sundh"

Dominion Engineering Agency Limited

TORONTO:- D. M. Fraser, 24 Adelaide East
MONTREAL:- E. W. Playford, 358 Beaver Hall Square



THE BROWN INSTRUMENT COMPANY
Largest Pyrometer Manufacturers in the World.
PHILADELPHIA, PA., U.S.A.

For Province of Quebec:
LaChapelle Eng. Co.,
414 St. James St.,
Montreal, Que.

For Ontario:
Brown Instrument Co.,
1421 Ford Building,
Detroit, Mich., U.S.A.

Send for Catalog No. 2.

Brown Pyrometers

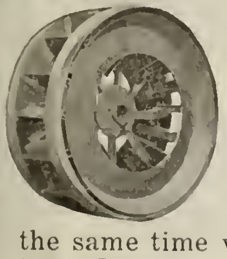
GARLOCK

Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que.
Calgary, Alta.
Toronto, Ont.
St. John, N.B.
Winnipeg, Man.
Vancouver, B.C.

PACKINGS

THE GARLOCK PACKING COMPANY



Origin of the Cindervane Fan

Back in 1916, an engineer of a large Power Company in New York City wanted an induced draft fan, which at the same time would act as a cinder separator. How and why Sturtevant got the job is told in Folder 609.

Ask for free copy.

B. F. STURTEVANT CO.
OF CANADA, LTD.
Montreal Galt Winnipeg Toronto

TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and draft in last pass.

It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

Write for Bulletin CF-131.

THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

FOXBORO
REG U S PAT OFF
THE COMPASS OF INDUSTRY

5323

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS

H. Mueller Mfg. Co., Ltd., Sarnia, Ont.

AIR COMPRESSORS

Laurier & Lamb Co., Montreal.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal,
American Steam Pump Co., Battle Creek, Michigan.
Smart-Turner Machine Co., Ltd., Hamilton,
Taylor Instrument Co., Toronto.

AIR FILTERS

Midwest Canada, Ltd., Montreal.

ALARMS (LOW WATER)

Bristol Co., Waterbury, Conn.
James Morrison Brass Mfg. Co., Ltd., Toronto.

AMMETERS

Bristol Co., Waterbury, Conn.

AMMONIA COMPRESSORS

The Vitter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

ASH CONVEYORS

Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.

BABBITT AND ANTI-FRICTION METAL

Can. Fairbanks-Morse Co.. Ltd., Montreal.
Magnolia Metal Co., Montreal.

BEARINGS

Can. Fairbanks-Morse Co., Ltd., Montreal.

BELT LACING

Bristol Co., Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd.. Montreal.

BELTING, LEATHER

Can. Fairbanks-Morse Co., Ltd., Montreal.
D. K. McLaren Ltd., Montreal.
Dominion Belting Co., Hamilton.
L. F. Smidth & Co., New York.

BELTING LINK

Can. Fairbanks-Morse Co., Ltd., Montreal.
Link-Belt Ltd., Toronto, Ont.

BELTING, ROLLER

Hans Renold of Canada, Ltd., Montreal and Toronto.

BELTING, RUBBER

Can. Fairbanks-Morse Co., Ltd.. Montreal.
Dunlop Tire & Rubber Co., Ltd., Toronto.
Gutta Percha & Rubber Co., Ltd., Toronto.

BLOWERS, TURBINE

Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal:

BLOWERS, FAN

De Laval Steam Turbine Co., Trenton. New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT

Canadian Blower & Forge Co., Kitchener, Ont.
De Laval Steam Turbine Co., Trenton New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BOILER TUBE CLEANERS

Pilley Packing & Flue Brush Co., St. Louis, Mo.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd Toronto.

BOILER COMPOUNDS

G. F. Sterne & Sons. Ltd., Brantford.
H. P. Stephens, Toronto.
Shell Bar Boico Co., Toronto.
Refinite Co. of Can., Ltd., Toronto.
Kirby & Co., Toronto.

BOILER TUBES

Babcock & Wilcox, Ltd., Montreal.

BOILER SETTINGS

A. E. Rule Co., Toronto.
Gates Engineering Co., Ltd., Montreal.
Celite Prodcuts, Ltd., Chicago, Ill.
Shell Bar Boico Co., Ltd., Toronto.
Sterne & Sons, G. F., Brantford, Ont.
W. R. Sexton Boiler Setting Co., Toronto.

BOILERS, HEATING

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Waterous Engine Works, Brantford.

BOILERS, RETURN TUBULAR

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOILERS, VERTICAL WATER TUBE

Geo. T. Ladd Co., Pittsburgh, Pa.

BOILERS, WATER TUBE

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOXES, STEEL, FOR ELECTRIC SERVICE

Canadian Drill & Electric Box Co., Ltd., Toronto.

BREECHINGS

Engineering & Machine Works of Canada, St. Catharines, Ont.

BRICK, FIRE

Goldie & McCulloch Co., Ltd., Galt, Ont.
Elk Firebrick Co., Ltd., Hamilton, Ont.
Sexton Boiler Setting Co., W. R., Toronto, Ont.

BRICK, INSULATING

Cellte Products, Ltd., Chicago, Ill.

CABINETS, LIGHTING

Canadian Drill & Electric Box Co., Ltd., Toronto.

CALORIMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

CASTINGS, BRASS & IRON

Canadian Steam Boiler & Equipment Co., Ltd., Toronto.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Kerr Engine Co.. Ltd., Walkerville, Ont.
Gollie & McCulloch Co., Ltd., Galt, Ont.

CASTINGS, GREY IRON

Velter Mfg. Co., Milwaukee, Wis.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CEMENT, ASBESTOS

Sterne & Sons, G. F., Brantford, Ont.

CEMENT, IRON

Can. Fairbanks-Morse Co., Ltd., Montreal.

CEMENT, FIRE BRICK

Sterne & Sons, G. F., Brantford, Ont.

CHAINS (See sprockets and chains)

Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, DRIVING

Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, ROLLER

Hans Renold of Canada, Ltd., Montreal and Toronto.

CIRCUIT BREAKERS

Dominion Engineering Agency, Ltd., Toronto.

COAL AND ASH HANDLING MACHINERY

Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox. Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COAL CRUSHERS

Babcock & Wilcox, Ltd., Montreal.
Canada Stoker Company, Ltd., Toronto and Galt.
The Canadian-Fairbanks Morse Co., Ltd., Montreal.

COAL PULVERIZING EQUIPMENT

Combustion Engineering Corp., Ltd., Toronto.

COCKS, BRASS & IRON

Homestead Valve Mfg. Co., Homestead, Pa.
James Morrison Brass Mfg. Co., Ltd., Toronto.

COCKS, GAGE

James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COCKS, STEAM

James Morrison Brass Mfg. Co., Ltd., Toronto.

CO2 RECORDERS AND FLUE GAS ANALYSIS INSTRUMENTS

Sarco Co., Inc., N. Y.
Foxboro Co., Inc., Foxboro, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal.

CONDENSERS

Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine, Toronto.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

CONDENSERS (JET)

American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Galt, Ont.

CONDENSERS (SURFACE)

Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CONVEYORS (SEE COAL AND ASH HANDLING MACHINERY)

Babcock & Wilcox, Ltd., Montreal.

COUPLINGS, FLEXIBLE SHAFT

De Laval Steam Turbine Co., Trenton, New Jersey,

COUPLINGS, SHAFT

De Laval Steam Turbine Co., Trenton, New Jersey.

CRANES

Babcock & Wilcox, Ltd., Montreal.
John T. Hepburn, Ltd., Toronto.

DEALERS (MACHINERY)

Can. Fairbanks-Morse Co., Ltd., Montreal.

DISTILLING APPARATUS

Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.

DISTRIBUTING BOARDS

Can. Drill and Electric Box Co., Ldt,. Toronto.

DRILLS

Can. Fairbanks-Morse Co., Ltd., Montreal.

EJECTORS

Laurie & Lamb Co., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ELECTRIC GENERATING SETS (STEAM ENGINE)

Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton, Ont.
Laurie & Lamb Co., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC GEN. SETS—(Steam Turbine)

Can. General Elec. Co., Ltd., Toronto.
Can. Westinghouse Co., Ltd., Hamilton.
Laurie & Lamb Co., Montreal.
F. Laurie & Co., Montreal.
De Laval Steam Turbine Co., Trenton,
Turbine Euipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC MOTORS

Can. General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

ENGINES, DIESEL

Laurie & Lamb Co., Montreal.

ENGINES, CORLISS

Laurie & Lamb Co., Montreal.
Frick Co., Wanesboro, Pa.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, GAS & OIL

Laurie & Lamb Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, PUMPING

Laurie & Lamb Co., Montreal.

ENGINES, STEAM

Can. Sirocco Co., Ltd., Windsor, Ont.
Laurie & Lamb Co., Montreal.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ENGINES, UNA-FLOW

Vilter Mfg. Co., Milwaukee, Wis.
Frick Co., Wanesboro, Pa.

ENGINE REPAIRS

Goldie & McCulloch Co., Ltd., Galt, Ont.

EXPANSION JOINTS

James Morrison Brass Mfg. Co., Ltd., Toronto.

FANS (SEE BLOWERS, FAN)

Can. Sirocco Co., Ltd., Windsor, Ont.

FEED WATER HEATERS

Arthur S. Leitch, Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Sims Company, Erie, Pa.

FEED WATER PURIFIERS

Sterne & Sons, G. F., Brantford, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

FILTERS, FEED WATER

Babcock & Wilcox, Ltd., Montreal.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

FILTERS, OIL

Babcock & Wilcox, Ltd., Montreal.
Turbine Equipment Co., Ltd., Toronto.

FILTERS, WATER

Laurie & Lamb Co., Montreal.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que,

FIRE BRICK ARCHES

Combustion Engineering Corp., Ltd., Toronto.

FITTINGS, AMMONIA

York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

FITTINGS, PIPE

International Malleable Co., Guelph, Ont.

FITTINGS, STEEL

Reading Steel Casting Co., Bridgeport, Conn.

FITTINGS, CAST IRON

Can. Fairbanks-Morse Co., Ltd., Montreal.

FLOATS

James Morrison Brass Mfg. Co., Ltd., Toronto.

FUEL OIL SYSTEMS

Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
T. J. Cunerty Co., Toronto.

FURNACES

Can. Sirocco Co., Ltd., Windsor, Ont.

FURNACE ARCHES, FLAT SUSPENDED

Canada Stoker Co., Ltd., Toronto and Galt.
Bell Fire Brick Co., Toronto.
Shell Bar Boico Co., Ltd., Toronto.
Gates Engineering Co., Ltd., Montreal.

FURNACE LININGS

G. F. Sterne & Sons, Ltd., Brantford, Ont.

GAGE COCKS (SEE COCKS GAGE)

Babcock & Wilcox, Ltd., Montreal.

GAGE GLASS GUARDS

Babcock & Wilcox, Ltd., Montreal.

GAGE GLASSES

Durabla Mfg. Co., New York City.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, DIFFERENTIAL

Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

GAGES, DRAFT

Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

Make a good article,
Advertise it,
Keep your promises,
Keep on Advertising,
Deliver the goods,
Keep on Advertising—
and you will get the
business.

FOR INSTANCE—

One large Canadian paper mill had this fire brick problem.

10 B and W boilers 500 H.P.; fired with fuel oil.

When this plant was built we recommended ELKO SPECIAL for this equipment.

They have had such complete satisfaction they have used ELK FIRE BRICK exclusively ever since.

This is only one little instance. Mill reference on request.

What's Your Problem?

Write for this—Refractory Efficiency Engineering

Elk Fire Brick Co. of Canada
Hamilton, Ontario

Dunham Radiator Traps Insure Service that is Noiseless—Sure—Lasting

The Dunham Two-Part Radiator Trap

Made in five sizes as shown. The Nos. 1, 2 and 3 Traps are regularly furnished nickel-plated and with union nut and nipple, threaded right hand. They may be supplied in angle, straightway, right hand or left hand pattern. The body and cover are made of red brass.

The Nos. 4 and 5 Traps are painted battleship gray and furnished in either patterns with female right hand threaded connections, both inlet and outlet. The body and cover are made of the best gray cast iron.

Maximum operating pressure ten (10) pounds gauge.

Dunham Radiator Traps were the first thermostatic disc traps. After 20 years of unparalleled service they are still the last word in radiator trap efficiency. To the heating contractor who has experienced the annoyances of other types we recommend the Dunham Trap as a certain means to personal satisfaction and better pleased customers.

The Dunham Radiator Trap automatically releases all air and condensate and retains the steam within the radiator. Its construction is simplicity itself. Write for detailed technical information to-day.

C. A. DUNHAM COMPANY, LTD.
Toronto - Ontario
Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary.
London, Eng.: 18 St. Thomas St., S.E. 1.

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE
(MADE IN CANADA)

GAGES, PRESSURE

Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Bndenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, RECORDING

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

GAGES, STEAM

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
Babcock & Wilcox, Limited, Montreal, Que.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, VACUUM

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, WATER

The Bristol Co., Waterbury, Conn.
The James Morrisson Brass Mfg. Co., Limited, Toronto, Ont.

GAS EXHAUSTERS

Can. Sirocco Co., Ltd., Windsor, Ont.

GASKETS

Jenkins Bros., Limited, Montreal, Que.

GEARS

E. Laurie & Co., Montreal, Que.
Turbine Equipment Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Limited, Montreal, Que.

GEARS, CUT

Hans Renold, of Canada, Ltd., Montreal and Toronto.

GEARS, ROLLER CHAIN

Hans Renold of Canada, Ltd., Montreal and Toronto.

GEARS, SILENT CHAIN

Hans Renold of Canada, Ltd., Montreal and Toronto.

GENERATORS, ELECTRIC

Laurie & Lamb Co., Montreal, Que.

GENERATORS, HOT WATER

The Sims Co., Erie, Pa.
Arthur S. Leitch Co., Toronto.

GOVERNORS, PUMP

Canada Stoker Co., Ltd., Toronto and Galt.
Northern Equipment Co., Erie, Pa.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

GRATES

Combustion Engineering Corp., Ltd., Toronto, Ont.
Can. Steam Boiler Equipment Co., Ltd., Toronto, Ont.

GRATE BARS

Canadian Steam Boiler Equipment Co., Toronto, Ont.
Engineering & Machine Works of Canada, Limited, St. Catharine, Ont.
Babcock & Wilcox, Limited, Montreal, Que.
John T. Hepburn Ltd., Toronto, Ont.
Goldie McCulloch Co., Ltd., Galt, Ont.

GREASE EXTRACTORS

Babcock & Wilcox, Limited, Montreal, Que.

HEATERS, FEED WATER

Goldie & McCulloch Co., Ltd., Galt, Ont.

HEATING SYSTEMS

Can. Sirocco Co., Ltd., Windsor, Ont.

HOISTS, ELECTRIC

Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

HOPPERS, COAL & ASH

Combustion Engineering Corp., Ltd., Toronto, Ont.

HOSE, AIR

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

HOSE, RUBBER

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Babcock & Wilcox, Limited, Montreal, Que.

HOSE, STEAM

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

HOSE, WATER

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

ICE AND REFRIGERATING MACHINERY (SEE REFRIGERATING MACHINERY)

Jamieson Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
Can. Ice Machine Co., Toronto, Ont.
York Mfg. Co., York, Pa.
Frick Co., Waynesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.

INDICATORS, SPEED

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INDICATORS, STEAM ENGINE

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INJECTORS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

LUBRICATORS, CYLINDER

The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, FORCE FEED

The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, SIGHT FLOW

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

MACHINE WORK, SPECIAL

Engineering & Machine Works of Canada, Limited, St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto, Ont.
The Canadian Fairbanks-Morae Co., Ltd., Montreal, Que.

METERS, BOILER

Laurie & Lamb Co., Montreal, Que.

METERS, FLOW

Canada Stoker Co., Ltd., Galt and Toronto.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

OILING DEVICES

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PACKING, ASBESTOS

Durabla Mfg. Co., New York City.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.

PACKING, METALLIC

Laurie & Lamb Co., Montreal, Que.

PACKING, SHEET

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Durabla Mfg. Co., New York City.
The James Morrison Brass Mfg. Co., Ltd., Toronto Ont.

PACKING, VALVE STEM PIPE

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

PIPE, BRASS & COPPER

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE BENDING

Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE COILS

Can. Ice Machine Co., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE CUTTERS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PUMPS, BOILER FEED

Albany Pump Co., Toronto.
American Steam Pump Co., Battle Creek, Mich.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CENTRIFUGAL

Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
E. Laurie & Co., Montreal, Que.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Co., Toronto, Ont.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CONDENSER

Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

PUMPS, FORCE FEED

Laurie & Lamb, Montreal, Que.

PUMPS, OIL

Turbine Euipment Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Westco Mfg. Co., Toronto.

PUMPS, POWER

American Steam Pump Co., Battle Creek, Mich.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, ROTARY

Turbine Equipment Co., Ltd., Toronto, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Westco Mfg. Co., Toronto.

PUMPS, STEAM

Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
John T. Hepburn, Ltd., Toronto, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
F. L. Smidth & Co., New York.
Turbine Euqipment Co., Ltd., Toronto, Ont.

"PUMPS-SUMP"

Albany Pump Co., Toronto.

PUMPS, TURBINE

Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto, Ont.

PUMPS, VACUUM

Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Young Pump Company, of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Arthur S. Leitch Co., Toronto.
Nash Engineering Co., (Hytor) South Norwalk, Conn.

PYROMETERS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd,. Montreal, Que.

REFRACTORY MATERIAL

G. F. Sterne & Sons, Ltd., Brantford.

REFRIGERATING MACHINERY

Jamison Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.
Frick Co., Wanesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

REGULATORS, DAMPER, DRAFT & FAN

Laurie & Lamb, Montreal, Que.
Julian D'Este Company, Boston, Mass.

REGULATORS, FEED WATER

Canada Stoker Co., Ltd., Galt and Toronto.
Northern Equipment Co., Erie, Pa.

REGULATORS, TEMPERATURE

Sarco Co., Inc., New York.
The Bristol Co., Waterbury, Conn.
Julian D'Este Company, Boston, Mass.
The Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

REGULATORS, PRESSURE

The Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, AIR

Can. Sirocco Co., Ltd., Windsor, Ont.

SEPARATORS, AMMONIA

York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.

SEPARATORS, OIL

Anderson Co., V. D., Cleveland, Ohio.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, STEAM

Anderson Co., V. D., Cleveland, Ohio.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SMELTING LININGS

G. F. Sterne & Sons, Ltd., Brantford.

SODA ASH

G. F. Sterne & Sons, Ltd., Brantford. Ont.

SODA SILICATE

Diamond Specialty Mfg. Co., Windsor.

SOOT BLOWERS

Diamond Specialty Mfg. Co., Windsor.
Pilley Packing & Flue Brush Co., St. Louis, Mo.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SPRAY NOZZLES

Can. Sirocco Co., Ltd., Windsor, Ont.

SPROCKETS AND CHAINS

Hans Renold of Canada, Ltd., Montreal and Toronto.

STACKS, METAL

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STACKS, RADIAL BRICK

Combustion Engineering Corp., Ltd., Toronto, Ont.

STEEL PLATE WORK

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STOKERS, CHAIN & TRAVELING GRATE

Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que Que.

STOKERS, OVERFEED

Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.
Detroit Stoker Co., Detroit, Michigan.

STOKERS, UNDERFEED

Detroit Stoker Co., Detroit, Mich.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.

STOKERS, HAND OPERATED

Combustion Engineering Corp., Toronto, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

STRAINERS, WATER

Sarco Co., Inc., New York.

SUPERHEATERS

Babcock & Wilcox Ltd., Montreal, Que.
Goldie & McCulloch Co., Ltd., Galt, Ont.

SWITCHES, ELECTRIC

Canadian Drill & Electric Box Co., Ltd., Toronto.
Canadian General Electric Co., Ltd., Toronto.

TACHOMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Laurie & Lamb, Montreal, Que.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TANKS

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

THERMOMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

THERMOMETERS, FLUE GAS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

THERMOMETERS, RECORDING

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.

TRANSFORMERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

TRAPS, NON-RETURN

Anderson Co., Inc., V. D., Cleveland, Ohio.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Sarco Co., Inc., New York.

TRAPS, RADIATOR

Sarco Co., Inc., New York.

EXTRAORDINARY BARGAINS

STEAM ENGINES

1 Goldie & McCulloch heavy duty, cross compound, latest type Corliss condensing engine with rope drive, line shaft pulley and idlers complete, equipped with Dean condenser. Cylinders are 20"x40"x42" stroke. Water heater included.

1 Robb-Armstrong, 18"x18" high speed automatic engine.

1 Robb-Armstrong 11"x14" high speed automatic engine, direct connected to a Westinghouse 70 k.w., 3 phase, 60 cycle, 220 volt generator, complete with exciter and marble control panel.

Also several smaller automatic engines and some air hoists from 4" to 10½".

CHAIN BLOCKS—

2 15-ton Herbert Morris chain blocks with trolleys.
1 10-ton Herbert Morris chain block with trolley.

WATER TUBE BOILERS--

2 250 h.p., 175 lbs. working pressure, government certificate. Everything complete and in first-class condition.

GET FULL PARTICULARS AND REMARKABLY LOW PRICES FROM

WILLIAM COATES

MAIL BUILDING PHONE GLAD. 1947 TORONTO, ONT.

Flue gases can be reduced 50 degrees by careful firing and clean boiler surfaces

Such is the substantial saving that can be effected by recording and measuring your flue gas temperature with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

Recording Pyrometers

Of course, the temperature of outgoing gases can be decreased by economizers, or by a change in the baffling — but such changes are costly and the economy depends upon the cost of coal.

The information supplied by Bristol's Pyrometers, as to the temperature of uptake gases leaving the boilers, is of prime importance as an aid to super-efficient plant operation.

Hundreds of Bristol's Pyrometers are recording flue gas temperatures in prominent power plants. Let us tell you more about what they could do in your plant. Our new Catalog O-1401 is waiting for your address.

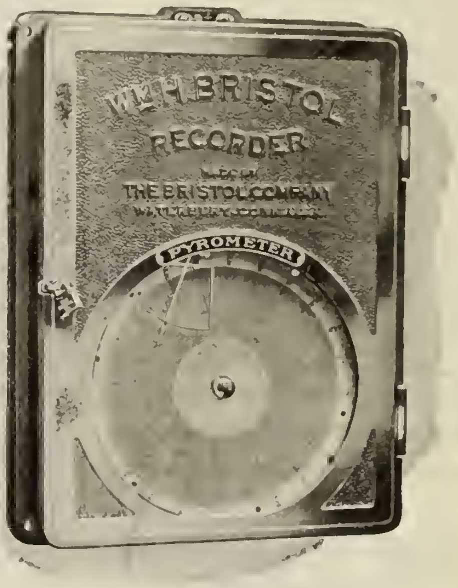


Fig. 1007

A suit has been filed in the United States Federal Court against a pyrometer manufacturer who is infringing patents owned by the Bristol Co. covering Automatic Cold End Compensation for Thermo-Electric Pyrometers.

The Bristol Company, Waterbury, Conn.

Canadian Distributors:

Eastern Territory: Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory: Gorman's, Ltd., Edmonton.

$5 May Save You $500 or $5,000!

You work hard for the dollars you save. Properly invested they can be made to work hard for you. But they must be properly invested.

If you feel the need of a guide to show you how to invest your money to bring you the biggest return consistent with safety; to show you how to avoid the pitfalls of investment; you need THE FINANCIAL POST.

It will give you a personalized investment service. Its articles every week will tell you what you want to know about investing. Its discussion of current business and national problems will give you a new angle on economic and political questions. You will have too all the privileges of the Investors Inquiries Department. You may ask as many questions as you like about your own investment and financial problems—the standing of your broker, and the analysis of particular securities, insurance problems, etc. This service is free to all readers.

Stop losing money on bad investments. Invest $5 now where it may save you $500 or $5,000. Pin a $5 bill to this ad. (or your letterhead), write your name and address and we will send you THE POST for one year (52 issues).

THE FINANCIAL POST 143 University Ave. Toronto

TRAPS, STEAM

Can. Sirocco Co., Ltd., Windsor, Ont.
Farrfhern Steam Services, Ltd., Toronto.
Laurie & Lamb, Montreal, Que.
Sarco Co., Inc., New York.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TRAPS, VACUUM

Anderson Co., Inc., V. D., Cleveland, Ohio.

TUBE CLEANERS, BOILER

Pilley Packing & Flue Brush Co., St. Louis, Mo.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal, Que.

TURBINE BLADING

De Laval Steam Turbine Co., Trenton, New Jersey.

TURBINES, STEAM

Coppus Engineering Corp., Worcester, Mass.
Laurie & Lamb Co., Montreal, Que.
E. Laurie & Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Arthur S. Leitch Co., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

TURBINES, WATER

De Laval Steam Turbine Co., Trenton, New Jersey.

UNIONS & UNION FITTINGS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVE DISK

Kerr Engine Co., Ltd., Walkerville, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, AIR

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BACK PRESSURE

The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jenkins Bros. Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BALANCED

Julian D'Este Co., Boston, Mase.
The James Morrison Brass Mfg. Co., Toronto.

VALVES, BLOW-OFF

Arthur S. Leitch Co., Toronto.
Babcock & Wilcox, Ltd., Montreal, Que.
Homestead Valve Co., Homestead, Pa.
Jenkins Bros., Ltd., Montreal, Que.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BRASS & IRON BODY

Reading Steel Casting Co., Bridgeport, Conn.
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BYPASS

Kerr Engine Co., Ltl., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, CHECK

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, EXHAUST RELIEF

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES FLOAT

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The James Morrison Brass Mfg Co., Ltd., Toronto, Ont.

VALVES, GATE

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, GLOBE

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, HYDRAULIC

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, NON-RETURN STOP

Babcock & Wilcox, Ltd., Montreal, Que.

VALVES, SAFETY POP

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, PUMP

Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, RADIATOR

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.

VALVES, REDUCING

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, REGRINDING

Jenkins Bros., Ltd., Montreal, Que.

VALVES, REGULATING

Northern Equipment Co., Erie, Pa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, RELIEF

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, SAFETY

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg Co., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, STOP

Babcock & Wilcox, Limited, Montreal, Que.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, SUPER-HEATED STEAM

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Reading Steel Casting Co., Bridgeport, Conn.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, THROTTLE

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, VACUUM

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VENTILATION

Can. Sirocco Co., Ltd., Windsor, Ont.

WASHERS, AIR

Can. Sirocco Co., Ltd., Windsor, Ont.

WATER COLUMNS

The James Morrison Brass Mfg. Co., Toronto, Ont.

WATER SOFTENING APPARATUS

Laurie & Lamb Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Babcock & Wilcox, Ltd., Montreal, Que.
W. J. Westaway Co., Ltd., Hamilton, Ont.

WHISTLES

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

WRENCHES

The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PRINTING

FORTY YEARS' experience—backed by one of the largest and best-equipped printing plants in Canada and the men who know how—enables us to offer you a complete printing service.

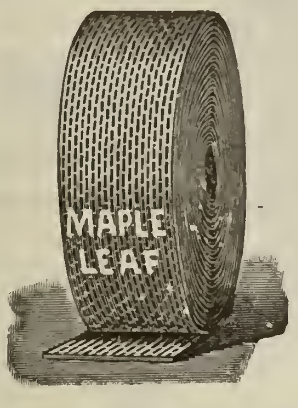
Send us samples of your catalogue or other printed matter, and write us fully as to your requirements. We will give your proposition thorough consideration and advise you intelligently. This will incur no obligation on your part, and may mean greatly increased effectiveness of your printing.

Specialists in the production of—
PUBLICATIONS, CATALOGUES
BOOKLETS, HOUSE ORGANS, FOLDERS
ADVERTISING LITERATURE

Commercial Printing Division
The MacLean Publishing Company, Limited
143-153 University Avenue, Toronto, Ontario

"Maple Leaf"

Brand

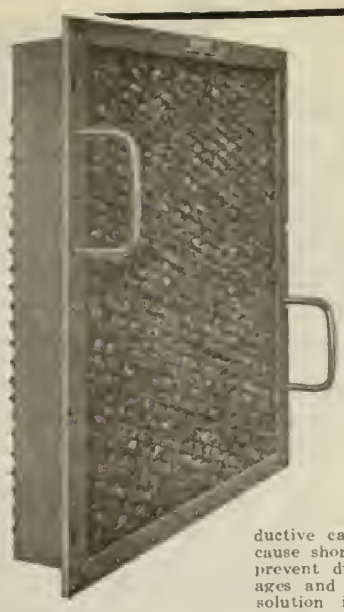


Stitched
Cotton
Duck
Belting *and*
Dressing

It is water-proof and economical; also more efficient than other belting. The standard of quality, "Maple Leaf" Brand, is always maintained. That is why the demand for this belting is steadily increasing. "Maple Leaf" Brand Belting and Dressing make a good combination—use both.

Write for prices and further information.

Dominion Belting Co., Ltd.
HAMILTON, CANADA
Quebec Branch: 51 Duluth Building, Montreal



Type U2
Single Cell

The Air Filters Without Moving Parts

DUST AND DIRT IN TURBO-generator and motor cooling air inevitably means loss of productive capacity and constantly threatens to cause short-circuits and damage. You should prevent dust getting into the fine air passages and windings of your equipment. The solution is simple and complete. Midwest Air Filters supply absolutely clean cooling air to your electrical apparatus, and yet require no operating supervision. They have no moving parts, no sprays—no pumps—nothing to get out of order. Let our engineers show you how they will solve your dust problems.

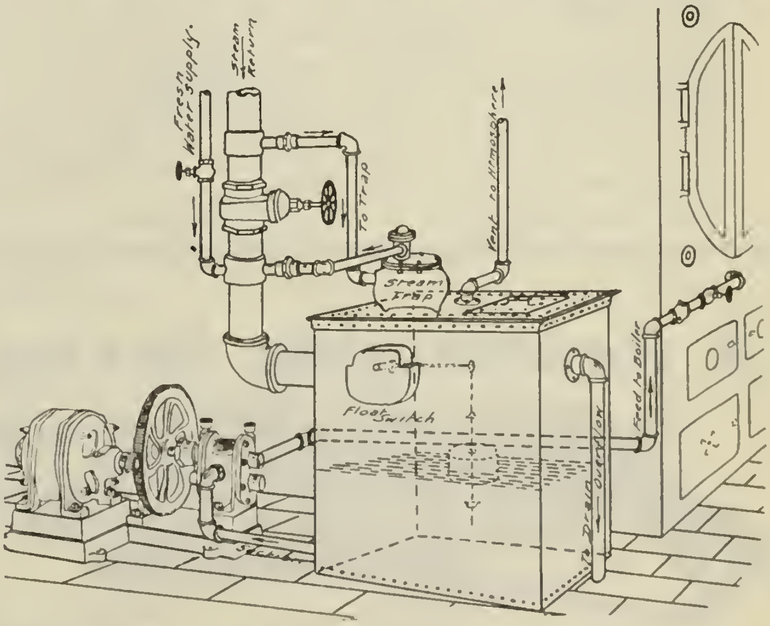
Send for Data Book F-15 Just Published

MIDWEST AIR FILTERS

MIDWEST CANADA, LIMITED
83 Craig Street, W. Montreal, Que.

ALBANY Electric Feed Water Pump

ELECTRIC PUMP
AND
RECEIVER
WITH
AUTOMATIC FLOAT
SWITCH
FOR
LOW PRESSURE
HEATING SYSTEMS



A New Pump—

Higher in Efficiency,
More Economical
in Operation

LOW IN PRICE

Will save its initial cost in a short time and add efficiency to the heating system. Will return the condensation to the boiler at a high temperature.

WRITE FOR SPECIFICATION AND PRICE

ALBANY PUMP CO. ESTABLISHED 1909
120 ADELAIDE ST. W., TORONTO Phone AD. 2504

Established 1907 **POWER HOUSE** Member A.B.C.

B. G. NEWTON, Manager **S. S. MOORE, Advertising Manager**

CANADA—**Toronto** (head office): 153 University Ave., Tel. Ad. 5740. **Montreal**: A. E. Guidal, 128 Bleury St., Tel. Plateau 946. **Winnipeg**: 810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—**New York**: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. **Chicago**: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. **Boston**: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—**London**: The MacLean Company of Great Britain Limited. 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek. London, England.

SUBSCRIPTION RATE:—Canada, $2.00; United States $2.50; Great Britain and other countries in Postal Union, 14s. per year. Australia and other countries not in Postal Union, 19s. per year.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A

Audel, Theo. 63
Allen Feed Water Purifier Co... 6
Albany Pump Co. 83

B

Babcock & Wilcox, Ltd. 61
Betson Plastic Fire Brick Co., Inc. 16
Brown Instrument Co. 77
Bristol Co. 81
Buyers' Directory 78, 80, 82
Bird Archer Co. 15
Burnett, J. A. 63
Bell Fire Brick Co. 63

C

Canadian Fairbanks-Morse Co., Ltd. 4
Conveyors Corp. of America... 76
Combustion Engineering Co. .24, 25
Cunerty Co., T. J.............. 76
Can. Allis Chalmers Co........ 1
Can. Steam Boiler & Equipment Co 84
Celite Products 73
Can. General Electric 67
Canada Cement Co. 7
Canada Stoker Co. 21
Canadian Ingersoll-Rand Co.... 23
Canadian Drill & Electric Box Co., Limited 66
Coppus Engineering Corp....... 19
Canadian Blower & Forge Co... 72
Coates, Wm. 81

D

Dart Union Co. 12
D'Este Co., Julian 16
De Laval Steam Turbine Co.... 3
Detroit Stoker Co. ....Inside Front Cover
Dominion Belting Co. 83
Dominion Engineering Agency.. 77
Dunham Co., C. A............. 79
Durabla Mfg. Co. 4
Dunlop Tire & Rubber Goods Co. 48

E

Engineering and Mach. Works of Canada 15
Edward Valve & Mfg. Co...... 74
Ever-Tyte Co. 63
Electrical Section ...65, 66, 67, 68
Elk Fire Brick Co. 79

F

Fisher Governor Co. 2
Foxboro Co., Inc. 77
Flexible Steel Lacing Co. 14
Flexible Metallic Packing Co... 14
Farrfhern Steam Service 70
Farrow & Son, Geo. 74

G

Garlock Packing Co. 77
Garth Co., The 76
Goldie & McCulloch 26
Gutta Percha & Rubber Co..... 46
Golden Anderson Valve Co..... 18

H

Hays Corp., Jos. W............ 10
Hans Renold of Canada, Ltd.... 47
Hepburn Limited, John T....... 71
Homestead Valve Mfg. Co...... 73

I

Irving Iron Works............ 11
Imperial Oil Co. 68
International Malleable Iron Co. 69

J

Jeffrey Mfg. Co. 5
Jamieson Cold Storage Door Co., Inside Back Cover
Jenkins Bros. ....Front Cover
Jointless Fire Brick Co. 70
Jones & Glassco 81

K

Kirby & Co. 76

L

Laurie Engine Co. 77
Leitch, Arthur S..... 17, 18, 19, 20
Linde Refrigeration Co. 22
Link-Belt Limited 45

M

Morrison Brass Mfg. Co., Jas. Outside Back Cover and 8 and 9
Moncrieff, Ltd. 77
Midwest Canada, Ltd. 83

N

National Exposition of Power & Mechanical Engineering 11
Nash Engineering Co. 17
Northern Equipment Co. 73

P

Pilley Packing & Flue Brush Mfg. Co. 76

R

Refinite Co. of Canada........ 41
Rule, A. E. 63

S

Superheater Co., Ltd. 63
Sterne & Sons, G. F........... 6
Sarco Co., Inc. 2
Sanford Riley Stoker Co....13, 70
Shell Bar Boico Supply Co..... 48
Sterling Engine Co. 75
Sturtevant Co. 77
Stephen Chemical & Mfg. Co. Limited 77
Stephens, H. P. 77
Smart-Turner Machine Co., Ltd. 14
Sexton Boiler Setting Co., W. R. 6
Sims Heater Co. 20
Smidth & Co., F. L. 48

T

Taylor Instrument Co., The..... 16
Thomson-Gordon, Ltd. 76
Transmission Section 45, 46, 47, 48

U

Underfeed Stoker Co. of Canada 13, 70

V

Vilter Mfg. Co. 22

W

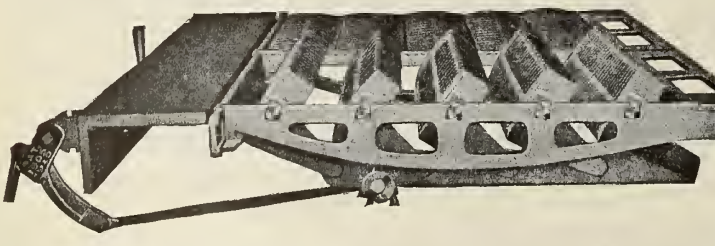
Wall, W. J. 77
Waterous Engine Works Co. .36, 37
Watson & McDaniel Co......... 76
Watson, M. Barry, M. E....... 63
Westco Mfg. Co. 10
Westinghouse Electric Co. 65

Y

York Mfg. Co. 77
Young Pump Co. of Canada.... 12

A Reasonable Saving of 5 to 10%

Should You Expect More?



WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee St. PHONE G. 3660 Toronto, Ont.

Leakproof!

If your rooms were filled with gas—

WERE it possible to replace the cold or dry air in your storage rooms with inflammable gas, you would have an opportunity to *test* Jamison Doors "under fire."

To learn whether the doors were *absolutely leakproof*, you could pass a lighted torch around the exterior frame of the door. The gas *would not* explode—it *would not* seep through to reach the flame of the torch!

It is well to remember that your *plant* is only as good as its *doors*. The *doors* will either *keep in* profits or allow them to *escape*. "Door Efficiency" is necessary. It minimizes changes in temperature due to leakage and through heat transmission.

Jamison Doors have *proved* themselves *efficient*. They are sturdily built and properly insulated. They bear unusually heavy hardware—three times the weight of the hardware on other doors—and embody exclusive Jamison patented features that make the *hardware* the "strong points" of Jamison Doors.

In equipping *your* plant, give consideration to the door *made leakproof* through its double seals of contact and *kept leakproof* through the practicability of its hardware. We shall be glad to mail you a copy of our catalogue which describes all of the Jamison Equipment, explains their construction, and outlines uses.

JAMISON COLD STORAGE DOOR CO.
Hagerstown, Md., U.S.A.

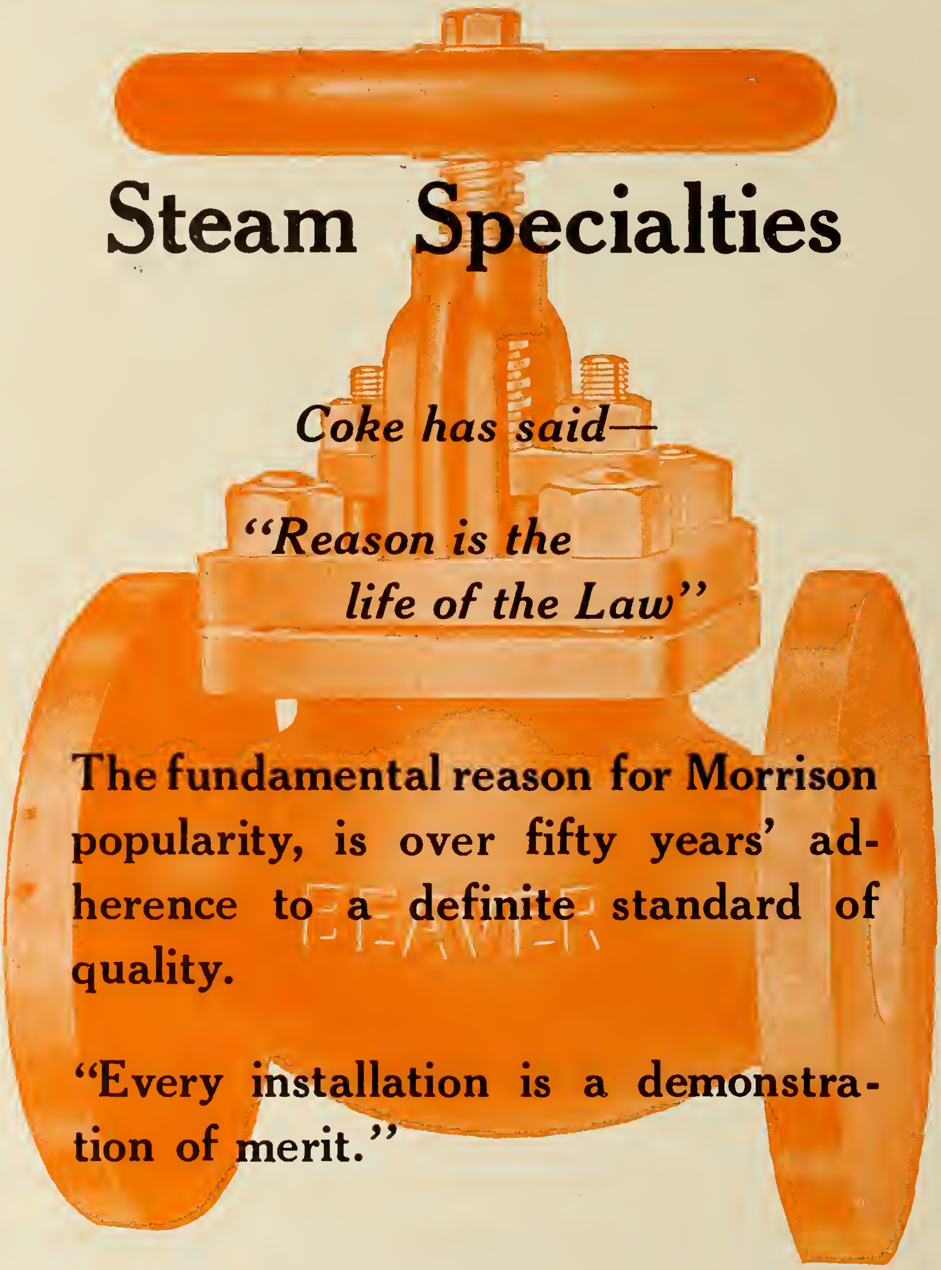
BETTER REFRIGERATION
JAMISON
HAGERSTOWN MD. U.S.A.

Write for copy of our catalogue "No. 10." It describes all of the Jamison Products in detail. Address "Desk 11" please.

Jamison Doors

for better refrigeration

MORRISON



Steam Specialties

Coke has said—

"Reason is the
life of the Law"

The fundamental reason for Morrison popularity, is over fifty years' adherence to a definite standard of quality.

"Every installation is a demonstration of merit."

See Pages 8-9

The James Morrison Brass Mfg. Co., Limited
93-97 Adelaide Street W., Toronto

POWER HOUSE

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto.
MONTREAL, WINNIPEG, VANCOUVER. LONDON, ENG.: 88 Fleet Street, E. C. NEW YORK, BOSTON, CHICAGO
Vol. XVI—No. 21 Publication Office, Toronto—November 5, 1923 Published Semi-Monthly Canada, $2; U. S. $2.50 a year

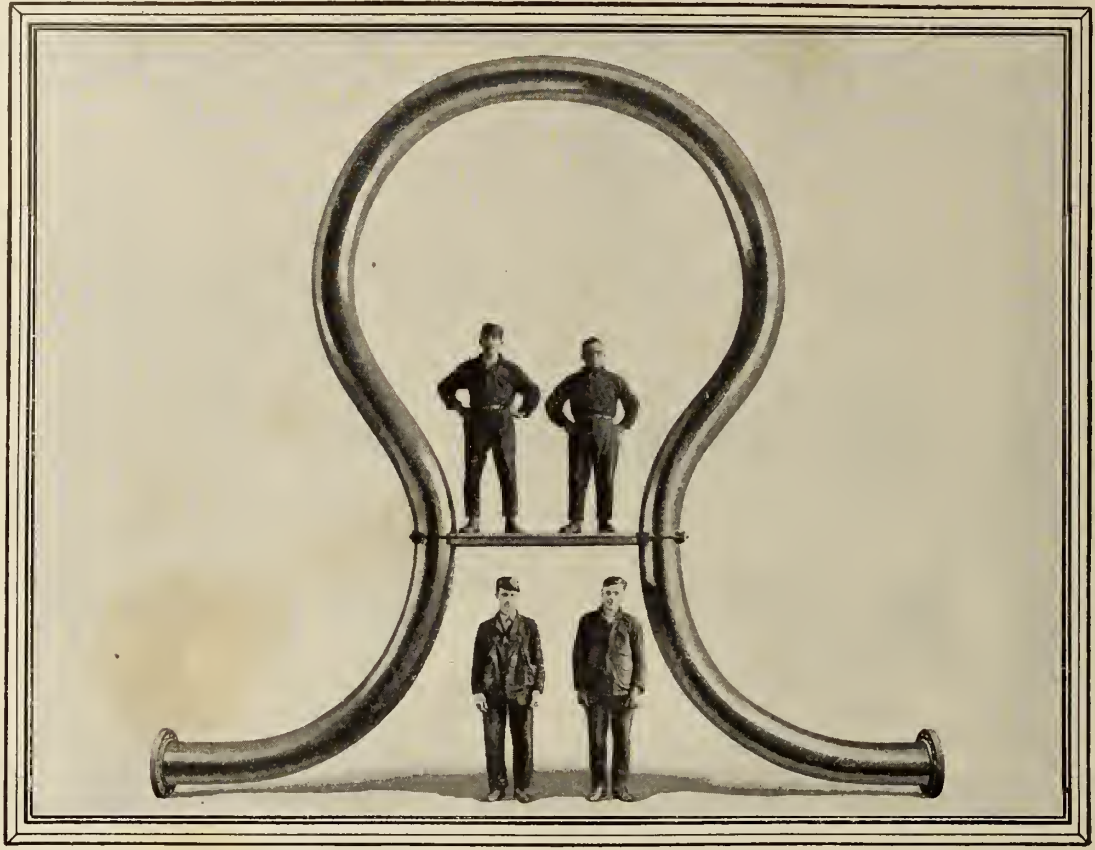
Zero weather—a raging snow storm—yet ashes in the storage tank do not freeze—are easily and quickly removed. When AMERICAN STEAM JET ASH CONVEYORS from intake to storage tank are designed, erected and operated in accordance with our instructions, we guarantee non-freezing of ashes in tank and economical ash handling. Ask for a booklet which lists guarantees and exclusive engineering features.

Conveyors Corporation of America
326 West Madison Street, CHICAGO

Canadian Representatives:
CLEATON CO. (Canada), Ltd., Montreal.
GORMANS, LTD., Calgary, Edmonton.
WM. A. GOOLD, Winnipeg.
T. M. GRINDLEY CO., Vancouver.

AMERICAN
STEAM ASH CONVEYORS

CENTS A COPY $2.00 A YEAR



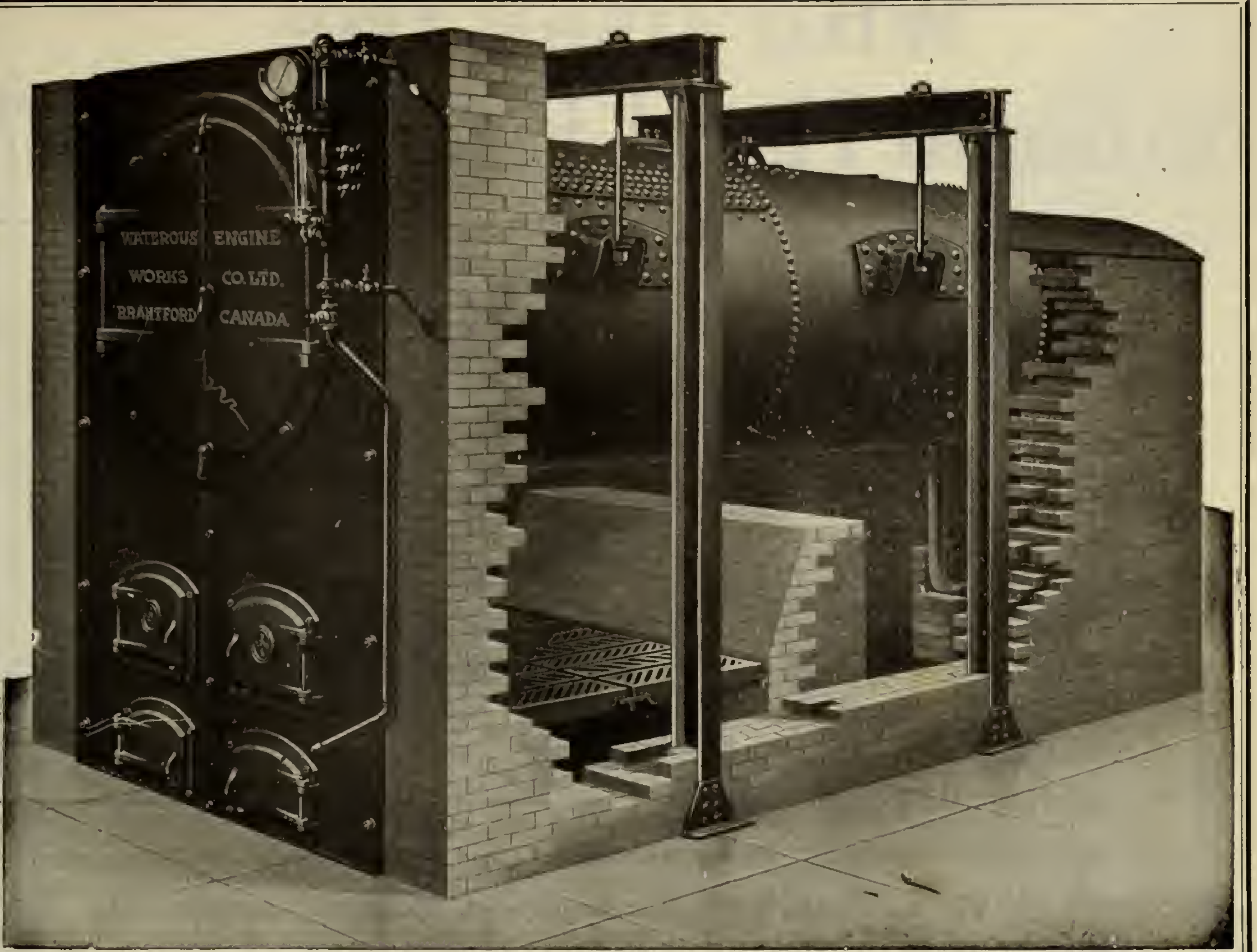
ALL PIPING REQUIREMENTS SUPPLIED

Crane standard proportions and regular Crane methods of construction, followed in the making of this huge 12-inch expansion bend, satisfied every requirement of the engineers of the Ford works at Toronto, where it will be used. The Crane plants are equipped to make bends of any size of pipe in any required shape. Crane's broad experience in planning piping equipment is always at your command to help you solve your particular problems.

CRANE

CRANE LIMITED, GENERAL OFFICES: 386 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., HEAD OFFICES: 45-51 LEMAN STREET, LONDON, ENG.
Branches and Sales Offices in 21 Cities in Canada and British Isles
Works: Montreal, Canada, and Ipswich, England

"Luxton" Drinking Fountain



BOILERS

All Types - All Sizes

We Also Manufacture

- Pressure Tanks
- Storage Tanks (*Rivetted or Welded*)
- Bins
- Stacks
- Steel Plate Work of all Kinds
- High Speed Automatic Engines
- Heavy Duty Mill Engines
- Portable Engines
- Stationary Engines
- Power Transmission Machinery
- Gray Iron Castings up to 15 tons

Waterous

BRANTFORD, ONTARIO, CANADA

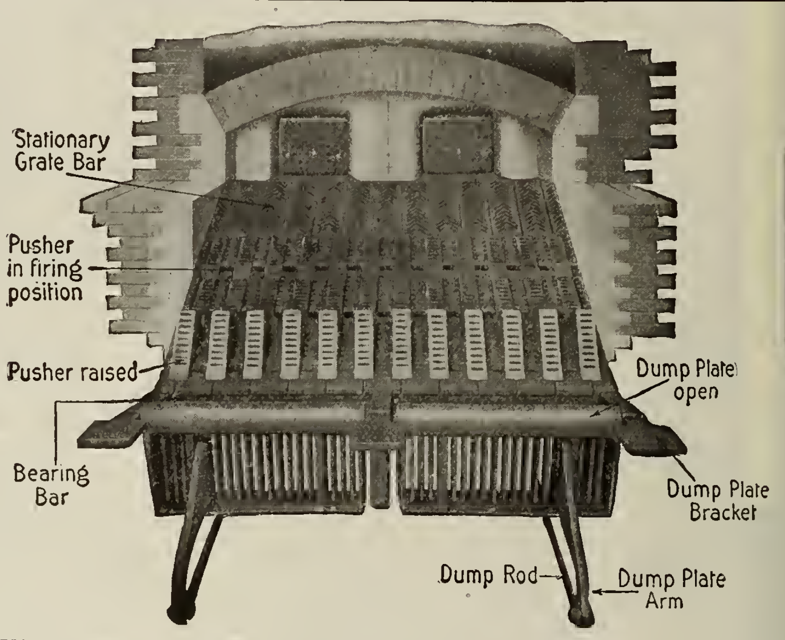
Who uses the National Hand Fired Stoker?

You have been reading our National Hand Fired Stoker advertisements for some months past and you may be curious to know what concerns in Canada use it.

Here is a partial list:

- Imperial Oil Co., Limited, Sarnia.
- Muskoka Hospital for Consumptives.
- Provincial Paper Mills, Georgetown.
- Toronto Golf Club.
- Toronto Hospital, Weston.
- Midland High School.
- Queen's University.
- Cobourg Dyeing Co.
- T. F. Shirley Co., St. Catharines.
- Prince Edward Hotel, Windsor.
- Culverhouse, Ltd., Vineland.

You are at liberty to write any of the above for their opinion of the value of the National Hand Fired Stoker. Booklet, price and full particulars sent on request. Remember, you can use the National under new or present Boilers.



WHAT IT IS

The National Hand Fired Stoker consists of a system of downward sloping grate bars, fuel pushers, dump plates, boiler front, bridge wall and ignition arch. In firing all that it is necessary to do is to dump the fuel on the upper end of the grate and when this is coked it is moved a stage further down by means of pusher rods operated from the front of the furnace, and the fresh charge of fuel may be dumped in.

No need to spread the fuel—any "green" hand can thus do the firing. The successive pusher rods keep the fuel marching downward, ensuring perfect and smokeless combustion, until the lowest or dump grates are reached. The draft is evenly distributed throughout the fire bed and excellent results can be secured with waste and low grade fuels.

You get all the advantages on a smaller scale, and without the great cost of the large mechanical stokers.

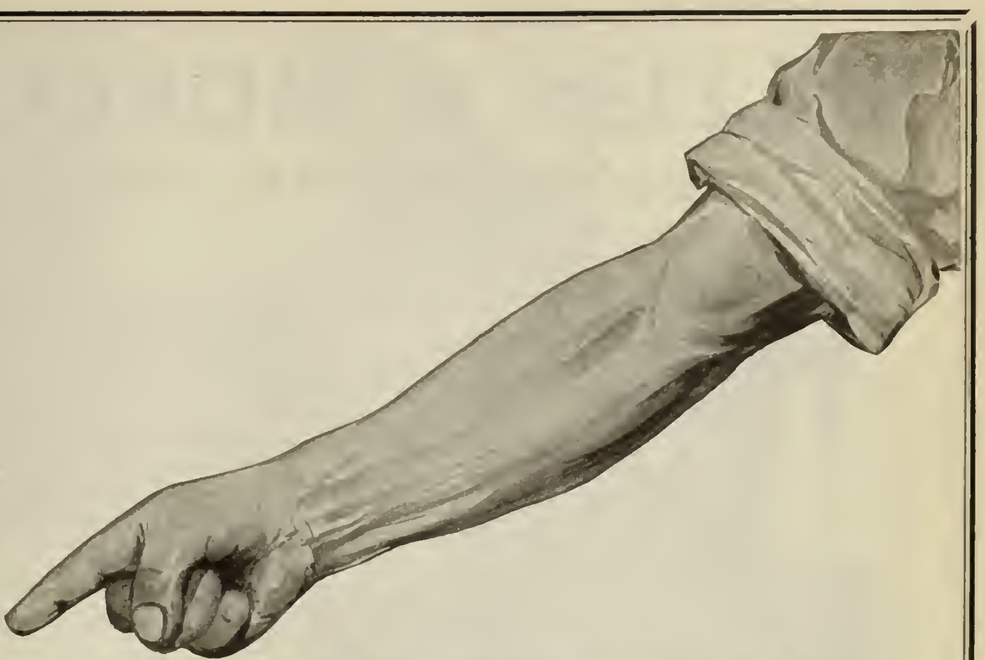
View of National Hand Fired Stoker taken from back of fire box looking towards the furnace doors, which are closed. Successive sloping banks of fire grates operated by pusher rods (not seen, because outside the furnace) are shown.

We build Horizontal Return Tubular, Vertical Tubular, Locomotive Type and Marine Boilers. We construct Tanks, Penstocks and Steel Plate work of all kinds. We furnish gray iron and brass castings of any size in the rough or machined to order.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal



"PALMETTO"

REG. TRADE MARK

PACKING

can be relied upon to give a length of life
in service unknown to other rod packings

LONG SERVICE MEANS TRUE ECONOMY

Braided for Rods
Twist for Valves

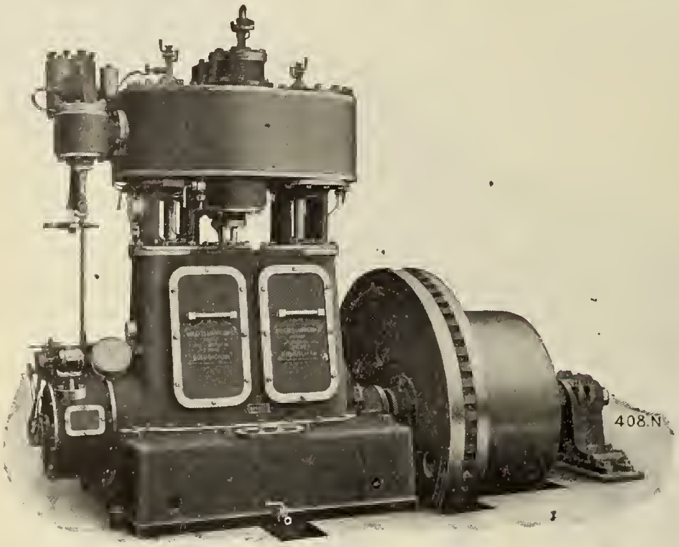
Let us send you samples to test under your own working conditions. No charge.

GREENE, TWEED & Co.
Sole Manufacturers
109 Duane St, New York

CANADIAN AGENTS:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

BELLISS & MORCOM LTD.

BIRMINGHAM, ENGLAND



Belliss Engine with Belt Drive

Are you getting cheap power?

Exhaust steam can be used for heating and process work, and thereby reduce power cost.

May we send you pamphlet on this question.

AGENTS :

LAURIE & LAMB, Board of Trade Bldg., MONTREAL

BOILER CHEMICALS

Made in Canada for You

Do it Now

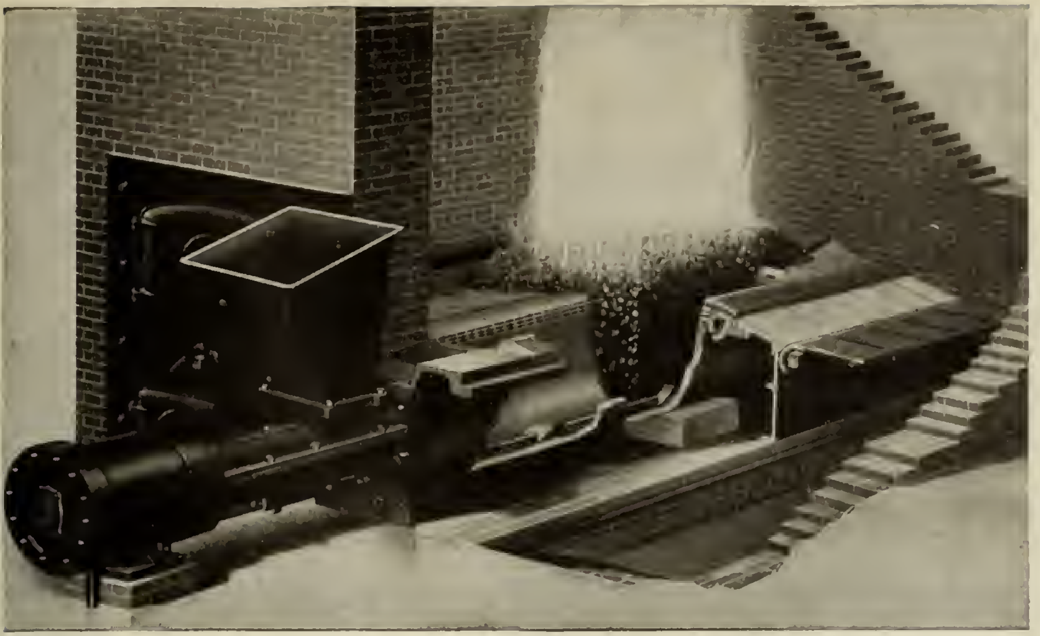
Not a hit-and-miss ready-made compound, but made for you on scientific principles.

Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal

Factory: Cobourg



Side dump attachments for "Jones Standard" Stokers

Any user of "Jones Standard" can quickly convert his stokers into the up-to-date side dump type. In place of the hand cleaned dead plates, sloping combustion grates and hand operated dump plates are substituted. The excavation of only a few inches is necessary.

Use the coupon to ask for details.

Its record recommends it

—the best investment for hundreds of Canadian plants

CONSULTING engineers are today recommending stoker firing for plants that a few years ago would have been considered too small for mechanical firing.

Stoker firing is paying big dividends in these smaller plants not alone because coal and labor costs are higher, but also because stokers have been developed to exactly meet the requirements of smaller plants.

The Jones "Standard Side-Dump" Stoker is in every detail an ideal stoker for hundreds of existing plants.

First cost is moderate because of the stoker's exceptional simplicity —the very quality that makes the "Side-Dump Stoker" ideal for smaller plants.

Installation is simple—and therefore inexpensive. No excavation is necessary for ash pits because the simple side dump plates discharge the ash and refuse into shallow pits that are only a few inches below the floor level.

But although this stoker can be purchased and installed at relatively small cost it is nevertheless a real self-cleaning under-feed stoker possessing all the established advantages of the underfeed principle —economy of fuel, quick response to load demands, heavy overload capacity and steady, trouble-free operation.

You will be surprised to find what a small investment is required to convert your plant into an economical stoker fired plant by installing the "Jones Standard Side-Dump" Stoker. Send the coupon for the bulletin.

Branch Offices

Alta. and West. Sask.
Mr. J. Twomey

Man. and East. Sask.
W. W. Hicks & Co.
Winnipeg

British Columbia
E. A. Earle, Ltd.
Vancouver, B.C.

Quebec: Cleaton Co.
(Canada), Ltd.
Montreal, Que.

The Under-Feed Stoker Co. of Canada, Ltd., 146 King St.W. Toronto

"Jones" Underfeed Stokers "Riley" Underfeed Stokers "Murphy" Automatic Furnaces

The "Jones Side Dump" Standard Stoker

The UNDER-FEED STOKER COMPANY OF CANADA LTD.
RILEY JONES MURPHY

P.H. 11-5-23

Send me { "Standard Side Dump" Stoker bulletin.
Details of side dump attachments.

Firm.......................................

Address.......................................

Att'n.......................................

To Under-Feed Stoker Co.
of Canada, Ltd.,
146 King Street W.
Toronto

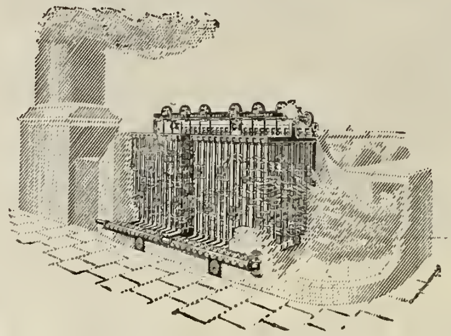
More Steam -- Less Coal

Up-to-date Boiler plants are saving thousands of tons of coal annually by the installation in the main flue between the boilers and the chimney stack of a

Green's Fuel Economiser

which by utilising high temperature flue gases

SAVES 15-20%



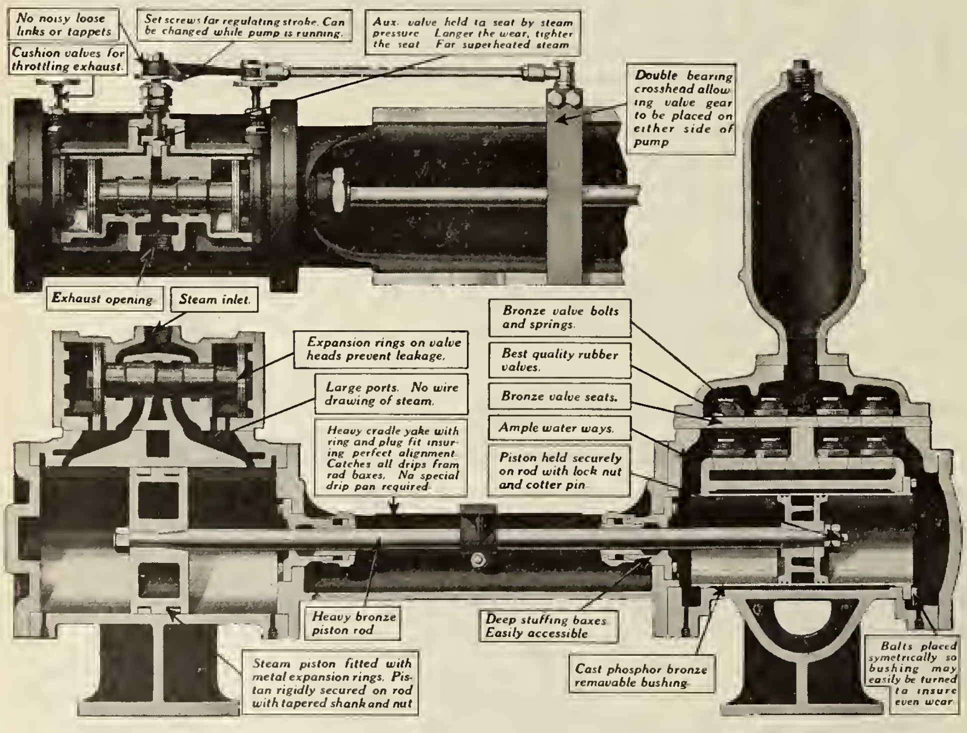
OF COAL

Write for illustrated and descriptive Catalogue D.J. to—

E. GREEN & SON, Ltd., Wakefield, England

Codes: A.B.C., 5th Edition; Bentley's Phrase; A1; Lieber's; Engineering; Western Union.

AMERICAN--MARSH PUMPS


No noisy loose links or tappets
Set screws for regulating stroke. Can be changed while pump is running.
Aux. valve held to seat by steam pressure Longer the wear, tighter the seat For superheated steam
Cushion valves for throttling exhaust.
Double bearing crosshead allowing valve gear to be placed on either side of pump
Exhaust opening
Steam inlet.
Bronze valve bolts and springs.
Expansion rings on valve heads prevent leakage.
Best quality rubber valves.
Large ports. No wire drawing of steam.
Bronze valve seats.
Ample water ways.
Heavy cradle yoke with ring and plug fit insuring perfect alignment. Catches all drips from rod boxes. No special drip pan required
Piston held securely on rod with lock nut and cotter pin
Heavy bronze piston rod
Deep stuffing boxes Easily accessible
Steam piston fitted with metal expansion rings. Piston rigidly secured on rod with tapered shank and nut
Cast phosphor bronze removable bushing
Bolts placed symetrically so bushing may easily be turned to insure even wear

THE illustration tells its own story. Why the American-Marsh are the most reliable, trouble-proof and efficient pumps on the market.

Less than one-half the wearing parts found in the duplex type while a saving of 25% in steam consumption is guaranteed.

Over 160,000 in successful operation.

Ask for catalog.

Canadian Agents: A. R. Williams Machinery Co., Ltd., Toronto and Winnipeg; Williams & Wilson, Ltd., Montreal. Bissett Pinder & Co., Edmonton. Stephens & Boyle, Vancouver. London Engine Supplies Co., London.

American Steam Pump Co., Battle Creek, Mich.

Put an End to Your Belt Troubles

ARE your transmission costs higher than they should be? Investigate where the trouble lies. Belt slippage and breakage may prove the seat of the cause.

You can eliminate excessive belt slippage and breakage by using D. K. McLaren's Belting. This belting is famous for its toughness and stretch-proof qualities. There is a reason. Every belt is made of the backs of the choicest hide—that portion of the hide which is toughest and free from stretching. In addition, all D. K. McLaren's Belting is British Oak Tanned—the most approved method for making belts that last.

See that your belting is stamped with D. K. McLaren's Oak Leaf. It's your guarantee of economy.

D. K. McLaren
LIMITED

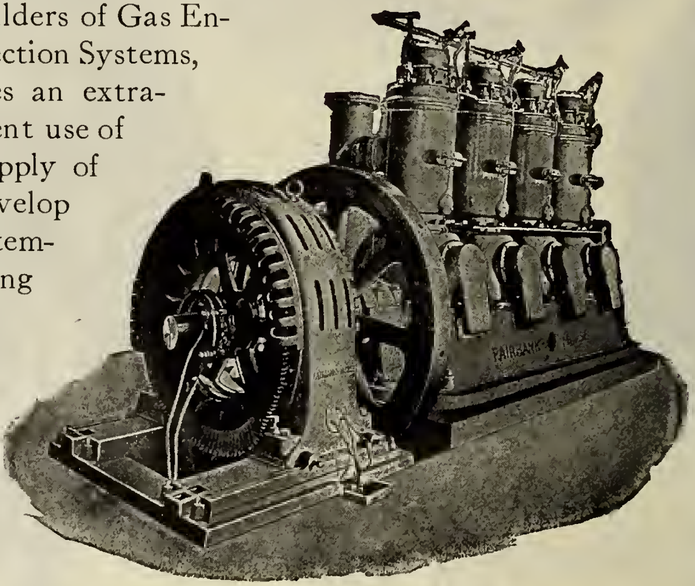
Head Office and Factory: **351 St. James Street, Montreal, Que.**

BRANCHES: Toronto, Ont., 194 King St. W.; St. John, N.B., 90 Germain St.

STOCK DEPOTS: Calgary, Alta., Gorman's, Limited; Edmonton, Alta., Gorman's, Limited; Vancouver, B.C., T. M. Grindley Company, 1158 Homer St.

For Thoroughly Dependable Low Cost Power Fairbanks-Morse "Y" Type Oil Engines

These simple rugged power plants are the result of generations of study and experiment by the pioneer builders of Gas Engines. Their entire freedom from Water Injection Systems, Hot Bulbs, Igniters and Timers guarantees an extraordinary low upkeep cost, while their efficient use of low grade fuel oils ensures a dependable supply of power at minimum expense. And they develop power day-in-and-day-out independent of temperature, weather, coal shortage or failing electric supply.



Write our nearest branch for catalogues and prices.

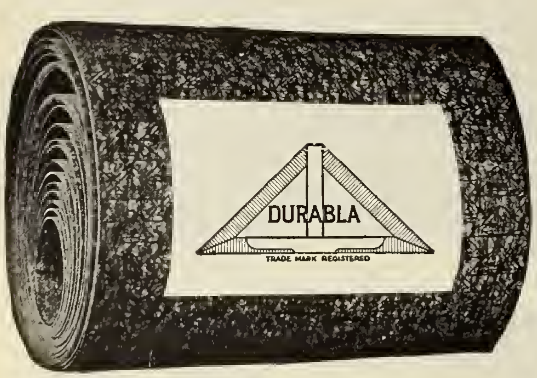
The Canadian Fairbanks-Morse Co., Limited

St. John Quebec Montreal Ottawa Toronto
Windsor Winnipeg Regina Calgary
Vancouver Victoria

35

Tight Joints

On Steam, Water, Air, Oil, Ammonia, and Acids at All Temperatures



Place Durabla Packing in the next joints you make and be insured against costly shutdown.

Durabla Compressed Asbestos Fibre Gasket material is not affected by vibration or condensation. It will not burn out, blow out, or pulp at the joints.

Made in Canada in stock sizes 36 in. wide by 150 in. long in thicknesses of 1/64, 1/32, 1/16 and 1/8 in.

CANADIAN DURABLA LIMITED, MONTREAL

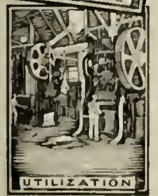
Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

"Let's Both Go"

Says the Progressive Engineer to the Boss. "We'll learn a lot about getting more power at lower cost—we'll examine the new equipment, and get acquainted with the people we buy from. They will be at the

POWER SHOW



December 3-8, 1923

Grand Central Palace
NEW YORK

NOT only the engineer, but the manufacturer, capitalist, dealer and consumer will learn something worth while at this great display of apparatus for creating and handling power.

A great deal of the equipment will be shown in operation under actual working conditions, and there will be trained men to explain the fundamentals of operation.

In these days of high-priced coal, anything that shows how to save fuel is of vast importance. What you will learn about this one thing alone will be worth the trip to the Power Show.

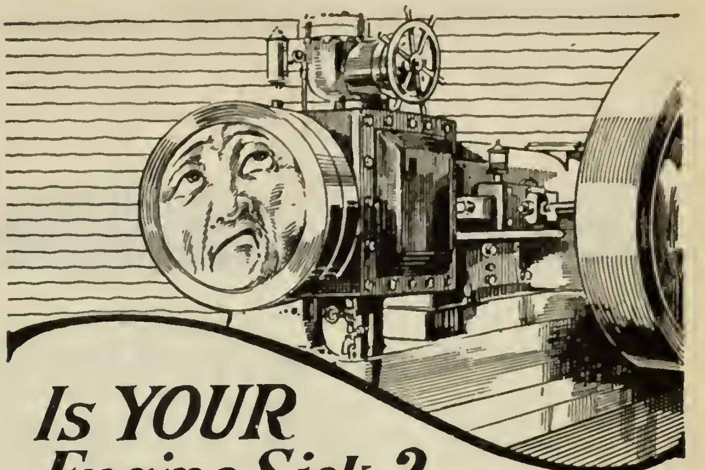
Keep up with the March of Progress! Stay in the lead by keeping posted. Come to the Power Show!

To Manufacturers! If you have something of positive merit and capable of comparison which is used either in producing, transmitting or using power or some mechanical equipment, or supply or materials used by the mechanical industry we welcome you as an exhibitor. Every application is subject to Exhibits Committee approval and no article can be exhibited unless it possess real merit.

For further information address

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING

Grand Central Palace, New York



Is YOUR Engine Sick?

Many an engine that keeps on running day after day ought to be on the "sick list." Because you can't see engine troubles you don't realize they are there and you continue to use more steam than is necessary, thereby wasting coal.

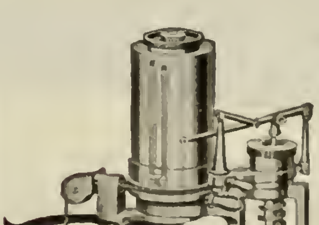
To get an accurate line on the condition of your engine—to learn whether it is pounding itself into premature old age—test it frequently with that infallible instrument, the

AMERICAN
THOMPSON
IMPROVED INDICATOR

You run your engine on a scientific basis when you own an American Indicator. It enables you to get the most out of your engine—to conserve steam and fuel—to detect leakage and losses of power—to correct internal troubles before they become serious—to produce a given horse-power on a minimum of coal.

It's as easy as ABC to use an American Indicator. No other indicator is so simple, so accurate, so up-to-date. Fitted with new Detent Motion, an exclusive feature, which permits the rapid changing of cards without unhooking cord.

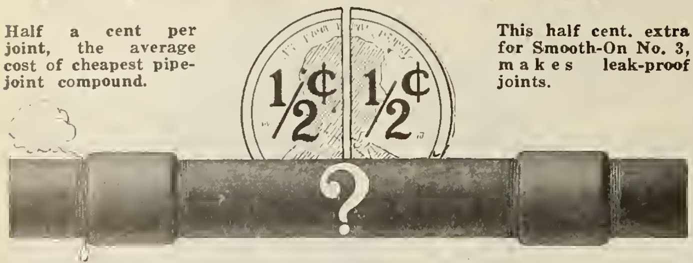
Write for Catalog T-33 giving full particulars



American Schaeffer & Budenberg Corporation
SUCCESSORS TO
Schaeffer & Budenberg Mfg. Co.
and
American Steam Gauge & Valve
Mfg. Co.
BROOKLYN, N.Y.
Canadian Agency:
THE CANADIAN FAIRBANKS-MORSE CO., LTD.,
Montreal, Toronto.

Half a cent per joint, the average cost of cheapest pipe-joint compound.

This half cent. extra for Smooth-On No. 3, makes leak-proof joints.



Isn't it worth the other half cent to make this joint tight for all time

LOOK to the future! What's half a cent compared with labor and material costs in remaking a screw-thread joint? As long as a Smooth-On joint stays in the line, it stays tight because the iron body in the Smooth-On can't dry out, shrivel or shrink—yet the joint can be unscrewed.

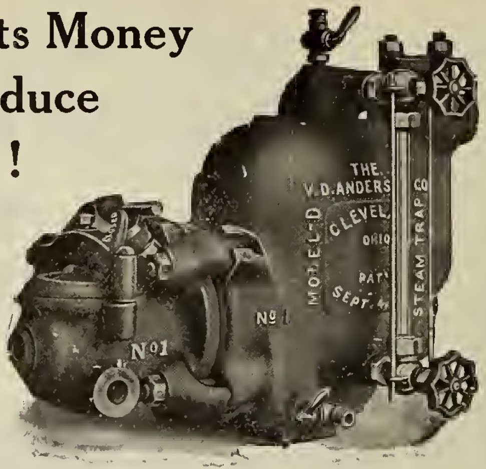
Send for a free sample and you will want more for every new screw-thread joint you make.

Smooth-On No. 3 comes ready to use, in 1-lb., 5-lb., and 10-lb. gray-labeled cans. If your dealer is out of stock, send us his name so we can see that you are supplied.

The Canadian Asbestos Co.
36 Youville Square
Dept. 52 Montreal, Que.

Do it with **SMOOTH-ON**

It Costs Money to Produce Steam!



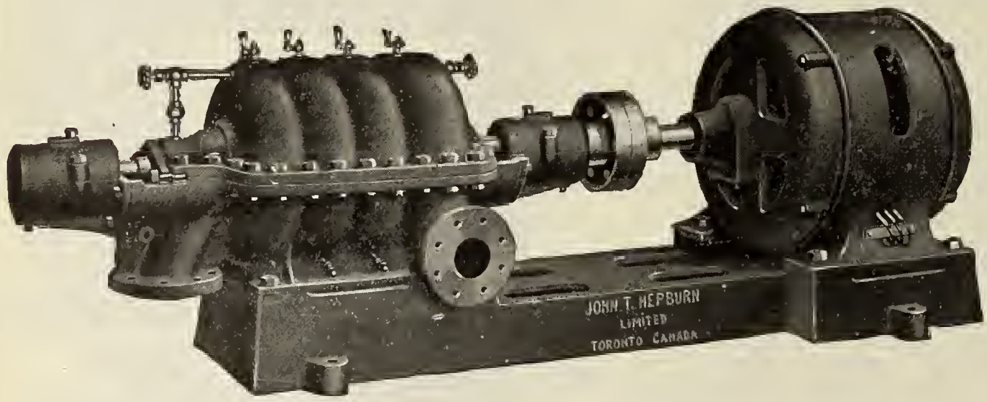
Don't Waste it—Use an
ANDERSON MODEL "D" STEAM TRAP

It is designed to give long, tight service. The deep water seal prevents the escape of steam. Operated by a simple counter-balanced float mechanism that can not get out of order.

All dirt and sediment is caught in the self-contained removable strainer and can not enter the trap. An outside gauge glass shows how quickly the trap is filling and discharging. Write for descriptive folder.

THE V. D. ANDERSON CO.
West 96th St., Cleveland, Ohio

Safeguarding the Water Supply of North Vancouver with



HEPBURN
Canadian Made
PUMPS

The 3-inch, 4-stage Hepburn Pump installed by the Lynn Canyon Waterworks, has justified the reputation of the makers by its consistent, dependable service. Operating against a head of 600 feet, it is still safeguarding the water supply of the North Vancouver district.

The Hepburn pumps are built on the most improved lines—Centrifugal, Simplex, and Duplex. Write for complete information regarding Hepburn Pumps and Hepburn Hand and Electric Overhead Cranes, Castings and Forgings.

JOHN T. HEPBURN, LTD. ENGINEERS AND IRON FOUNDERS **18-40 Van Horne St., TORONTO**

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

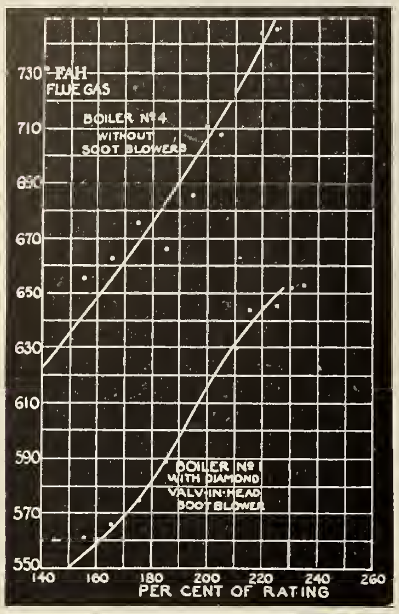
Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast

Diamond Soot Blowers Save Fuel at all ratings



This test was conducted on two duplicate 1000 h.p. horizontal water tube boilers, 170 lb. pressure, burning anthracite coal.

The lower curve covers the performance of boiler No. 1, fitted with Diamond "Valv-in-Head" soot blowers. The soot blowers were operated once every eight hours. Boiler No. 4, covered by the upper curve, was hand-cleaned once a week by means of an air hose.

The points plotted are reasonably consistent, and show an average gain of 90 degrees in favor of the "Valv-in-Head" soot blowers as compared to the air-cleaning. A 90 degree decrease in flue temperature at say 12 per cent. CO_2, represents a saving of 3.5 per cent. in carbon or about 3.1 per cent. in combustible.

An equipment, costing no more than Diamond Soot Blowers do, and which effects such savings in fuel, is an investment of the very first order. Diamond Soot Blowers pay for themselves many times over during their period of service.

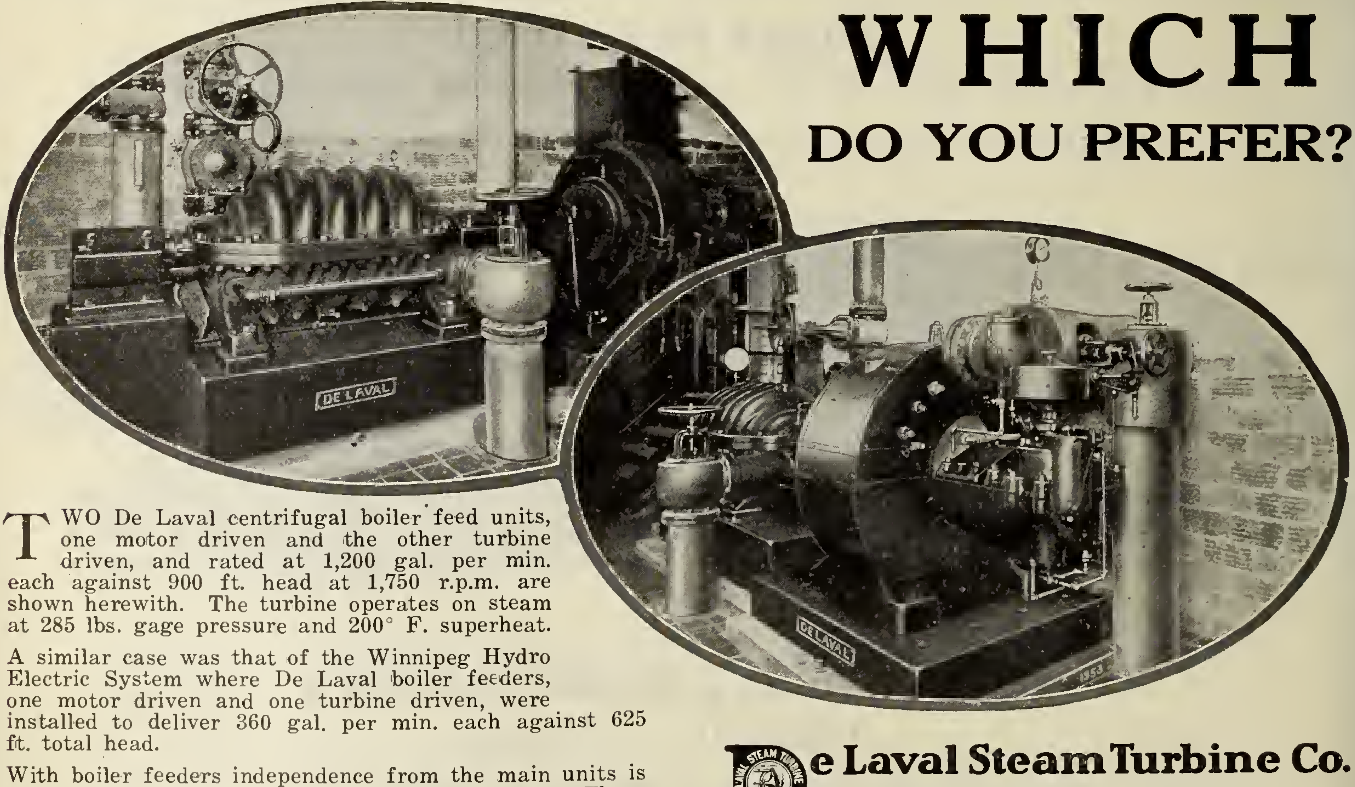
Ask for Bulletin 287.

DIAMOND SPECIALTY LTD.
Windsor, Ontario

Diamond

Soot Blowers-Save 4 to 8% Fuel

WHICH
DO YOU PREFER?



TWO De Laval centrifugal boiler feed units, one motor driven and the other turbine driven, and rated at 1,200 gal. per min. each against 900 ft. head at 1,750 r.p.m. are shown herewith. The turbine operates on steam at 285 lbs. gage pressure and 200° F. superheat.

A similar case was that of the Winnipeg Hydro Electric System where De Laval boiler feeders, one motor driven and one turbine driven, were installed to deliver 360 gal. per min. each against 625 ft. total head.

With boiler feeders independence from the main units is a strong argument for using steam turbine drive. There is no denying, however, that motor drive gives higher theoretical station efficiency, especially if the feed water is heated by steam bled from the main unit. For this reason De Laval centrifugal boiler feed pumps driven by electric motors were installed under the same capacity, head and speed conditions as the turbine driven boiler feed pumps.

De Laval Steam Turbine Co.

TURBINE EQUIPMENT CO., LTD.
73 King St. West, Toronto.

THE E. LAURIE COMPANY
243 Bleury St., Montreal, Que.

The
LACHINE HIGH SCHOOL
is equipped throughout with
JENKINS VALVES

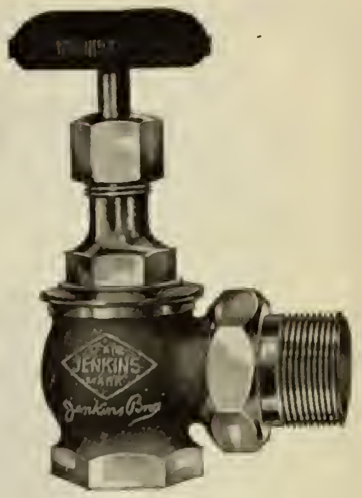
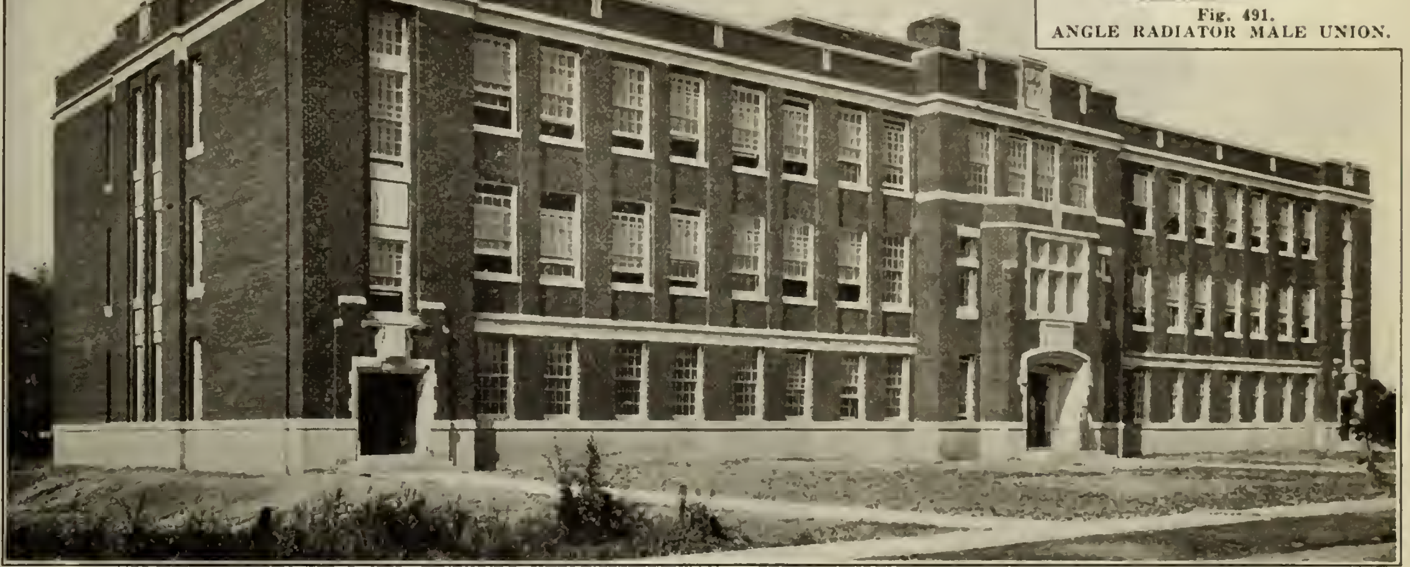


Fig. 491.
ANGLE RADIATOR MALE UNION.



C. R. TETLEY, *Architect, Montreal.* WALTER J. ARMSTRONG, *Consulting Engineer, Montreal.* D. A. BETHUNE, LTD., *Plumbing and Heating Engineers, Montreal.*

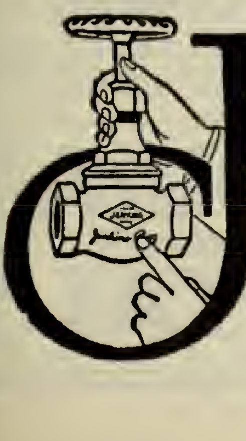
Here is a modern school building where every provision is made to assure the comfort of the pupils.

Realizing what an important part dependable valve equipment plays in providing this comfort, it was decided to install only genuine Jenkins Diamond-marked Valves throughout the entire building. Both architects and engineers have pinned their faith to Jenkins Valves knowing that the Jenkins line assures lasting trouble-free service.

This confidence in Jenkins dependability is further proof of the fact that men whose knowledge of valve values is based upon practical experience recognize the name Jenkins as a guarantee of satisfaction.

Jenkins Valves are made in a big range of types and sizes for requirements of Power Plant, Plumbing and Heating service. Catalog No. 9 shows the complete line. Write for free copy.

JENKINS BROS. LIMITED
Head Office and Works: 103 St. Remi St., Montreal
EUROPEAN BRANCH: London, W.C. 2, Eng.
SALES OFFICES: Toronto, Vancouver.
FACTORIES: Montreal, Bridgeport, Elizabeth.



Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

KERR

"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited

Valve and Hydrant Manufacturers

Walkerville Ontario

Where you can get Plibrico!

SOMETIMES when furnace linings are needed, they're needed quick. Then it is that the engineer is glad that Plibrico—the one-piece lining—can be had from warehouse stocks close to him, where ever he is. In Canada a 'phone call, wire or letter will start Plibrico on the way if addressed to:

Montreal—Beveridge Supply Co.
Toronto—Shell, Bar, Boico Supply Co.
Vancouver—Evans, Coleman & Evans.
Winnipeg—Winnipeg Supply & Fuel Co.
Saskatoon—Building Products & Fuel, Ltd.
Regina—Dominion Lime & Coal Co.

When you need furnace linings in a hurry order Plibrico—you'll get long life in addition to speed of delivery.

PLIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO.
1142 CLAY ST. CHICAGO

Plibrico is delivered only in steel containers of distinctive appearance, as shown above.

Use Logic in Buying Your Babbitt Metal

Protection from power waste, hot boxes and complete bearing breakdowns involves no particular increase in initial cost if you line your bearings with Magnolia Anti-Friction Metal, but you would effect a substantial ultimate saving, to say nothing of the more dependable service and relief from bearing worries.

If your supply man offers a substitute, write us direct.

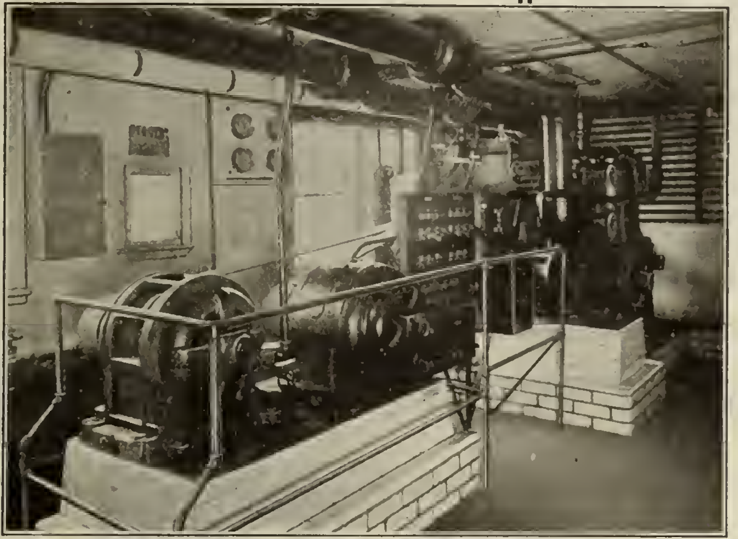
Magnolia Metal Company

37-39 Shannon St., Montreal, P.Q.

Magnolia Factories also at London, New York, Chicago, San Francisco.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK

REFRIGERATION DEPARTMENT



An installation of York Enclosed Refrigerating Machines in a Candy Factory.

Mechanical Refrigeration

—is an important adjunct to many lines of industry and commerce. In moderate size installations the best results can be obtained by using the—

YORK Enclosed Machine

These machines can be driven by any available power. Their simplicity of construction permits them to be operated successfully by employes, who have had no previous experience in operating one.

They are carried in stock in all our warehouses for prompt delivery. Write our nearest office and give our engineers the opportunity to assist you in solving your Refrigerating Problems.

Canadian Ice Machine Co.,
Limited

TORONTO ....Villiers & Munition Sts., Eastern Harbor Terminal
MONTREAL ....324 Craig Street West
WINNIPEG ....1415 Whyte Avenue
VANCOUVER.. ....1138 Homer Street

Representing
YORK MANUFACTURING COMPANY
York, Penna., U.S.A.

REFRIGERATING MACHINERY

Expansion Pipe Ammonia Fittings. Calcium Chloride.
Ammonia. Ice Machines.
Agents for "TRIUMPH" Ice Machines.

J. L. WILSON & SONS
REFRIGERATING ENGINEERS.
3 SILVER AVE. TORONTO

REFRIGERATION SUPPLIES

REPAIRS - FITTINGS
AGENT FOR FRICK REFRIGERATING EQUIPMENT

REFRIGERATING ENGINEERS
LIMITED
457 King W. TORONTO Adel. 7753

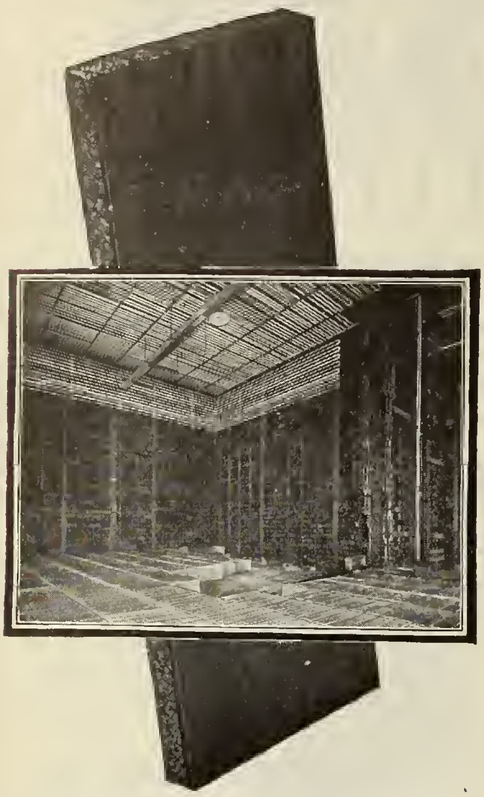
MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA



Interior of the storage room of the Denver Ice and Cold Storage Company, Denver, Colo., showing Armstrong's Mastic Finish on Nonpareil Corkboard

No Other Finish Necessary

NONPAREIL Corkboard with 1/8-inch coating of Armstrong's Mastic Finish needs no plaster. The unbroken, impervious sheathing is perfect and permanent protection.

Armstrong's Mastic Finish is a waterproof mineral rubber compound, not mopped on the job, but ironed on Nonpareil Corkboard at the factory. It is keyed into the surface under pressure. Hot irons press out all bubbles and airholes. Armstrong's Mastic Finish does not soften at ordinary temperatures. It does not crack when cold. It has no odor.

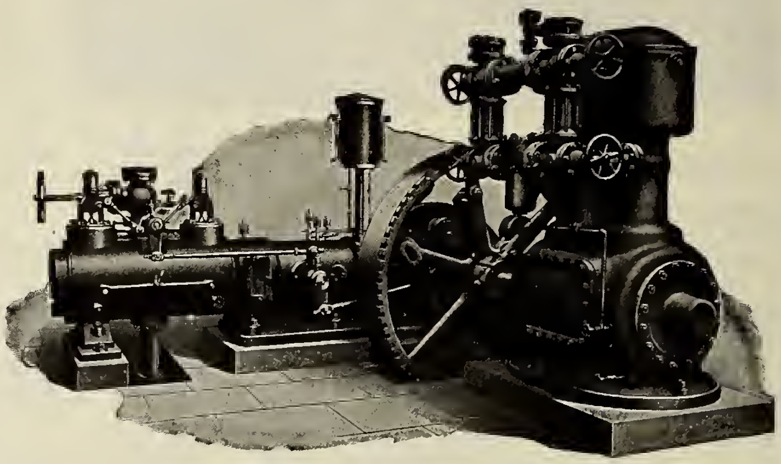
The V-shaped joints are easily filled with a plastic compound which, when ironed, amalgamates with the mastic on the corkboard. There are no breaks between the boards.

In ice storages, coil lofts, hardening rooms and in all cold storage rooms where there is much moisture, Armstrong's Mastic Finish is recommended.

Full information will be furnished and a sample of Armstrong's Mastic Finish on Nonpareil Corkboard sent on request.

ARMSTRONG CORK & INSULATION CO., LTD.

902 McGill Bldg., Montreal, Que. 11 Brant St., Toronto, Ont., Can.



FRICK COMPANY, INC. TRADE FRICK MARK WAYNESBORO, PA. U.S.A.

REFRIGERATION

Safe—Simple—Economical

Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.

It will pay you to investigate.

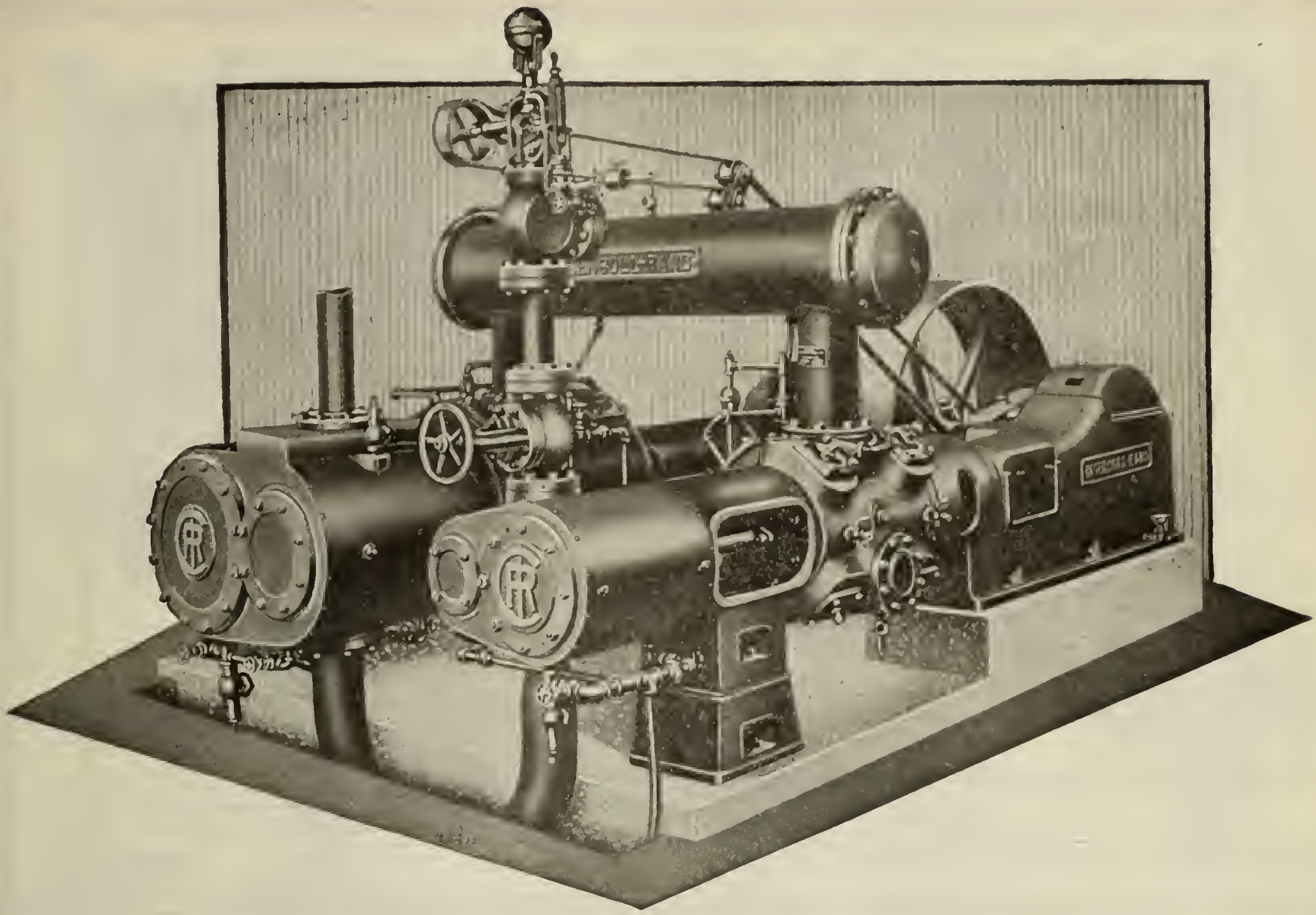
See our installation in the new Mount Royal Hotel at Montreal, which was opened last month.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto



Class "PRS" Steam Driven Compressors

To meet the demand for a high grade steam Driven Compressor of larger capacity than our Class "FR-1" Straight-line type, we have designed the Class "PRS" Duplex Steam Driven Units shown above.

These machines are of enclosed construction with automatic lubrication. Frames, running parts, lubrication system and plate valve air-ends are identical with those used on our well known Class "PRB" and "PRE" belt and motor driven units.

Steam-ends are simple or compounded and are equipped with Ingersoll-Rand Balanced Piston Valves. These valves are very efficient and have much longer life than any other types.

Speed and Pressure Governing Devices or a combination of Speed and Pressure Governor and our Free Air Unloader can be furnished as desired.

Class "PRS" Compressors are suitable for mines, construction jobs or industrial plants where steam is used. They may be readily converted to power drive and are thus adapted for use where hydro-electric plants are under construction or where a combination of steam and motor drive is desirable.

Write for further information

Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

Ingersoll-Rand

Flue gases can be reduced 50 degrees by careful firing and clean boiler surfaces

Such is the substantial saving that can be effected by recording and measuring your flue gas temperature with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

Recording Pyrometers

Of course, the temperature of outgoing gases can be decreased by economizers, or by a change in the baffling — but such changes are costly and the economy depends upon the cost of coal.

The information supplied by Bristol's Pyrometers, as to the temperature of uptake gases leaving the boilers, is of prime importance as an aid to super-efficient plant operation.

Hundreds of Bristol's Pyrometers are recording flue gas temperatures in prominent power plants. Let us tell you more about what they could do in your plant. Our new Catalog O-1401 is waiting for your address.

The Bristol Company, Waterbury, Conn.

Canadian Distributors:
Eastern Territory: Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory: Gorman's, Ltd., Edmonton.

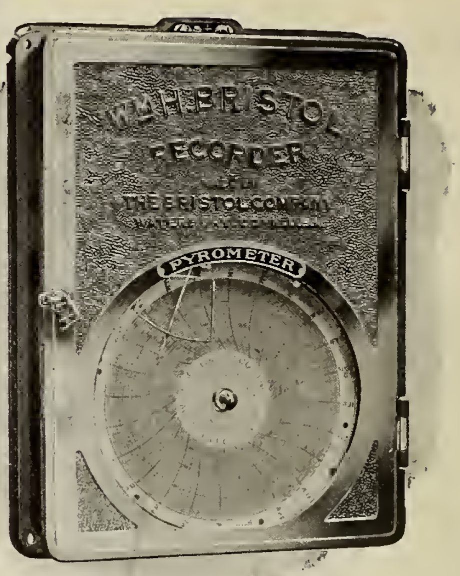
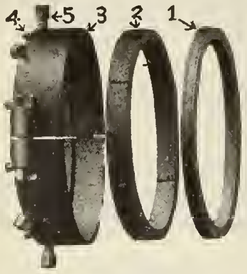


Fig. 1007
A suit has been filed in the United States Federal Court against a pyrometer manufacturer who is infringing patents owned by the Bristol Co. covering Automatic Cold End Compensation for Thermo-Electric Pyrometers.



YARWAY
Pipe Joint Clamp

Stops leaks in threaded joints. Application: 1—Square packing ring, forced against leaky joint; 2—Inside ring, forced against packing 1 by screws 4; 3—Outside ring, bolted around pipe and secured by set screws 5, prevents slipping when adjusting screws 4.

A YARWAY Pipe-Clamp Will Stop that Leak

The coming cold weather will increase the danger of split pipes and costly leaks. Protect your plant against leak losses by laying in a supply of Yarway Pipe Clamps now—the least expensive and most effective leak insurance.

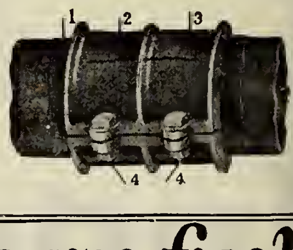
The Yarway Pipe-Joint Clamp immediately stops leaks in threaded joints. The Yarway Holtite Pipe Clamp stops holes and splits in straight pipe. Either can be applied in a few moments by any workman, and they are equally efficient for temporary or permanent repairs.

Full description of both clamps, with prices, in Booklet C-805. Send for your copy to-day.

YARNALL-WARING COMPANY
Mermaid Lane and Ardleigh Street, Philadelphia
207 St. James Street, Montreal
400 Penobscott Bldg., Detroit

YARWAY
Holtite Clamp Pipe

Stops holes and splits in straight pipe. Application: Packing (1) is placed over hole or split (2) in pipe; metal clamp (3) is then placed over packing and around pipe; bolts (4) tighten clamp and hold it in place.



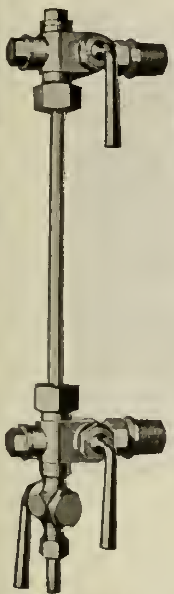
YARWAY

POWER PLANT DEVICES *to save fuel*

YARWAY BLOW-OFF VALVES—YARWAY SPRAY NOZZLES—YARWAY-LEA V-NOTCH METERS

MORRISON

STEAM GOODS


Water Gauge.

Recording Gauge.

Model "C" Safety Valve

In this age of strenuous competition only those commodities which meet the most exacting demands of careful buyers are able to survive for any length of time.

Morrison Steam Goods have been on the market for fifty years. During this time they have won widespread popularity in Canada wherever steam goods are used.

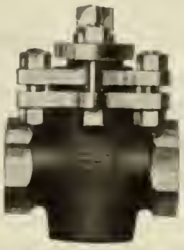
They have survived the test of time and shocks of changing conditions because their quality, workmanship and design is fully recognized by the engineering profession.

J. M. T. Reducing Valve

Beaver Valve

J. M. T. Check Valve.

Non-Return Stop and Equalizing "Y" Valve.


Asbestos Packed Cock.

J. M. T. Twin Safety Valve

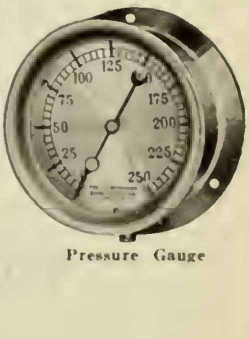
Steam Whistle

Gem Ejector

Throttle Valve

Morrison Injector.

Atlas Gate Valve


Pressure Gauge

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide Street W., Toronto

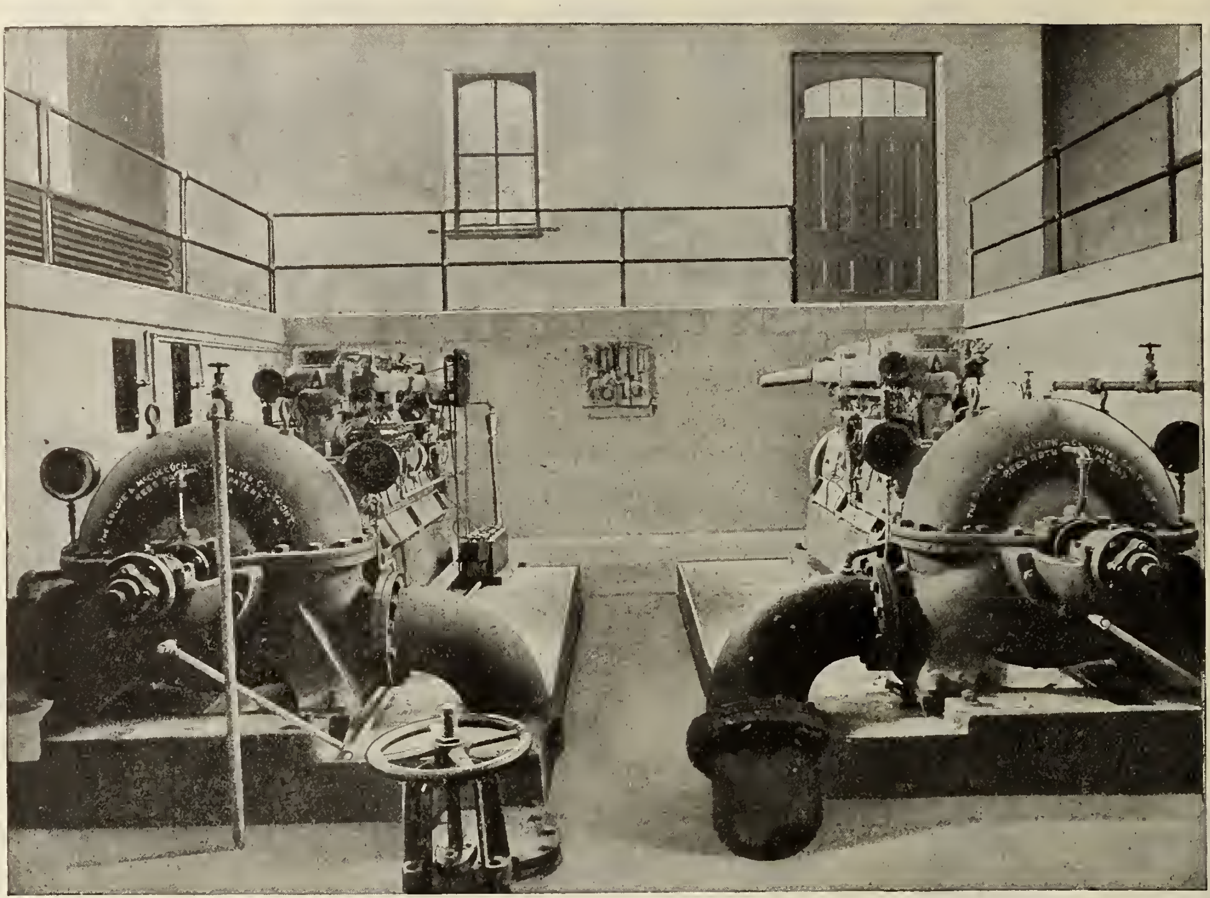


Illustration shows a portion of the Waterworks Pumping Station at GUELPH, ONTARIO

Equipped with

Two REES RoTURBo PUMPS

Driven by Sterling Gasoline Engines

These pumps were installed after several other REES PUMPS, motor driven, had been giving highly satisfactory service in the same plant for several years.

A Tribute to the efficiency of G. & McC. Co.

REES RoTURBo PUMPS

Catalogs Supplied on Request

THE GOLDIE & McCULLOCH Co., Limited

Head Office and Works: GALT, Ontario, Canada

Toronto Office:
Suite 1101-2,
Traders Bank Bldg.

Western Branch:
248 McDermott Ave.,
Winnipeg, Man.

Quebec Agents:
Ross & Greig,
412 St. James St.,
Montreal, Que.

British Columbia Agents:
Robt. Hamilton & Co.,
Vancouver, B.C.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

J. MACTAGGART
News Editor

Gasoline as a Refrigerant

THE conclusion reached by L. D. Wyant of the U. S. Bureau of Mines, after lengthy research, that gasoline is a convenient, economical and useful refrigerating medium, will prove unintelligible to the Canadian engineer.

From a careful examination of the report all that seems to be presented is the fact that gasoline can be used as a medium to which heat may be given at low temperature planes, and added to at progressively higher planes, by the heat equivalent of power and the sum total of heat added at both points may be used for heating a quantity of water at convenient planes of temperature.

This fact is merely a statement of general laws of thermodynamics that have been established for more than a century.

From the data given no one can tell whether the horse power per ton of refrigeration, when taking and discharging heat at certain planes, is more or less than with other fluids nor whether the displacement per unit of refrigeration, and hence the speed and size of the cylinders, will have to be greater or less than with other fluids.

Further, no information is given as to the boiling point of the liquid at different temperatures, the heat of the liquid, or the volume of the gas at different pressures. Without such data it is impossible to judge of its value, except perhaps to fall back on the general proposition that between the same temperatures, of reception and discharge of heat, the horse power is nearly the same for all fluids, barring incidental circumstances connected with their use. There is nothing in the report that throws any light on this subject and absolutely no data as to the practical volume and, therefore, design for a certain duty, or the horse power per ton.

The impression conveyed is that gasoline, as the motorist knows it ordinarily, was used, but although the specific gravity of the sample is given and the words volatile gasoline are used, there is indication that some hydrocarbon of lower boiling point than what we ordinarily call gasoline was used in the experiment, and perhaps a compound containing gasoline as a base having in solution many of the lighter hydrocarbons.

* * * *

Men Who Are Busy

BUSY men—men who are really busy—always find time to do the things they should do. If you want something done, ask a busy man to do it. The men who are following the Hubbard articles—who are staying up half the night studying Watson's Easy Lessons—they are busy men—and to use the words of a prominent stoker manufacturer the other day: "Because they keep still, and you seldom or never hear from them, is no sign that they do not appreciate the many instructive articles contained in each issue of Power House."

Just the same, it's fine to hear from those who don't always keep still, for at no time has full credit been given those engineers who have worked out our modern comforts and well-being through the medium of the power house. Of all things in the scientific world, the furnace is the one that is most hidden, yet it is the origin of the great power that makes life in Canada what it is to-day.

It is not in the boiler nor in the machinery nor in the electricity that is generated. The combustion of coal is the main source that we have for living in this most comfortable of all ages—1923.

* * * *

Innovations in Design

IN THE consideration of any problem connected with the generation of steam power to-day, it must be remembered that we are in the early stages of a new era in the design of plants using coal as a fuel. The outstanding innovations confronting engineers, may be safely summarized in three groups, such as, more economical combustion of fuel; more economical generation and delivery of steam; and better utilization of the steam.

In the first group, one of the notable projects of the year in Canada has been the impetus given the burning of fuel in pulverized form, by material evidence of Henry Ford's project "to burn coal twice" in a $500,000 plant at Ford. The new process is based upon a method of coal distillation, which differs from all previous practice, in that the coal is distilled at a comparatively low temperature, making possible the recovery of "volatiles" which have hitherto been lost.

In the second group of innovations, must be noted the tendency to instal incline tube boilers, some only 9 tubes high, and up to 24 tubes high, varying in length from 18 to 25 feet. Superheaters also have been installed in various localities with wide differences in design. Economizers have been changed considerably in design and materials and in the treating and heating of boiler feed water, including condensate, long neglected, substantial progress is now being made.

The third group of innovations, embodying the utilization of steam, are those concerned with the so-called higher steam pressure of 400 and 550 lb., requiring smaller tube diameters and different design of boilers than for pressures under 385 lb. Extra high pressures of 1200 lb. naturally require heroic departures in boiler design of turbines, accessories, piping, boiler feed pumps and other equipment.

* * * *

Keep B. T. U's in Your Pocket

THE average executive demands the power plant supply—necessary heat and power—at the lowest possible cost. Aside from paying the bills he is not interested, yet, how many engineers, in recommending the purchase of new equipment, cite the B.t.u.'s that will be saved per hour and the increase in thermal efficiency such equipment will effect?

Wouldn't it be better for the engineer in giving the reasons for his purchases to keep the B.t.u.'s and efficiencies in his pocket and submit instead a reliable estimate of the savings in dollars and cents he hopes to effect?

His approach might be: "As an engineer, I know what I am talking about when I tell you these improvements will cost you——dollars and from them you will get a net return of——dollars a year."

Here in substance, is the kind of an approach that will get the attention and support of the busy executive.

Power—Their All!

POWER is a blessing to all its possessors,
Givers, receivers, and mediums, too,
Cherished alike by both clowns and professors,
Cause of our joys whether many or few.

Power is the life of the worst and the best of us,
Over us, under us, in and around,
Power to the north of us, south, east, and west of us,
Power in the water, the air, and the ground.

Dynamo, motor, train, boat, plane, or auto,
Man, beast, or bird, or the creatures that crawl,
Sun, wind, or river, they follow one motto,
Power is their pulses, their passion, their all.

Whether in pipe, cable, shaft, or conductor,
Power is the purpose and power the desire,
Power is our slave and our boss and instructor.
Light, heat, and power in eternity's fire.

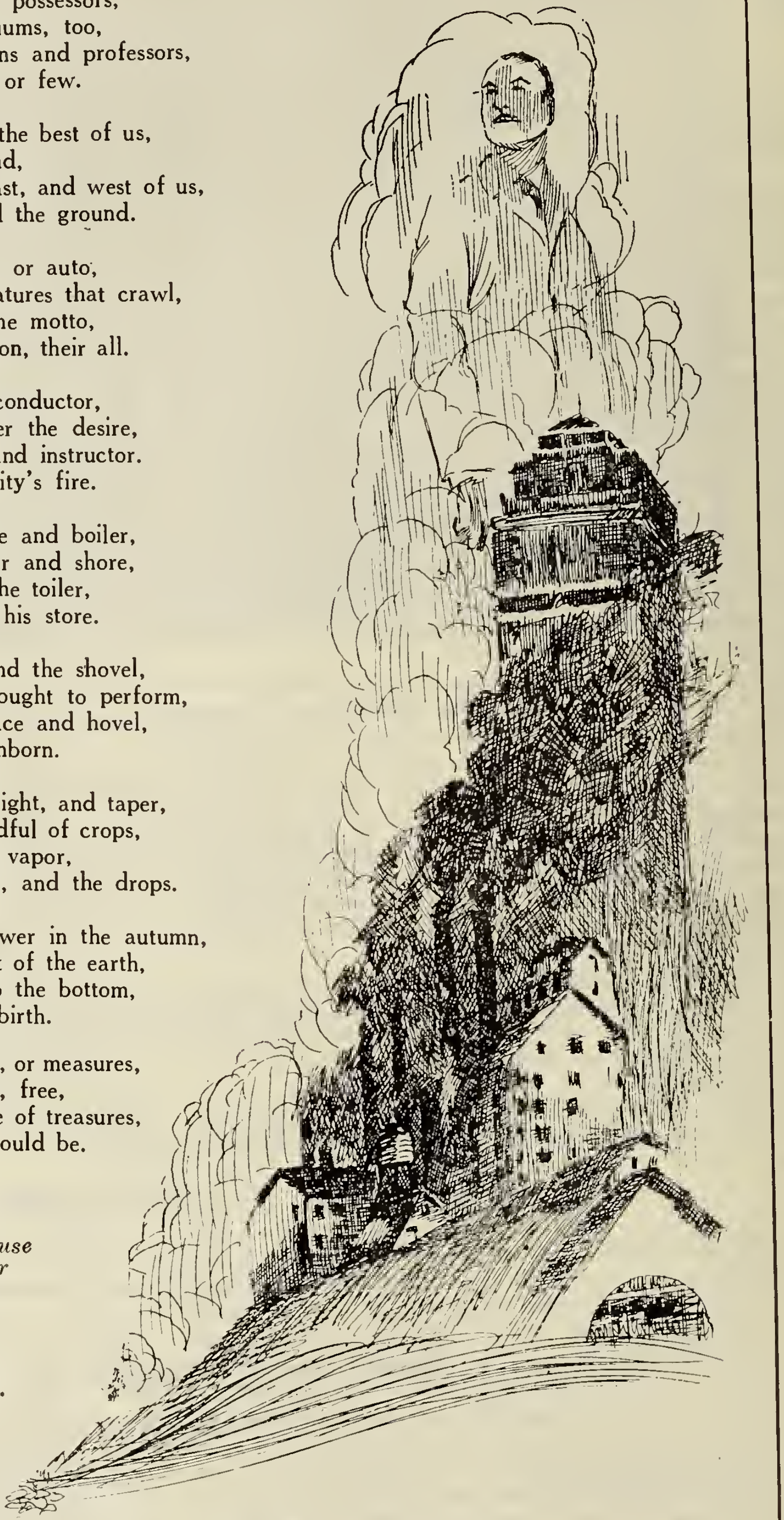
Coal, wood, and oil for the engine and boiler,
Tides for the burdens of harbor and shore,
Powers for reducing the load of the toiler,
Spreading his table and filling his store.

Power for the needle, the pen, and the shovel,
Power for the task which we ought to perform,
Power for all needs, both of palace and hovel,
Limitless power for the ages unborn.

Power in the lightning, the searchlight, and taper,
Power in the growth of a worldful of crops,
Power in the liquid, the solid, the vapor,
Power in the atoms, the flakes, and the drops.

Power in the spring-time, and power in the autumn,
Power in the swing and the tilt of the earth,
Sweeping its map from the top to the bottom,
Fully conserved in a yearly rebirth.

Power beyond language, or figures, or measures,
Power omnipresent, omnipotent, free,
Bidding mankind to its store-house of treasures,
Manifold riches, conscripted would be.



Reproduced in Power House
by request of the author
R. MANLY ORR,
1551 Granville St.
Vancouver, B.C.
Chief Engineer
Pacific Coast Pipe Co.

Don't Treat a Lump of Coal With Contempt!

By K. L. DAWSON, Assistant Superintendent Gas Department, Nova Scotia Tramways & Power Company

An Increase of 10 Per Cent. in the Overall Efficiency of 95 Per Cent. of the Power Plants in the Dominion Would Cut the National Coal Bill $9,000,000 a Year

THE average person considers a lump of coal simply a convenient source of the heat which he finds necessary for the cooking of his food or the warming of his home.

He is so familiar with coal that he treats it with contempt, except perhaps when he comes to pay for it; then he transfers his contempt with his cheque to the party from whom he purchased it. He fails to see that the rising price is an indication of the approaching exhaustion of the beds from which coal can be easily mined and a warning that he should cease its indiscriminate destruction.

Coal is so much a part of our life that we all know something about it. We know there are different kinds; some of which break easily, others do not; some kindle easily, others do not; some burn with little smoke, others with much smoke. A few people have searched for the reasons behind these phenomena and have found that coal is a complex mineral containing many things, not the least wonderful of which are the liquids which are the basis of coal-tar dyes comprising 397 colors and shades.

Deplores Waste

This article is compiled for the purpose of illuminating the relationship of some physical and chemical facts as to the combustion and commercial distillation of coal and the preparation and use of some of its products. Incidentally, references will be made to the wastefulness of common methods of obtaining useful heat from raw coal.

When it was learned that coal was a better fuel than wood from the consumption of insignificant quantities, picked up on the earth's surface, man's ingenuity and mechanical ability were called upon to provide means whereby it could be brought from the depths of the earth.

In most mines it happens that coal occurs in several strata separated by layers of rocky material and it becomes necessary to excavate complicated systems of shafts and tunnels. Once reached, the coal may be mined by the pick and shovel or by machinery operated by electricity or compressed air.

Let us meet a "Lump of Coal" at the pit head and accompany it through a few vicissitudes to its ultimate destiny as a heat, light and power derivative.

Consumption Seasonal

The natural surroundings, and the methods used for mining it, demand that coal be produced at a more or less constant rate for maximum quantity and minimum price. At the same time its consumption is subject to seasonal demands.

In the spring and summer it cannot be sold as fast as it is produced and in the fall and winter it cannot be produced as fast as it is sold. Therefore, it is necessary for the producer to store it during times of small demand at points from which it can be conveniently distributed during times of maximum demand.

Those who have the facilities of space and cash for doing so usually purchase a yearly supply during the season of small demand when prices are easier, deliveries more prompt and quality more stable.

Journey to Pile

Suppose a group of us are interested in the purchase of a large quantity of coal. For the purpose of sampling it, we journey to the pile. Let us choose a lump from near the edge. If we closely examine it, turning it in our hand slowly to permit the light to fall on it from different angles, we shall see that it is laminated and that certain parts shine more brightly than others.

You may not be able to exit your flue gases at a temperature of 350 deg. as some plants do, but you must not let them get away a single degree hotter than your equipment, coupled with your best obtainable operation, warrants. Seventy-five per cent. efficiency may be far beyond the possibility of your outfit, but if 68 per cent. is actually possible, then 65 per cent. is not good enough. If you are able by your ability to get the best results possible right where you are, and if you actually do it, then and only then have you mastered the secret that will fit you to undertake a bigger job in a better equipped plant.

A pile of coal is not uniform. If it is formed by dumping from a trestle the larger lumps will be at the edges and the smallest at the top. An average sample must therefore be a fairly large quantity made up of smaller quantities, preferably equal in size, selected from the accessible portion of the pile at points separated by approximately equal distances.

This sample should be taken to a clean concrete floor and thoroughly mixed. It is then reduced in quantity by successive quarterings and in size of aggregate by pounding between quarterings, until a quantity and size are obtained which are suitable for the laboratory. After reaching the laboratory and undergoing grinding and further quartering with screening it is ready for chemical analysis.

Definite Information

In our endeavor to get definite chemical information we might try the method of preferential solution, on the same principle that a mixture of brick dust and common salt can be separated by dissolving the salt in water. By treating powdered coal with a suitable solvent we can separate it into two parts—one soluble in the solvent and the other insoluble.

This method has its difficulties. Ordinary solvents, such as ether and benzene, will dissolve very little of the coal substance. Stronger solvents may effect more or less decomposition in addition to, or without any, extraction. Therefore, in examining the extract and residue from strong solvents we must not assume that we are dealing with unchanged material.

If we have several weeks available we can attempt a slow distillation of the coal, raising the temperature of the sample so slowly that its every constituent will boil over at its proper boiling point and be entirely distilled over, as far as it will distil, before the temperature goes higher.

For the proper pursuit of this method we need equipment of larger than laboratory size, because some of the constituents of coal are present in very small quantities. If toluene is one per cent. of tar which in turn is five per cent. of coal by weight then the quantity of toluene to be found in a gram sample of coal would be infinitesimal.

Comparing the Results

Now suppose we take a portion of our sample and heat it quickly to 400°C., collecting the products and examining them; then we take a second portion and heat it to 600°C., again collecting and examining the products, repeating the process with other portions at 800°C. and 1,000°C. By comparison of the results obtained at one temperature and another, we shall derive useful information, although there can be no pretense of having obtained primary products of decomposition.

Next we may take a sample of suitable size and determine the elements from which the compounds in the coal are built up. The results of this process, expressed in percentages, are termed the "ultimate analysis" of the coal and will show the relationship of carbon, hydrogen, nitrogen, oxygen, sulphur, and ash to the whole. By further analysis of the ash we can determine whether or not the coal contains minerals which will make it unsuitable for boiler or other use or will cause clinkering.

Having accomplished these tests to our satisfaction, we shall probably agree with those who have made such tests before us, that coal consists of three groups of substances which may for convenience be termed celluloses, resins and the degraded products of nitrogen proteins. We shall also recognize that there is a definite relation which must exist between the celluloses and resins before a coal or mixture of coals will be suitable for distillation on a commercial scale with marketable products.

Proximate Analysis

There is a last treatment which we may give a portion of our sample. In commerce it is the most widely known analysis of coal and is called the "Proximate Analysis." By it we can determine quickly the quantity of moisture, volatile matter, fixed carbon and ash in our sample.

After making the volatile test by heating a gram sample in a crucible, with a snug cover, over the flame of a Meker burner for seven minutes, a cake will remain. The appearance of this cake will generally provide the answer to the question of the suitability of our coal for commercial distillation.

The cake is known as "coke." A hard coke of silvery lustre indicates a sufficiency of resin, a powdery coke indicates almost absence and a weak black coke indicates insufficiency.

Suppose that the results of all our analyses show the coal to be suitable for our purposes and we order the pile shipped to our plant.

Coal, after some weeks of exposure to the air and sun is liable to take fire. Coal stored in a building is also liable to take fire. What then is the best way in which to store coal?

Storage under water, out of contact with the air, is undoubtedly the best means of preserving coal, and one which has been adopted in some places on a large scale. While the elimination of any risk of fire is obvious, it is not to be assumed that the coal suffers no alteration in these conditions. Analyses show a slight loss of calorific power in coal so treated.

There is in fact a slow oxidation by oxygen dissolved in the water, and also solution of the gases occluded in the coal. The loss may, however, be considered negligible in comparison with the advantages secured. Nevertheless the cost of reservoirs and conveying gear, and the necessity of handling coal in the wet state are considerations which militate decisively against adoption of the system.

Storage in Buildings

Concerning storage in buildings recent experiments made by M. Forrieres, in France, are interesting. This scientist designed three covered coal-stores. One of these had brick walls on three sides, but was open along one of the short sides. The other two had only two walls at right angles—the roofing being supported by brickwork pillars on the open sides.

The first thing which was noticed was that no fire or overheating developed in the first of these stores. On the other hand, every case of incipient fire in the other stores originated not to the rear near the walls, but always near the outside, from nine to sixteen feet from the open side. The coal was about 25 per cent. broken and the height of the stack eleven feet. Evidently there are limits to the quantity and condition of air which is favorable to spontaneous combustion.

Storage in the open is best accomplished when the piles are not more than six to eight feet deep and limited in area so that all parts are readily accessible for the detection of overheating.

There are several things which contribute to the spontaneous combustion of coal, chief of which is the oxidation of the coal substance itself on exposure to the air. The presence of excess moisture and the oxidation of pyrites contained in the coal are secondary in importance. They seem to be assistants, rather than coworkers in that the moisture helps to distribute the heat generated by the oxidation of the coal substance, while the oxidation of the pyrites, although productive of some heat, serves to disintegrate the coal, thereby exposing a larger area of its surface to oxidation.

Power House travels far with its message of economy and its ideas for better methods, and it serves broadly every industry that exists, for it serves a profession that is basic and a group of men universally needed in the industrial scheme of things. Their number is small, but the power they wield is great, for the combustion problems of all industries offer in their solution a tremendous opportunity for both those who supply brains, and those who supply equipment, doubly for those who supply both.

Lignites Oxidizable

It has long been recognized that there is no close relation between the proximate and ultimate analyses of coal and its liability to spontaneous combustion. Coals of different classes may be differentiated, however; the ease of ignition decreasing with the degree of "carbonization" of the coal. Thus lignites are the most easily oxidizable, then follow the various grades of bituminous coals, the steam coals and anthracites.

Let us turn our attention now for a little while to the use of coal for the purposes of the home and the power plant.

Recently David Brownlie divided the steam-raising plants in the United Kingdom into three classes to each of which he gave efficiency ratings for water tube and fire tube boilers as follows:

Percentage of whole	Class	Efficiency Rating Water Tube	Efficiency Rating Fire Tube
10%	Bad	61%	49%
85%	Average	69%	60%
5%	Highly Efficient	83%	79%

Probably the percentage in the first column can be applied to Canadian steam plants, although I have heard it said that the average efficiency of North American steam plants was higher than the average of the United Kingdom, but I have never seen figures to prove the contention. On the whole it will probably be agreed that the efficiency of steam plants with the exception of five per cent. which are already highly efficient, can and should be improved as a matter of national importance.

A Public Nuisance

The use of coal for domestic purposes and in inefficient steam plants gives rise to a public nuisance, which has grown in some places to such an extent that statutes have been passed which tend to its abatement. I refer to the smoke nuisance.

In Glasgow investigators have proved that the deposits of carbonaceous matter are heaviest in the residential and office-building sections of the City. The formation of smoke is wasteful. Smoke abatement practically always results in fuel conservation, usually not less than 10 per cent. and frequently 20 to 30 per cent.

It is estimated that smoke costs every man, woman and child in the Pittsburgh district $20.00 per year. This is the cost of extra laundry work, for paint to renovate smoked walls and woodwork, and for cleaning and materials for this purpose, without consideration of the matter of health.

It is probably ultraconservative to state that the damage per ton of bituminous coal burned in a city having a fair degree of smoke abatement is not less than $1.00 per ton of coal consumed, and that the loss per head is not under $8.00 per annum.

Combustion Problems

The cause of the production of smoke is wrapped up in the chemistry of the combustion of coal, of which time will permit no comprehensive speaking. Briefly, coal is a mixture of many compounds containing varying quantities of carbon and hydrogen. Some of these compounds are very unstable even at ordinary temperatures. Some are readily gasified and others cannot be gasified except at high temperatures. Although combination with oxygen at high temperatures appears to take place in a simple manner, this is really not the case.

It has been shown that, when combustion proceeds at low temperatures in the presence of a catalyst, many intermediate products are formed before the final products, carbon dioxide and water vapor, emerge. Thus during the slow combustion at 400°C of the simple hydro-carbon ethane, products such as ethyl, alcohol, glycol, acetaldehyde, formaldehyde, and formic acid are formed before the final production of carbon dioxide and water vapor. Oxygen enters the molecule at several definite stages involving the successive formation of the products mentioned above. Therefore the apparent simplicity of the reactions involved in the combustion of simple gaseous hydrocarbons is due to their high velocity at high temperatures.

The combustion of the more complex hydrocarbon molecules has not yet been studied in the manner described above, but it is easy to imagine that, as the hydrocarbon molecules increase in their complexity, so the number and variety of intermediate stages in the oxidation process will increase, and that a culminating point will be reached when the formation of intermediate products cannot be masked by the high velocity of reaction. The result is a tendency to incomplete combustion.

Complexity of Reactions

In the case of the combustion of raw coal, the complexity of the reactions which take place during oxidation is augmented by a number of side reactions of a physical as well as a chemical nature. The process is preceded and accompanied by the decomposition of the coal substance.

Long before the ignition temperature has been reached—which for the purposes of discussion may be regarded as the temperature at which active oxidation occurs—some of the coal substance melts or decomposes into less complex bodies, and frequently with the evolution of gas, while the newly formed degradation products may also melt and further decompose.

If the boiling point of any of these liquids is lower than the temperature of decomposition distillation will immediately take place; and if the vapors come into contact with a cooler zone, condensation and smoke formation will result. The gas may, however, become heated in the course of its passage, so that ignition takes place; but it is impossible to predict the sequence of events, as it is impossible to control the conditions to which the products of combustion will be subjected. There is no doubt that the coal substance undergoes extensive decomposition, either in the solid or liquid form, prior to distillation.

Whether the distillation products ignite or escape as smoke would appear to depend upon the relation between the ignition temperature and the boiling point. Where there is a large temperature difference there is obviously greater opportunity for the gas to be carried away into a cooler zone before combustion occurs.

Preheated Air

Another factor to be considered in the production of smoke is the fact that it is usually evolved in a zone already highly charged with the products of combustion. For this reason, a suitable excess of air must be provided; and if such air is admitted to the combustion chamber above the level of the fire it must be preheated to avoid cooling the smoke below the ignition temperature.

The use of raw coal is deprecated owing to the impossibility of controlling the combustion process. The lack of control results in either the production of smoke or the use of a large excess of air, both of which represent the loss of energy.

Finally, the combustion of raw coal represents to the chemist an appalling waste of chemical products, such as ammonia, sulphur, cyanogen and coal tar derivatives; the latter being those products on which we must depend in Canada for building up an organic chemical industry to successfully resist foreign competition.

If a thimbleful of powdered coal is heated in an open test-tube it will first send off little puffs of vapors which will condense further up. Further heating will drive off brownish fumes, some of which will float away and some condense until the test-tube is black. Stronger heating will drive away everything which will distill, leaving solids in the bottom and clinging to the sides.

Should all the fumes be caught in a large transparent jar it will be found that some will condense to form the brownish-black, viscous liquid known as tar. The water vapor which is not needed for saturation will condense and mix with or float on the tar. The remainder will be impure gas. The solids remaining in the test-tube make the substance known in the fuel trade as "coke."

Two Processes

Commercially this phenomenon is utilized in two high temperature processes, gas works and coke oven practices. The first aims to produce the best possible grade of gas for heating and lighting purposes, the second aims to produce the best possible coke for the purposes of the metal working industries.

In modern gas works construction the chamber or retort into which the coal is placed for treatment is more or less rectangular in cross-section. According to the position of its longitudinal axis it is known as a horizontal, inclined or vertical retort. It may be built to hold 300 pounds to 2,000 pounds of coal. Usually it is made up of carefully molded silica blocks, grooved and tongued to fit snugly together. Any small cracks fill with carbonaceous material the whole soon becoming tight.

In the ordinary manufacturing plant, only three per cent. of the heat energy in coal is effectively utilized. Think of this in relation to this year's coal consumption, and you will realize the enormous waste. Probably, fifty million dollars will be the price paid this year for inefficient combustion methods in Canada.

Because the heat which is applied to the exterior of the retort must penetrate through its walls into the heart of the coal mass inside, the walls are made as thin as possible, consistent with strength and the width of the retort is restricted to from 12 to 24 inches. The other dimensions of the cross-section may be, say 15" to 36". The length of the retort may be five feet to 20 feet or more, depending upon the position of the long axis or the methods employed for filling or emptying.

Doors are provided at one or both ends through which the coal is inserted and the residue removed and one or more openings through which the gas may escape.

Adjustment of Air

The heat to which the coal is subjected comes from a furnace below the retort in which is a bed of incandescent coke three to six feet deep.

The air for its combustion is admitted through a shutter, which can be readily and accurately adjusted. On its way to the underside of the grate it is conducted through passages heated externally by the waste gases on their way to the chimney. In these it is preheated and mixed with superheated steam.

The steam serves two purposes. It abates the evil formation of hard clinker and gives to the furnace the function of a gas producer. The gas from the top of the fire passes through nostrils upwards into the flues surrounding the retort. Here it meets a current of preheated secondary air and complete combustion is attained giving a higher temperature around the retort than is attained in the furnace which is just what is needed. In the gas works at Halifax the temperature in the furnace is between 1,800°F to 2,000°F; around the retorts 2,200-2,300°F.

The distillation by which coal is now being separated is a violent affair, much different to our laboratory distillations. The coal is placed in a retort already as hot as we expect to get it and therefore our distillation products are going to be entirely different from the original constituents of the coal.

After gasification the products are subjected to the decomposing influence of the red hot coke and the silica walls of the retort and their radiant heat. Also the atmosphere in the retort is continually changing and to a certain extent the pressure. These physical surroundings give rise to secondary chemical reactions which are of first order of importance. Without them benzol and toluol which are so important in the color industry would be produced in much smaller quantities.

Distribution of Heat

The temperature around the retort and the distribution of the heat along its surface must be capable of control and regulation. Precision instruments and properly placed dampers are in continuous use in an efficient plant. Too high temperatures cause the formation of lampblack and napthalene.

Lampblack is carried forward in the gaseous stream from the retort and mixing with the condensed tar gives rise to stoppage in gas and tar mains, which must be dug out. One can hardly visualize how tenaceous and rubbery a mixture of lampblack and tar can become until he opens a passage through a pipe which is stopped with it.

Napthalene will be carried forward into the distribution pipes where it will sublime in flakes like snow. As the pressure in these mains is usually small very little napthalene can produce a stoppage. If the temperature is too low not all the gaseous constituents will be removed from the coal and the residue will have a dirty appearance instead of the clean, silvery lustre which we are accustomed to see. Too high or too low temperatures will therefore result in decreased efficiency.

The gaseous mixture coming from the retorts is of course hot and requires cooling, a matter of equal importance with its production. Any method of reduction will not suffice. The reduction must take place in such a way that a maximum quantity of all the valuable constituents will be retained in the gas.

Describes Halifax Plant

Perhaps the best way to tell the various steps in the process of preparation through which coal gas must pass before it is marketable is to describe how it is done in a plant with which I am familiar.

In Halifax crude gas is drawn from the retorts through the primary condenser to the exhauster. The condenser is a vertical cylindrical tank containing a number of large tubes. Through the tubes a current of air is flowing upward under natural draft. The gas entering the condenser is forced to take a circuitous path back and forth around and between the tubes by baffles which are placed horizontally. As it passes, the liquid and solid matter is reduced by agglomeration and subsequent deposit in the same way as globules of water in a cloud produce rain. The change in direction and velocity of the gas caused by the baffles produces the necessary physical conditions. As this is going on the temperature is reduced under absolute control to a predetermined point.

The exhauster is a mechanical contrivance usually operated by a steam-engine which sucks the gas through all the apparatus preceding and pushes it through all the apparatus following it. The vaccum created on the suction side will support a column of water one inch high at the exhauster and two tenths of an inch high at the retort. The pressure in the main at the outlet of the exhauster will support a column of water about fourteen inches high.

Use Tar Extractor

The first piece of apparatus on the pressure side is the tar extractor. The gas enters an inner chamber of which the walls are made of several perforated plates, one outside the other. The perforations are so made and arranged that a row of pinholes in the inner plate will oppose a blank space on the plate next outside. Screening by and impact on the successive plates following change in velocity and direction of flow between the plates changes the vapors of tarry liquids into liquid tar which runs down the plates and is withdrawn through a seal.

Because tar vapor absorbs various undesirable constituents such as napthalene, its capacity increasing with the reduction of the temperature, it is allowed to remain with the gas to as low a temperature as may be for the purpose; but as it is also an absorbent for the hydrocarbons required for illuminating purposes, it must not be allowed to remain when the temperature falls so low that the illuminants will be removed to an injurious extent. The proper temperature as determined by numerous experiments is 90°F to 105°F.

In a plant sending out 300,000 cubic feet of gas per day the secondary condensation and cooling for the reduction of other vapors can usually be accomplished by a water-cooled condenser, similar in construction to the air cooled primary condenser, just described. Such vapors as will condense here will be deposited in very close accordance with their vapor tensions. As they deposit they are removed from contact with the gas to prevent their solution of vapors which it is desirable to retain.

Vapor of Napthalene

As an illustration of factors to be remembered in the design of this condenser consider the vapor of napthalene. At any temperature say 70°F, there will be a certain amount of napthalene vapor in the gas according to the vapor tension of napthalene at that temperature. Benzol will be present in a certain quantity due to its corresponding vapor tension. But as benzol is a solvent for napthalene it is found that the napthalene content in the presence of benzol may exceed the quantity corresponding to its simple vapor tension.

If the condensation and cooling is not done efficiently here then at some point further along some benzol may liquefy, freeing the napthalene it was carrying. This will cause a super-saturation of the napthalene followed by its deposit in the solid form.

The gas passes from the secondary condenser to the washer where its flow is broken into many minute streams which bubble upward through two or three inches of water.

The primary function of the washer is to remove the final traces of tarry matter and whatever dust may have remained in the gas to this point. It has however a secondary function which is due to the use of water in it. At the inlet of the washer the temperature of the gas is 50–70 degrees F. At this temperature the gas is ready for the removal of ammonia and hydrogen sulphide. Water readily absorbs ammonia, ammonia reacts slightly with hydrogen sulphide, therefore the washer removes a little of each.

The combustion engineer, operating engineer, and fireman who takes the time and trouble to educate himself to reduce the amount of coal consumed, and to produce steam at less cost, should receive the support of every power plant owner in the Dominion.

From the washer the gas is conducted to the bottom of a steel tower which contains layers of coke supported on perforated trays over which a small quantity of water is trickling.

As the gas passes upward it comes into intimate contact with the water exposed over the vast surface of the coke and a great proportion of the ammonia is absorbed by the water. The remainder is absorbed in a second tower to such an extent that a stream of gas impinging on moistened tumeric paper will cause no change of color.

Gas Contents of Coal

Gas from a good grade of United States gas-coal will contain from 200 to 500 grains of sulphuretted hydrogen per 100 cubic feet at this point. The gas from native coals contains 500 to 800 grains. Its removal in its entirety is comparatively simple.

When the gas is passed through layers of iron oxide such as bog iron ore, two to three feet deep, supported on perforated trays in suitable containers, the sulphuretted hydrogen is removed by a reaction which changes the oxide to the sulphide.

The purification of a daily output of 300,000 cubic feet of gas containing 700 grains of sulphuretted hydrogen per 100 feet means the removal of 300 pounds of hydrogen sulphide per day, four and one half tons per month. Under these conditions the oxide is rapidly sulphided until it must be removed and replaced. Up to a certain point the foul oxide will be revivified by exposure to the air, but repeated foulings will finally render it useless when it must be discarded in favor of fresh.

Gas from American coal will now contain 10–20 grains of organic sulphur per hundred cubic feet while gas from the best native coals which we have been able to obtain will contain from 50 to 70 grains.

The larger quantity is present in the form of the vapor of the extremely volatile carbon bisulphide and there is no simple way of removing it. One company accomplishes it by raising the gas to a high temperature, 500 degrees F., in the presence of iron oxide. The water vapor ordinarily carried in the gas augmented by the introduction of steam if necessary reacts, with the carbon disulphide and results in hydrogen sulphide and the oxides of carbon. The hydrogen sulphide may be removed by further contact of the gas with iron oxide.

Processes like these could not be considered for Halifax because of their high cost. Instead the gas is passed through a series of three towers in which a petroleum distillate known as pale paraffin oil is flowing downward through excelsior and wooden grids while the gas is passing upward.

Using about ten gallons of oil per 1,000 cubic feet of gas at a temperature slightly lower than that of the gas it is possible to accomplish the removal of 40 per cent. of the organic sulphur, which leaves a quantity entirely inoffensive when the gas is burned in properly vented appliances.

A good general rule is that all appliances consuming extensive oxygen should be vented. By heating the oil to 260 degrees F. the absorbed vapors are expelled. It is then ready for use again.

Residue in Retort

The residue left in the retort when the distillation has been carried as far as it is practicable is coke. Except in the case of some types of vertical retorts it is hot when withdrawn and has to be cooled by quenching or smothering. When crushed and sorted it is ready for marketing.

The hydrocarbons in the coal and the products which give rise to the smoke from an ordinary fire may be considered to comprise that portion of the coal from which gas and tar are obtained—the greater their quantity in the original coal or, technically speaking, the higher the volatility of the coal, the greater the volume of gas obtainable.

Whether or not marketable products may be obtained from the distillation of a given coal is usually inferable from its proximate analysis and the appearance of the residue left from the volatile test. A high percentage of volatile must be accompanied by a low percentage of ash and especially a low percentage of sulphur, and the qualities which will produce a clean coherent coke, not readily friable. Such coal is growing rarer and the price of what is now available is rising.

Dream of Paradise

It seems natural then for the gas men to dream of a paradise where any old kind of coal can be changed entirely into a marketable gas with no by-product except

(Turn to page 44)

Facts You Should Know About Steam Generation

*By CHARLES L. HUBBARD

Steam Simply a Convenient Medium for Carrying Heat From Boiler Furnace to Engine or Turbine Where a Portion is Transformed Into Work in the Ratio of 778 Foot-Pounds per B.T.U.

AS STEAM is so intimately connected with the subject of prime movers, and power plant equipment in general, it is well to dwell somewhat upon the principles involved in its generation before considering its transformation into work in engines and turbines.

Strictly speaking, it is the heat which it contains and not the steam itself, which produces mechanical energy. Steam is simply a convenient medium for carrying the heat from the boiler furnace to the engine or turbine, where a portion of it is transformed into work in the ratio of 778 foot-pounds per B.t.u.

There is probably nothing better than the old illustration of the closed cylinder and movable piston for showing what takes place in changing water into steam by the application of heat. The apparatus shown in Figure 1 consists of a vertical cylinder, open to the atmosphere, and provided with a tight-filling piston which moves easily within it.

Three Results Obtained

If a given quantity of water is introduced beneath the piston, a weight placed on top of it, and the gas jet beneath it lighted, three definite results will be observed as follows:

1. The temperature of the water will gradually rise until a point is reached where boiling takes place and steam begins to form. If the sectional area of the cylinder is 30 sq. in. and the weight of the loaded piston 150 pounds, so as to exert a gage pressure of 5 lbs. per sq. in. upon the surface of the water, boiling will take place at a temperature of 228 deg. F.

2. During the process of evaporation, the piston will rise to make room for the greater volume required by the steam; but although heat is constantly supplied the temperature will remain the same as when boiling first began (see Figure 2) and continue so until the water has all been changed into steam.

3. If, after evaporation has been completed, heat is still supplied, the piston will continue to rise, and the temperature increase, but the pressure remains constant as before, (see Figure 3).

Analyzing Phenomena

Let us now analyze these various phenomena, and see what has actually taken place.

1. The heat absorbed by the water in raising its temperature to the boiling point, under the given pressure, is called the "heat of the liquid." For the sake of uniformity, this is commonly measured from 32 deg., in the results given in "steam tables."

In the above example, the heat in the liquid would be measured from the initial temperature when the gas burner was lighted.

2. During the period of evaporation, the heat which disappeared was used in two ways, part, called the "internal latent heat," being absorbed in the work of changing the liquid to a gaseous form, and part, called the "external latent heat," in the work of expansion, and shown by the increase in volume in Fig. 2. The sum of these two is called the "latent heat of evaporation," and is given out again when the steam is condensed.

Steam Is "Saturated"

During the process of evaporation, and as long as any water remained in the bottom of the cylinder, the steam was what is known as "saturated." In the case of saturated steam there is always a definite relation between pressure and temperature.

In the illustration of the cylinder, the pressure was assumed to be 5 lbs. per sq. in., (above atmospheric pressure) in which case the temperature was 228 deg. If the pressure had been 10 lbs.. the temperature would have been 240 deg., and so on.

After the water in the cylinder was all evaporated, it was found that the continued application of heat increased the volume of the steam and raised its temperature, but did not affect the pressure as long as it was able to expand by raising the piston.

Steam in this condition is said to be "superheated," and the definite relation between pressure and temperature no longer exists. The heat contained in a pound of superheated steam is the same as that in a pound of saturated steam at the same pressure, plus that absorbed in the process of superheating. The heat of the liquid and the latent heat of evaporation are the same in each case, because the superheated steam has been produced from a pound of saturated steam by adding more heat.

ADVANTAGES OF SUPERHEATED STEAM

1. Ability to use smaller piping.
2. Steam separators are not required
3. Radiation losses are reduced.
4. So used in turbines superheated steam impinges against blades at higher velocity.
5. Absence of condensation in the pipe lines which results in (a) elimination of water hammer and (b) reduction in radiation losses.

Properties of Steam

The various properties of saturated steam at different pressure, are given in "steam tables," which are found in engineering handbooks and in many trade catalogs devoted to power plant equipment. In the latest books on steam engineering, the properties of superheated steam are also included.

In case a table of this kind is not at hand, and it is desired to find the total heat in a pound of steam containing a certain amount of superheat, the factors in Table 1 may be made use of in connection with an ordinary steam table.

TABLE I

Steam pressure (Gage)	Degrees of Superheat 60	100	150	200
85	0.546	0.534	0.522	0.515
110	0.565	0.548	0.534	0.524
135	0.585	0.562	0.544	0.533
185	0.623	0.590	0.563	0.548

Example—What is the total, heat above 32 deg., contained in a pound of steam at 135 lbs. pressure and having 150 deg. superheat? Also what would be its temperature?

From a table of the properties of saturated steam, we find for this pressure the total heat per pound to be 1,193.4 B.t.u. and the temperature 358.5 deg. The factor for 135 lbs. pressure and 150 deg. superheat is found from Table 1 to be 0.544, which gives a total heat for the superheated steam of 1.193 + (150 × 0.544) = 1,275 B.t.u. The temperature will evidently be 3.85 + 150 = 5.35.5 deg.

Saturated steam may be either dry or wet, the term "wet" denoting the presence of a certain amount of water in the form of a mist or priming. The percentage of dry vapor in steam containing moisture (wet steam) is called the quality, that is, steam containing 3% of spray or mist would have a quality of 100 — 3 = 97%.

Superheated Steam Dry

Superheated steam, from its nature, is always dry. Saturated steam supplied to an engine or turbine should always be passed through a separator to remove the moisture before it is delivered to the machine, as its presence lowers the efficiency. Spray or priming

---

*Consulting Engineer of Power House Problems. Reprinted in Canada by special permission from Factory, the Magazine of Management.

in considerable quantities may do serious damage, both to engines and turbines.

As superheated steam has come into quite general use during recent years, it may be well to devote a little time to a discussion of its advantages, its limitations, and matters to be considered in its practical application to the generation of power in engines and turbines.

It is a well-known fact that the greatest waste of heat in a steam engine, aside from that carried away in the exhaust, is that due to cylinder condensation. When saturated steam enters the cylinder, a large percentage is at once condensed by contact with the cool walls, which are at approximately the temperature of the exhaust which has just been expelled. After the point of cut-off, the pressure, and consequently the temperature fall, due to expansion, and condensation still continues through in a lesser degree, until a point is reached where the temperature of the steam and that of the cylinder walls are the same, at which time condensation ceases.

Will Return Heat

From this point to the end of the stroke the walls will return a certain amount of heat to the steam, causing a part of the moisture to be re-evaporated. This process, however, returns only a small part of the moisture to a gaseous form, as the greater part of the heat is given back from the cylinder walls during the period of exhaust, and is, therefore, wasted, so far as doing useful work in the cylinder is concerned.

When superheated steam is employed, no condensation can take place until sufficient heat has been extracted to reduce its temperature to a point corresponding with that of saturated steam at the same pressure. It is common practice to superheat the steam just enough to supply the necessary heat transfer to the cylinder walls up to the point of cut-off, thus doing away with initial condensation entirely.

Beyond Cut-Off Point

While it is true that heat is lost in this case, the same as though condensation took place, the quantity is greatly reduced. Beyond the point of cut-off the steam is saturated, and sufficient condensation takes place to moisten the cylinder walls and thus assist in proper lubrication.

The amount of superheat required will depend somewhat upon the initial pressure of the steam, the ratio of expansion, and so forth, and in general will vary between 100 and 300 deg. The earlier the cut-off, the higher the degree of superheat required, so that the process is limited to some extent because it is not practicable to exceed a temperature of about 500 deg. with the form of valve construction commonly employed.'

Under average conditions, 150 deg. of superheat has been found to give very satisfactory results in practice, which, in case of steam at 150 lbs. gage pressure, would give a maximum temperature of 350 + 150 = 500 deg. The actual reduction in cylinder condensation, under the general conditions of practical operation will amount to 1% for each 8 to 10 deg. of superheat.

Again in Volume

Another advantage to be derived from superheating is a reduction in the weight of steam used per stroke for a given amount of work. For example, saturated steam at a gage pressure of 125 pounds, has a total heat of 1,192 B.t.u. per lb. above 32 deg., and a volume of 3.22 cubic ft. Adding 150 deg. of superheat increases the volume to 4.10 cubic ft. at the same pressure and requires 81 B.t.u. Here we have a gain in volume of $\frac{4.10}{3.22} = 1{,}242$ or 24.2%, with an increase in heat expenditure of only $\frac{1.192+81}{1.192} = 1.068$ or 6.8%.

Increase in volume at constant pressure means a gain in power for a given water-rate, or a reduction in water-rate for a given power of engine. While the above figures are theoretical they show the general effect of superheating as regards economy of operation.

Although both theoretical computations and actual tests show a reduction in steam consumption in favor of superheated as against saturated steam, for a wide range of conditions, the actual saving must take into account cost of equipment, depreciation, operation, and so on, which makes a wide variation and sometimes reverses the results.

Various Figures Given

Various figures are given for the saving in steam consumption with superheating, and run from 10 to 20%. Gebhout gives 20% for simple noncondensing engines with medium piston speed; and 10% for compound condensing Corliss engines, with 100 to 125 deg. of superheat, and continuous operation. Simpson gives an average of 15% for engines of 250 to 500 horsepower, with the same range of superheating as above. St. Cyr gives 10% for steam turbines, 15% for compound engines, and 20% for simple engines with 100 deg. of superheat in each case.

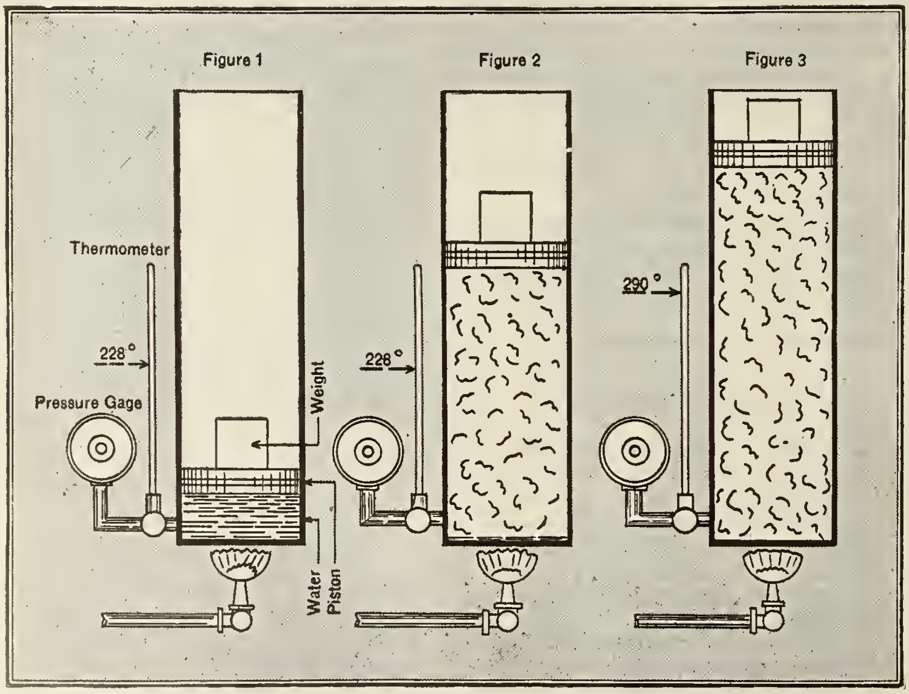
While a saving in weight of steam per unit of power developed by the engine may be obtained by superheating, it does not follow that the saving in fuel is in the same proportion, because the total heat contained in a pound of superheated steam at a given pressure is greater than that in a pound of saturated steam at the same pressure.

This may be illustrated as follows: Suppose, in a given case, the steam consumption of an engine operating at 125 lbs. gage pressure, with saturated steam, is reduced 20% by superheating 150 deg. That is, for every pound of steam required in the first case only 0.8 pounds will be used in the second.

One pound of saturated steam at 125 lbs. gage pressure contains 1,192 B.t.u. above 32 deg., and 0.8 lbs. of steam at the same pressure, superheated to 150 deg., contains (1,192 + 81) × 0.8 = 1,018 B.t.u., or 1,192 — 1,018 = 174 B.t.u. less, and is capable of doing the same amount of work.

That is, a reduction of 20% in steam consumption produces, under the above conditions, only $\frac{174}{1{,}192} = 0.146$ or 14.6% reduction in the amount of heat required of the boiler. When computing, the ultimate saving by superheating, this fact must be taken into account as well as the interest and depreciation charges on the superheater.

On the other hand, a saving of 20% in steam consumption for a given



Figures 1, 2, and 3: One of the simplest methods of illustrating the amount of heat stored in steam which can be converted into useful mechanical work is that of the closed cylinder with a movable piston.

amount of power means a corresponding reduction in boiler capacity, which is an important item in the construction of a new plant or the extension of an old one.

If four boilers may be made to do the work of five, the omission of the extra unit would probably cover the cost of the superheating equipment, so that in certain cases the full saving in fuel, as computed above, might be realized.

In making estimates for increased economy, the total number of hours per year at which the plant is operated should be taken into account, as the load factor is an important matter in determining the advisability of installing superheaters as well as other forms of power plant equipment.

In a general way, superheaters should affect a net saving equivalent to about 10% on the first cost, above depreciation and maintenance charges, to warrant their installation in the average case.

Distortion of Gear

The degree of superheat which it is practicable to employ is limited by difficulties experienced in lubrication and in the distortion of certain forms of valve gear under excessively high temperatures. A maximum steam temperature of 500 deg. is about the limit for reciprocating engines, and corresponds to 175 deg. of superheat at 100 lbs. pressure, and 125 deg. at 200 lbs. The obstacles to high temperatures have been overcome to some extent by the introduction of special lubricating oils and devices for suitably atomizing it. Piston and poppet valves give especially good results under high temperatures and are being used to a considerable extent in the latest types of engines.

Steam turbines require no lubrication inside the steam chambers, and from their mechanical construction are not so liable to distortion as the valves of reciprocating engines.

Advantages Marked

The advantage of superheated steam in connection with the turbine is especially marked. Although the item of condensation is small in this case, because the surfaces in contact with the steam are always at practically the same temperature, there are other advantages equally important, among which may be mentioned the higher velocity with which superheated steam will impinge against the blades. Experiments have shown a saving of 10 to 12% when the steam is superheated.

This advantage, however, is limited to new plants, as there would be nothing gained in taking down piping already installed for the sake of using smaller sizes for the same work. In new plants there will be a substantial saving, as the cost of pipe, filling, and valves increases rapidly with any increase in size, and especially with material of the comparatively large size employed in power plant work.

Another advantage is the absence of condensation in the pipe lines, as there can be no moisture in the steam until it falls below the point of saturation. This is desirable both on account of the elimination of water hammer and the reduction in radiation losses, as previously stated. In various processes involving the use of steam it has been found advantageous to add a certain amount of superheat in a variety of cases, as in kettles, dryers, stills, and so on, regardless of whether jackets and coils are employed or the steam mixed directly with the substance to be heated.

Suitable for Strain

A matter which must be carefully looked into when changing over from saturated to superheated steam is whether the existing pipes and fittings are suitable for withstanding the higher temperature and the greater expansion strains resulting.

In new work steel fittings are recommended, or if cast iron is used, the metal should be low in silicon and high in steel so as to give the greatest degree of toughness possible. Many plants are running at the present time with steam superheated to a moderate degree and employing piping systems made up with cast-iron fittings, and have given satisfaction through many years of service. Much depends, however, upon the quality of the iron and the arrangement of the pipe lines for taking up the expansion.

Now let us consider briefly tests and measurements. Steam is tested for quality by means of an instrument called a "calorimeter." These are of two kinds, the "throttling" and "separating." The first is adapted to cases where the amount of moisture in the steam is small. The limits are about 3% at 80 lbs. gage pressure and 5% at 200 lbs. pressure.

The general construction of a throttling calorimeter is shown in Figure 4. Steam entering from the main pipe strikes thermometer No. 1, which indicates its temperature, and from which the corresponding pressure may be obtained from a steam table.

It then passes through a small orifice (a) into a chamber (b) which is under atmospheric pressure. As the total heat in a pound of steam is greater at the higher boiler pressure than at atmospheric pressure, a certain amount of heat is liberated in the process of expansion in chamber (b), and the steam becomes superheated, and the thermometer No. 2 will register a higher temperature than that corresponding to saturated steam at atmospheric pressure.

The formula for determining the quality of steam with a throttling calorimeter is

$$x = \frac{r_2 + q_2 + 0.47\,(ts - t_2) - q_1}{r_1}$$

in which X = quality of the steam.

r_2 = latent heat of steam at atmospheric pressure = 972 B.t.u.

r_1 = latent heat of steam entering calorimeter at initial pressure.

q_2 = heat in the liquid at initial pressure, 180 B.t.u.

q_1 = heat in the liquid at initial pressure.

ts = temperature indicated by thermometer No. 2.

t_2 = temperature of saturated steam at atmospheric pressure = 212 deg.

Testing a Sample

Example—In testing a sample of steam, thermometer No. 1 indicates a temperature of 358 deg., and No. 2 a temperature of 262 deg.—what is the quality of the steam?

Referring to a steam table, we find that a temperature of 358 deg. corresponds to a gage pressure of 135 lbs.; also we find for this pressure, that r_1 =

(Turn to page 46)

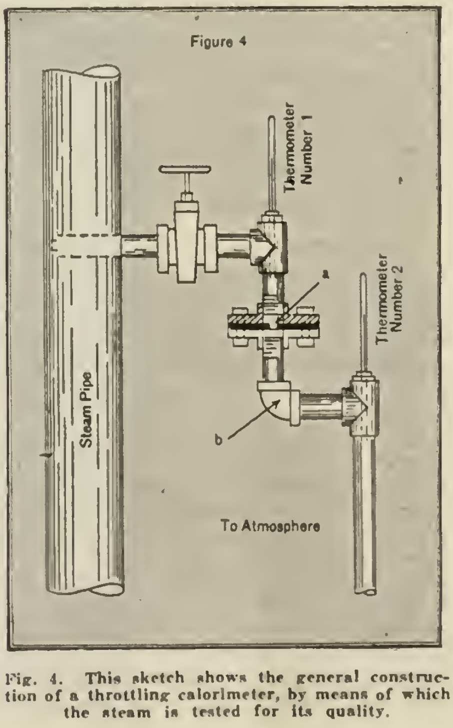


Fig. 4. This sketch shows the general construction of a throttling calorimeter, by means of which the steam is tested for its quality.

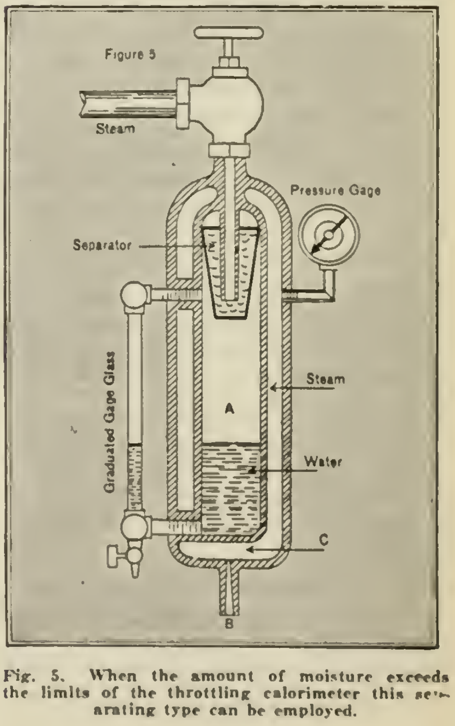


Fig. 5. When the amount of moisture exceeds the limits of the throttling calorimeter this separating type can be employed.

How to Repair Electrical Indicating Instruments

***By VICTOR H. TODD**

Power Plant Engineers Should Always Have the Moving Element in Good Mechanical Balance—The Pointer Should Indicate Zero No Matter in What Position the Instrument is Turned

TWO conditions exist when an indicating instrument is not in order. The instrument may not indicate at all, that is, it not only does not indicate properly, but the pointer does not move appreciably and there is no indication whatever. Or the instrument may indicate but not indicate properly.

When an electric measuring instrument fails to indicate, the trouble may be caused by one of four defects: (1) lack of current or voltage, (2) open circuit in the instrument, (3) short circuit of measuring element and (4) mechanical difficulties. The first three are purely electrical defects and can be located by the proper use of additional instruments, while the fourth can be located usually by a close inspection.

For mechanical troubles, a kit should be used. This contains necessary tools such as large and small pliers, wrenches, screwdrivers, soldering copper, eye-loop, magnet cleaner, tweezers, soldering flux, etc.

An Important Item

The soldering flux is an important item, as one of the first rules of instrument repairing is that fine wires or springs must never be soldered with any paste or flux containing the least acid. There are several acid-free compositions on the market, but an unexcelled paste is made by dissolving powdered rosin in alcohol and adding a little glycerin to prevent drying or caking. This must be used with thin wire-solder and a well-tinned soldering copper to produce perfect electrical connections. No acid or salammoniac and zinc chloride should be used.

Let us assume that a direct current voltmeter suddenly ceases to indicate. The first point is to see if it is caused by line trouble.

Connect a portable standard voltmeter across the terminals of the non-operating voltmeter. Lack of indication denotes line trouble and the voltage should be tested nearer and nearer the bus or generator until the cause can be located. Loose connections or blown fuses often cause a lack of indication. If there is an external resistor in series with the voltmeter, connect the portable instrument across the line sides of the voltmeter and resistor to ascertain that the line voltage is on; then connect the voltmeter across the external resistor.

Indication on both instruments shows an open circuit in the resistor; lack of indication shows open circuit in the voltmeter indication of portable instrument alone shows short circuit or mechanical troubles in the voltmeter.

Lamps May Not Light

If a portable standard voltmeter is not available, then low wattage lamps (5 or 10 watts) may be used to advantage, except that in some cases the lamps may not light because of high resistance in the voltmeter.

If the voltmeter shows open or short, this may further be confirmed by disconnecting one terminal and connecting the standard in series where lack of indication shows open circuit in either voltmeter or resistor and indication shows either "short" or mechanical troubles in the voltmeter.

"Opens" in the potential circuits of wattmeters, watthour meters, frequency meters, power factor meters, reactive factor meters, and synchronoscopes can be detected as shown above, provided the other circuits of the instruments are functioning correctly. "Shorts" may be determined in the above instruments except those where the total impedance of the potential circuit is in the measuring element, as in the watthour meter. In this case, however, a mild short circuit does not cause non-registration but causes increased registration, while a large short circuit eventually causes a burn-out and open-circuit.

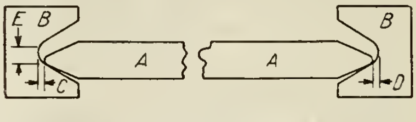


Fig. 1. Diagram of shaft showing end play and side play.

Millivolt meters are tested exactly like voltmeters, except that a portable millivoltmeter should be used in the test. Self-contained ammeters should be tested with a similar range portable instrument, by connecting in parallel, to indicate the presence of current. If the ammeter is open in the main winding, this results in the completion of the circuit and main line current on the portable. Half line current on the portable indicates either electrical or mechanical trouble in the measuring element.

Wipe Off Dust

Let us assume that our original voltmeter has been proven intact electrically but still does not indicate. First, wipe all dust or dirt off the cover and then remove it carefully. Give the pointer a gentle push with a matchstick or toothpick to see if it is stuck (meter elements are usually alive and should be touched with caution). Possibly, it will stay wherever it is pushed and will not return freely to zero. Now disconnect the voltmeter and remove from the board.

One of the most important mechanical points in an electrical instrument is the correct adjustment of "end play." This is illustrated in Fig. 1 where enlarged and exaggerated views are shown of the shaft A with glass-hard pointed ends and sapphire jewels B and B. The total distance C plus D that the shaft can move from end to end is called the "end-play" and the distance E that the pivot can move from one side of the jewels to the other is called the "side-play."

End-play and side-play are usually only a few thousandths of an inch and upon the correctness of this detail depends much of the success of the instrument. A most important rule of instrument repairing is, never screw the jewel-screws in until they clamp or pinch the moving element; even once may ruin the pivots.

Side-Play Adjustment

Correctly designed jewels and pivots, usually, require adjustment of only "side-play" which is done as follows: Lay the instrument on its back and grasping the pointer gently but firmly with either tweezers or thumb and finger, wiggle it gently back and forth, meanwhile tightening the jewel screw with a screw-driver a fraction of a turn at a time until it wiggles only a few thousandths of an inch (about the width of a paper) and then holding the driver firmly, but not pressing down, tighten the jewel lock nut with a suitable wrench.

It may be superfluous to caution the repairman to ascertain that the pivots are actually in the polished recess in the jewel in making this adjustment and not in a crack between jewel and mount, but many pivots are ruined from this oversight.

The deflection of the induction type instrument varies slightly with frequency changes. This is not objectionable when the instruments are used on an ordinary power system. The small variations of frequency have no influence upon their reading. The latest designed instruments are of the dynamometer type; they read practically the same up to 133 cycles.

The best induction type instruments are the least affected by stray fields and static charges. The well designed iron case of dynamometer type meters will shield well the stray field encountered in general switchboard practice. The protective influence of the shield falls off as its mag-

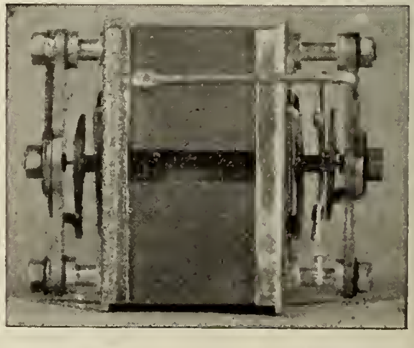


Fig. 2. End view of pole piece core assembly with springs and moving elements showing bearings and parts.

---

*Engineer, Westinghouse Electric & Mfg. Co.

netic density increases and disappears entirely at saturation.

Effect Is Noticeable

With the induction type instrument, the effect is only noticeable when the stray field is exactly in synchronism with the current in the instrument. In such cases the distance between the instrument and the current-carrying bus should be

$$\frac{\text{current}}{5} \text{ inches}$$

Instruments are also susceptible to external electrostatic effects. These effects usually manifest themselves by an attraction of the pointer toward the glass or case. Under certain conditions, by clearing and rubbing the glass in the cover with a soft rag, the pointer of such an instrument may be moved a considerable distance up scale and remain there for some time.

Direct current instruments using permanent magnets, under normal conditions, have small errors due to external field, but may be permanently affected by such fields under short circuit conditions. The minimum distance between an instrument and a current carrying wire or bus bar should be

$$\frac{\text{current}}{5} \text{ inches}$$

in order to protect the instrument.

Temperature errors in instruments are due to changes in physical dimensions and changes in electrical constants. It will be remembered that there are two active forces in an instrument; the deflecting and the restraining forces. The deflecting force is the product of the actuating current, and the strength of the reacting element.

If the temperature of an instrument increases, it may increase the resistance of its windings; this in turn lessens the current and results in a lower deflection. This is further aggravated by the weakening of the magnetic system due to heating. On the other hand, increased heat tends to weaken the restraining control spring, which tends to produce a higher reading. The correct balancing of these two opposite effects is one of the great problems of design and has been so nearly perfected that the actual error in the best instruments is well within the limits of commercial accuracy.

Mechanical Changes

Mechanical changes are also possible due to heating; for instance, heating may distort a coil, or expand a shaft and smash the pivot ends. The first is overcome by a thorough seasoning of all parts, and the second by correctly designing the shaft so that it has the same coefficient of linear expansion as its supports.

Heating errors are produced from two sources: ambient temperature and self-heating. Over the first, the manufacturer has no control, other than to recommend that the instruments should not be used in places subjected to excessive temperatures, if at all avoidable. The second point is taken care of by means of external shunts and resistors, thus liberating the heat where it will cause no errors, instead of in the instrument cases.

An amount of energy insufficient to cause heating alone will operate the moving elements of any fairly good instrument. It is, generally, the excess energy consumed in series resistors and shunts which causes the excess temperature. The errors due to mechanical causes are, probably, of greater importance than purely electrical errors, as the causes leading to them, reduce also the life of the instrument and increase the errors with use and time.

Other things being equal, the frictional error of an instrument is proportional to the ratio of torque to weight of the moving element.

Absolute Cleanliness

Success in instrument work comes only with absolute cleanliness, as the greatest enemy of an instrument is iron filings and dirt; sooner or later they find their way into the air gap and stop the moving element. To inspect the air gap of a direct current instrument, push a piece of white paper between base and element and then holding the instrument so that the light shines on the paper, look through the air gap as shown in Fig. 3.

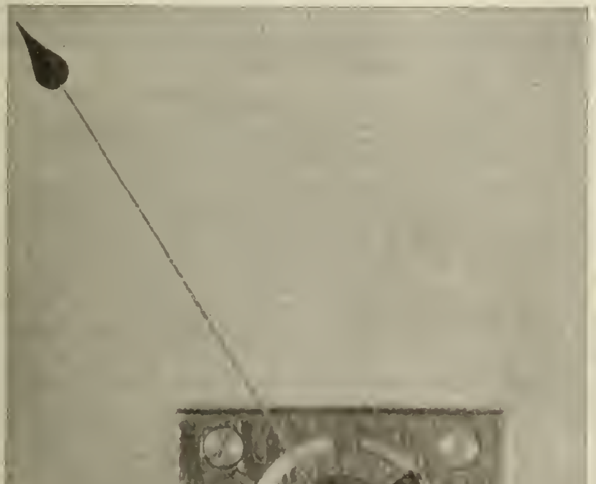


Fig. 3.—Instrument in position for inspection of air gap.

A magnifying glass may be used to advantage, and the least filing or hair or fuzz or dirt should be carefully removed. Iron filings can best be removed by using an iron wire or unbent paper clip, and dirt and fuzz removed by using the tweezers or an ordinary chicken-wing feather. Other defects such as loose wire or parts out of alignment are easily discernible by a simple inspection and are, generally, repairable.

A good instrument should always have the moving element in good mechanical balance; i.e., the pointer should indicate zero no matter in what position the instrument is turned. To secure this, the best instruments have threaded weights, although the principle of balancing is the same in all cases.

Lay Instrument Flat

The first step is to lay the instrument flat on its back and set the pointer on zero. Then hold the instrument so that the pointer is horizontal and adjust the weight on opposite end of pointer so that it again indicates zero; then turning the instrument so the pointer is vertical, adjust either weight until it again indicates zero. Recheck and adjust the other positions if necessary. The instrument should now be in perfect mechanical balance.

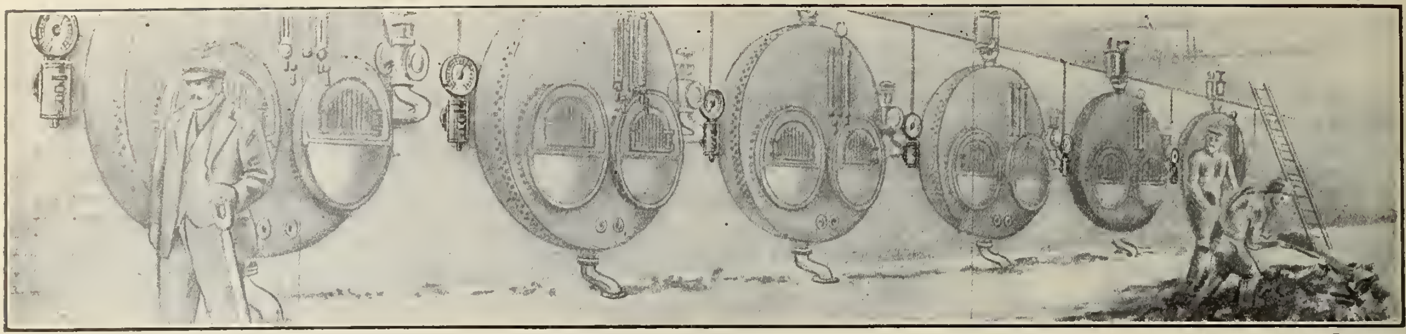
After final inspection, the instrument may be retested and replaced on the switchboard.

After the instrument is repaired, it may be found that it is in serious error due to a variation in spring strength or magnets. Or it may be desired to change the capacity of the instrument by changing the spring strength. In either case, it is necessary to measure the "torque" or deflecting force of the instrument, usually expressed in "milligrams." Turn the instrument so that the full scale mark is in a horizontal line with the pivot and then hang a small weight on the pointer, until it deflects the pointer to full scale. Measure the distance from the center of the jewel to the center of the rider in "millimeter," using a pair of dividers if necessary and multiplying by the weight of the rider in "Grams." Their product is the torque of the instrument in "millimeter grams." In the absence of metric standards, the torque may be calculated in "Inch-Ounces" using a copper wire table to obtain the weight of the wire used and reduce to "millimeter grams" by multiplying "Inch-Ounces" by the constant, 718.8.

Assume for example that a piece of No. 24 B. & S. G. copper wire one inch long balances at a distance of 2.25 inches out. From a wire table we learn that No. 24 copper has a weight of .001223 lbs or .019568 oz. per foot; or 00163 oz. per inch. Multiplying by 2.25 inches gives .003667 inch-ounce torque. Multiplying by 718.8 gives 2.635 millimeter grams torque.

If the scale deflection is 90 degrees, and two springs are used, then the torque of one spring will be 1.317, for 90 degrees or

(Turn to page 46)



Easy Engineering Lessons in the Power House

By **M. BARRY WATSON, B.A.Sc., M.E.**
Director of Engineering, Central Technical School, Toronto.

STEAM QUALITY

TO KEEP the efficiency of a steam plant high, the steam must be kept as dry as possible. In order to know the quality of the steam, or the amount of moisture in it, we use special instruments known as steam calorimeters.

The word calorimeter means an instrument for measuring heat. It will be seen from what follows that with some types of calorimeters we do make calculations involving the quantity of heat in order to determine the quality of the steam. The name calorimeter has, however, been used to include all types of quality-of-steam measuring devices even though with some of them the heat of the steam does not enter into the problem at all.

On the other hand a steam calorimeter must not be confused with a fuel calorimeter, which is an instrument for measuring the heat value of a fuel.

In the case of superheated steam we can by means of the pressure gauge and a thermometer determine the amount of superheat in the steam by referring to a steam table. These instruments alone will not, however, give us any indication of the quality of or the amount of priming in saturated steam. This is because the temperature of boiling water, dry saturated steam or any mixture of them is always the same at any particular pressure.

Heat Content Less

From a study of the tables of the properties of saturated steam, we know that the heat content of boiling water, at any temperature at which we commonly use it, is much less than the heat content of dry steam at that pressure and temperature. The difference between these quantities is known as the latent heat of evaporation at that temperature.

Thus, if we know that we have 0.97 pounds of dry steam mixed with, say, 0.03 pounds of moisture, we can, by using the steam tables, calculate the heat of a pound of the mixture, or the heat content of a pound of steam of quality 0.97.

Conversely if we can find some way of measuring the total heat of a pound of steam at a certain pressure we will be able to work out the quality of the steam. This is the principle on which one of the simplest types of calorimeters operates.

The Barrel Calorimeter

While not absolutely accurate, the barrel calorimeter is the simplest and least expensive. It consists of a wooden barrel, about 60-gallon size, mounted on a scale for weighing. A sampling pipe is connected to the steam main or boiler and is connected through a valve and piping to a piece of rubber hose which can readily be inserted into the barrel to about two thirds of its depth.

The method of operation is simple. The barrel is weighed when empty, it is then filled about two thirds full of cold water and weighed again. The difference in the weights is the weight of the cold water. The temperature of the cool water is taken just before the test is to be made, making sure the water is well mixed up.

Steam, the pressure of which in the main is read both on opening and closing the valve, is then admitted through the hose pipe, which is held under water, and the steam is condensed by the water until the temperature of the water is raised, say, 60 to 100 degrees. The steam is then shut off, the hose pipe removed but allowed to drain into the barrel, and the temperature of the water is read, making sure it is thoroughly mixed up so that the temperature is the same in all parts of the water.

This reading of temperature should be taken as soon as possible, because heat is being lost through the air and the sides of the barrel all the time. Then the final weight of the barrel of water is found.

A Typical Case

Example:—Suppose the following readings were obtained:

Weight of barrel, empty, 180 lbs.

Weight of barrel and cold water, 635 lbs.

Weight of barrel and hot water, 675 lbs.

Temperature of cold water, 50 degrees Fahr.

Temperature of hot water, 140 degrees Fahr.

Average steam pressure, 60 pounds per square inch gauge, or about 75 pounds per square inch absolute.

Since we know that the specific heat of water is 1, or that it requires one B.t.u., to raise the temperature of one pound of water through one degree Fahr., also that the heat content of water or steam is measured from that of water at 32 degrees F.; we find that each pound of water at 50 degrees contains 50 — 32 = 18 B.t.u.'s. Also at 140 degrees, each pound of water has a heat content of 140 — 32 = 108 B.t.u.'s. We have then:

Total weight of cold water = 635 — 180 =455 lbs.

Total weight of hot water = 675 — 180 = 495 lbs.

Total weight of wet steam = 495 — 455 = 40 lbs.

The cold water has been raised in temperature 140 — 50 = 90 degrees, or has had added to it 455 × 90 = 40,950 B.t.u.'s. This heat must have come from and will therefore equal that given up by the steam in condensing and cooling down to 140 degrees.

Consult Steam Tables

By consulting the steam tables we find that for a pressure of 75 pounds per square inch absolute, the total heat content of one pound of dry steam was 1,181.1 B.t.u.'s, while that of water at the same temperature is found to be 277.4 B.t.u.'s.

Let X be the proportion of dry steam in the steam supplied to the barrel. This should be expressed as a decimal of the whole. Then the total amount of dry steam that was condensed was 40 × X lbs., and the amount of water in this steam was 40 × (1 — X). When it is condensed the dry steam gives up its latent heat, which is 1,181.1 — 277.4 = 903.7 B.t.u.'s per pound.

The total amount of latent heat given up by this steam will be 40 × X × 903.7 = 36,148 X. Besides this latent heat there is given up heat by the condensed steam and the moisture along with it, in cooling from 277.4 degrees to 108 degrees. For the whole 40 pounds this will amount to $40 \times (277.4 - 108) = 40 \times 169.4 = 6{,}776$ B.t.u.'s. Thus the total heat given up by the steam in condensing the dry part and cooling all down to 108 degrees was $6{,}776 + 36{,}148$ X B.t.u.'s, which we said above was equal to the heat added to the cool water or 40,950 B.t.u.'s; thus we have an equation

$$40{,}950 = 6{,}776 + 36{,}149\,X$$

or $$36{,}148\,X = 40{,}950 - 6{,}776 = 34{,}174$$

therefore $$X = \frac{34{,}174}{36{,}148} = 0.945,$$ which is the quality of the steam.

This may also be expressed as 94½ per cent. dry, or 5½ per cent. wet.

The barrel calorimeter is naturally inaccurate, because no account is taken of the amount of heat that is absorbed by the barrel itself, or that given off to the atmosphere. However, results obtained by its use are sufficiently accurate for all but exact calculations, and it is, of course, a splendid check on the constancy of steam quality.

The Separating Calorimeter

The second type of calorimeter from the point of view of simplicity is known as the separating calorimeter, and is, in effect, a steam separator. The separating calorimeter belies its name in that it has nothing whatever to do with the heat value of the steam, except that once knowing the quality of steam its heat value may be calculated from the steam tables.

The operation of the separating calorimeter is identical with that of a steam separator. In its passage through the separator the steam is forced to make one or more sharp turns, the drops of moisture having greater density than the steam tend to travel on in straight lines and are collected in a reservoir, while the steam passes out of the separator with practically no moisture in it.

In the simple type of separating calorimeter the water collected must be drawn off to be measured, and the dry steam must be condensed in order to be weighed. In this way we can find directly the proportion of the moisture to the mixture, which, when expressed as a decimal or a percentage is the quality of the steam.

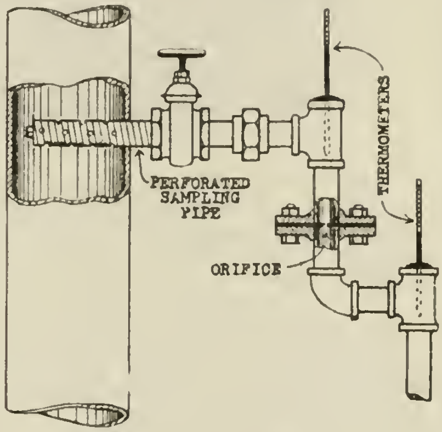
In the more elaborate types there is a gauge glass on the reservoir with a scale to show pounds of water collected, and the orifice through which the steam escapes is so calibrated that for each different steam pressure there is a corresponding definite amount of steam discharged per minute. There is also mounted on the calorimeter a pressure gauge with an extra scale graduated to show the flow in pounds of dry steam per minute.

Must Be Warmed Up

In using the separating calorimeter the instrument is connected by a short nipple and valve to the sampling pipe in the steam main, and is thoroughly lagged with hair felt. It must be warmed up by passing steam through it before commencing the test. The test should be made with a flying start. In the simple type the height of the water in the gauge glass should be marked and the weight of the condensing tank taken at the same instant; after several minutes the same readings are taken again.

The difference between the weights of the condensing tank show directly the amount of dry steam passed during the time chosen. The calorimeter reservoir, after turning off the steam, should be drained down to the second mark. Then it should be drained down to the first mark into a weighed vessel. The weight of this water between the two marks is the amount of moisture in the steam.

In using the calibrated type it is merely necessary to read the water gauge at the beginning and end of, say, 10 minutes. One tenth of the water collection will then be the amount of priming in the steam passed in one minute. The pressure gauge is read on the pounds-per-minute scale every minute or half minute and the average of all the readings is the amount of dry steam per minute.



The Steam Calorimeter

Weight of Dry Steam

Let W represent the weight of dry steam passed per minute or during the whole test as the case may be, and w represent the weight of priming collected in the same time. Then the total weight of wet steam used will be W + w, and the proportion of priming or moisture will be $\frac{w}{W + w}$ while the quality of the steam will be $\frac{W}{W + w}$ or expressed as a percentage will be $\frac{100\,W}{W + w}$ per cent.

Example:—Suppose the weight of dry steam collected or passed per unit of time was 72 lbs., and the amount of moisture separated 4.8 lbs., the quality of the steam will be

$$\frac{72}{72 + 4.8} = \frac{72}{76.8} = .938.$$

and the percentage of moisture

$$\frac{4.8}{72 + 4.8} = \frac{4.8}{76.8} = .062.$$

The separating calorimeter is more accurate with poor quality steam, or a high proportion of moisture, because it does not separate quite all the moisture from the steam. However, for steam having five per cent. or more of priming, it is fairly accurate.

The Throttling Calorimeter

The third type of calorimeter, which is very simple in its construction, though somewhat involved in the computation of results, is known as the throttling calorimeter. A simple home-made form of this calorimeter is shown in the illustration. In use it should be lagged to prevent the radiation of heat. It consists of a thermometer cup on the supply pipe, a small orifice through which the steam is throttled and its pressure reduced, and a second thermometer cup in the low pressure side.

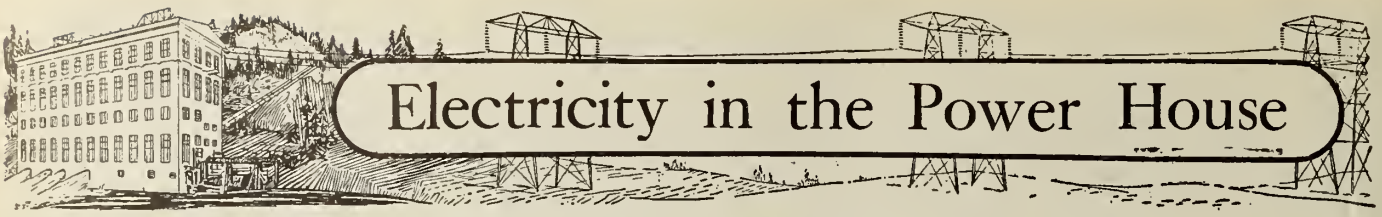
The inlet is connected to a sampling pipe with short connections, as shown, and the exhaust is allowed to escape to the atmosphere or to any other low pressure. If the exhaust goes other than direct to the atmosphere, a pressure gauge is also needed on the low pressure side.

The action of the throttling calorimeter is as follows: When the wet steam passes through the small orifice its pressure drops; and since low pressure dry steam contains much less heat than high pressure steam, there will be more heat in the original dry part of the steam than is required to keep it dry at lower pressure, and this heat is used to evaporate any moisture that may be present; if there is no moisture to be evaporated the excess heat superheats the steam. Since the high pressure steam is wet, saturated steam, we know by reference to a steam table its temperature and its pressure, if we know either of these quantities.

To know the condition of the superheated steam in the body of the calorimeter we must know both its temperature and its pressure. Therefore, the readings which we are required to make in using this type of calorimeter are temperature or pressure of the high pressure steam and temperature and pressure on the low pressure side of the orifice.

It is generally easier to read a thermometer accurately than to take accurate readings on a pressure gauge, therefore temperature, instead of pressure, is usually read on the high pressure side of a throttling calorimeter. In case the discharge takes place from the calorimeter, at atmospheric pressure, we will either assume that the temperature of saturated steam is 212 deg., and subtract that from the temperature shown on the low pressure thermometer to find the amount of superheat, or in very accurate work we may read atmospheric pressure from a barometer and the gauge pressure in the calorimeter by means of a monometer, a draft gauge reversed, and find the true corresponding boiling point from the steam tables.

(Turn to page 42)



Electricity in the Power House

By J. A. BURNETT, M.E.I.C., Consulting Engineer, 205 St. James St., Montreal

SOLDERING JOINTS

CLEAN and hot, are two essentials of a good soldered joint, which must be kept in mind on every job.

In making an ordinary spliced joint, the wires are bared of insulation for a distance of about one inch from the joint and carefully cleaned by the use of sand paper or emery cloth. Emery cloth is preferable because it is tough and flexible and a rapid scouring of the surface can be made.

The two ends of the cleaned wire are butted together after slipping over them a carefully prepared sleeve. The surfaces may be brushed with a solution of sal-ammoniac, or preferably, coated with a soldering paste.

A solution of resin in alcohol is sometimes employed for this purpose. The joint is now ready for the application of the solder.

Flows Readily

It is heated by a hot soldering iron or in the flame of a gasoline torch until the application of a soldering stick to its surface shows that the solder will readily flow over the cleaned surfaces.

Certain precautions must be observed in heating the joint, as, for instance, not to get the surface too hot, as the copper will then oxidize. Neither must the surface be too cold, as the solder will not then readily flow, as a consequence of which the joint may be imperfectly united, or because of frozen dripping, it will present stalactitic points which have to be cut or filed off before taping the joint.

It is absolutely necessary that the soldered joint have a smooth surface, otherwise the insulation will be cut.

If, however, the joint need not have mechanical strength and is only required to be electrically conducting, the use of a sleeve may be dispensed with. The wires may then be placed side by side and overlapped, wrapped with fine copper wire, about No. 26 in. size. The fine wire holds the joint in position.

Care should be used in wrapping, that the untaped wire presents no sharp points. Solder is now flowed on as before. After a sufficient amount has been put on to cover the surface and the interstices of the fine wire are filled, it is advisable to wipe the joint with a cloth just as a plumber does in wiping a joint.

This removes any excess of solder and makes the joint smooth on its surface.

If the conductor is two wires in multiple and it is desired to solder it to a similar pair of wires, it is usual to cut one wire of each pair half an inch to an inch shorter than the other and then place the two conductors together.

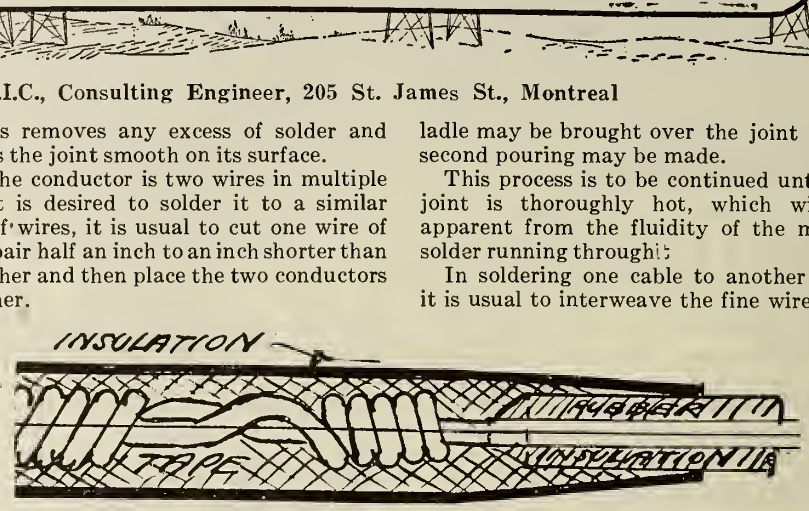


Fig. 2

These may be wrapped as above and their soldering then presents no difficulty.

Obviously, this may be extended to the soldering of any number of conductors in parallel.

Solder Copper Strip

It is sometimes necessary to solder a sheet copper strip to a wire in order to provide a flexible lead for wires of large size. After the surfaces are cleaned, one end of the copper strip is formed to fit the wire to which it is soldered.

After fluxing, the soldering operation is performed as usual.

If a single copper strip does not provide sufficient conductivity for a wire cable, two or more of them are placed in parallel upon it, in which case difficulty is apt to be experienced from the flowing of solder between the strips.

Solder will always run on hot copper. To obviate this difficulty it is usual to place strips of material between the sheets of copper to prevent their being united by the flowing solder.

Copper wire up to the size of No. 0 may readily be soldered by a soldering iron of the usual size, say an inch and a quarter square.

With larger sizes a gasolene torch must be used unless one has a pot of hot solder with two ladles, when the hot solder may be poured upon the ladle directly on the joint. This can be accomplished by pouring upon the joint and catching the drip in the ladle underneath the joint.

If the joint is such a size that it is not warmed at the first pouring, the lower ladle may be brought over the joint and a second pouring may be made.

This process is to be continued until the joint is thoroughly hot, which will be apparent from the fluidity of the molten solder running through it.

In soldering one cable to another cable it is usual to interweave the fine wires to a sufficient length and then wrap the whole with fine wire, after which it may be treated in the usual way.

When a cable is to be inserted in a sleeve or terminal plug it may be dipped in the soldering fluid and then plunged into molten solder.

The plug in which the cable may be placed can be tinned in the same manner. The receptacle of the plug is now filled about half full of solder, when the tinned cable may be plunged into it.

The sleeves used for soldering joints are made of copper or brass tubes, slotted end to end to permit solder to run in, and tinned.

Fig. 1 shows one type of sleeve.

The joints are often insulated by means of friction tape, but it is advisable to use a coating of rubber tape first, then to apply friction tape. The joint is then well painted with insulating paint.

Fig. 2 shows this feature and the "scarfed" insulation, on a joint.

One of the writer's early jobs was the erection of a low voltage generator where large cables had to be run from the machine to the switchboard.

Cast brass terminals were to be soldered on the ends of these cables. Local workmen who had applied to the writer for work were given the task.

They were fairly good mechanics along certain lines, but they were not accustomed to soldering.

When the writer returned to the work after a short absence, suspicions were aroused by the rapidity with which it was progressing, so one of the soldered terminals was given a few raps with a hammer, whereupon it promptly fell off.

The solder and terminal had been heated all right, but the cable had not been heated sufficiently to keep it from "freezing" the solder when inserted into the terminal, and the torch had not been applied to the terminal long enough to sweat the solder into the cable.

The inside of the terminal had not been properly cleaned and tinned, so the solder did not adhere.

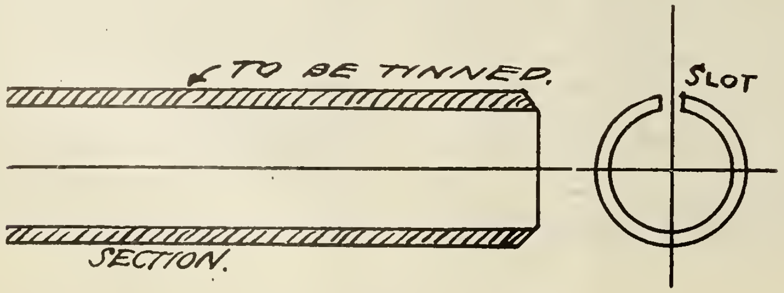


Fig. 1

Practical Ideas From Practical Men

LATCH-HOOK SPRING

The spring on the latch-hook of a Corliss engine valve gear gave us no end of trouble some time ago. The spring as originally supplied with the engine was made of a thin flat spring and fitted as shown in Fig. 1.

Trouble was experienced with the springs after they had been in service a short time, breaking off at A Fig.1. Some of the springs would last only a day and as the supply of springs soon ran out and were difficult to get, it was decided to use a different type which could be readily procured.

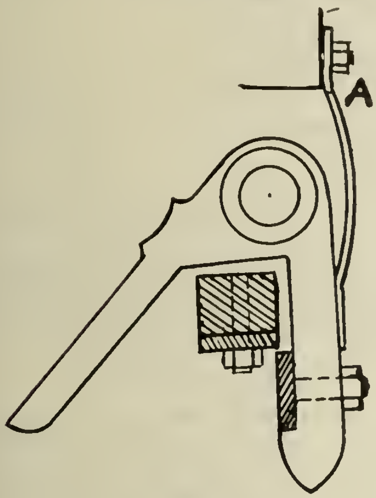


Fig. 1.

The new arrangement of the spring is shown in Fig. 2. A strip of steel one inch wide and one-eighth inch thick was bent as shown at F. A block of brass B with a small hole in it to act as a guide for the bolt through the spring was soldered to the valve gear.

Instead of a flat steel spring, a helical spring H was used as shown in the drawing.

With the new spring system on the engine all troubles from that source were ended. The whole job was rushed in order to have the engine idle as short a time as possible, so it was not made as carefully as it would have been had more time been available, but so well has the temporary affair worked that nothing has been done in the way of repairs for several years.—T. H. HOPE, Toronto.

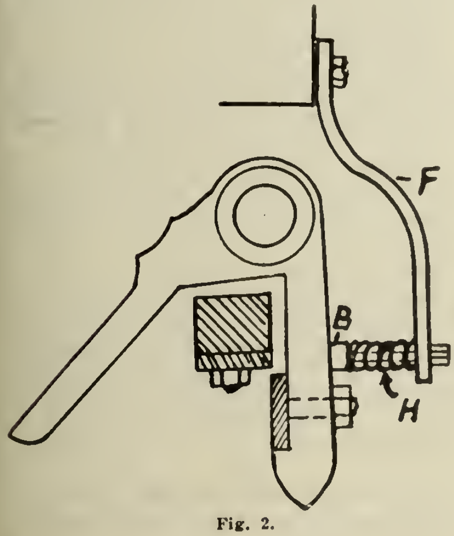


Fig. 2.

EYE PROTECTION

We read and see much about safety first, and still more about economy, yet there is a common, every-day occurrence in our boiler rooms that is contrary to both precepts. We all seem to accept it as an unavoidable evil, although its elimination pays splendid dividends.

The evil is the intense brightness and heat to which the fireman exposes his eyes every time the door of a hand-fired furnace is opened.

This evil is a costly one on coal consumption and should be stopped for that reason, as well as for the comfort of the fireman. As eyes are one of the most essential organs of firemen, whether off or on duty, they should receive protection from the bright light and heat, as much as possible. If not, strained eyes, stomach trouble, lack of ambition, and a general run-down condition will result.

This may seem "tommy rot" to some engineers, but to me it is a reality which has cost me real money. When I was striving to find something to protect my eyes, I found that with several of the devices on the market, I could see through the flame to the coal bed, which was uneven with some holes through to the grates. These holes were near the bridge wall, and hidden from the view of the naked eye by the flame in the front portion of the furnace. I levelled out my fire and my coal, where needed, and in this way was able to come up on the CO_2 from 11 to 13 per cent., holding it there as easily as I could at 11 per cent. without the eye protector.

Tries Smoked Glasses

The usual devices to protect the eyes are similar to those used by oxygen welders, but as I was exposed to conditions which made these neither comfortable nor serviceable, I used smoked glasses, later trying a green celluloid shade with excellent success. In selecting a shade the engineer will find there are several different kinds on the market, but the one best suited to the fireman's purpose is the kind through which you can clearly see the wires of an electric bulb.

Personally, I think that a good eye shade used as above described is as good a fuel saver as either a draught gauge or a the:mometer.—C. RYE, Wesley College, Winnipeg.

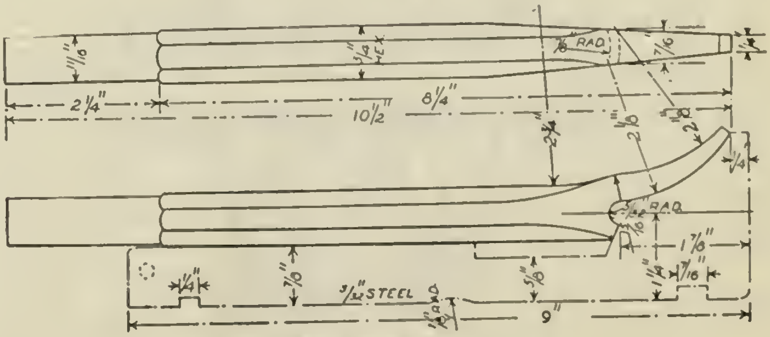
FLUE BEADING TOOL

The accompanying illustration shows with full detail measurements of the standard flue beading tool that has been found to be very efficient and satisfactory on locomotive boilers.

It is 10½ in. long over all and is made of hexagon steel. The forming curve is of 5/32 in. radius so as to form a 5/16 in. bead at the end of the tube and the heel and toe are cut at such an angle and given the proper curve to facilitate the upsetting and belling of the end of the tube so as to put it in shape for the final beading.

In connection with the beading tool a template for making it is also provided. This is shown by dotted lines as lying against one side of the lower drawing of the tool. It has a bevel that bears against the heel with a projection fitting into the beading groove and then fits against the curve up to the tip that serves as a fulcrum for the belling out of the tube.

On the lower face of the template there are three grooves: one ¼ in. wide, one 7/16 in. wide and one cut to a radius of ⅞ in. These serve respectively for bringing the tip and heel to proper widths and the heel to a proper radius. It is thus possible to make all of these tools alike and with the minimum of trouble. —A. SMYTH.



Flue Beading Tool.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

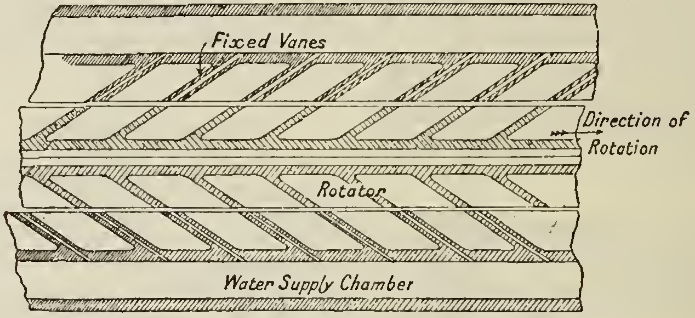


Fig. 2—Section Showing Vanes.

WATER DYNAMOMETER

How is the ordinary water dynamometer constructed and how is it used to measure the horsepower of an engine?

—H. H. CURTIS, Edmonton.

Ans: The ordinary water dynamometer or, as it is sometimes called, the "Froude," is shown in section in Fig. 1.

It consists of two main elements, a case or shell in which revolves the wheel or the rotor, the latter being a circular disc. On each side is formed a circular channel of semi-elliptical cross-section. These channels are placed back to back and are provided with a number of vanes fixed obliquely, as shown in section in Fig. 2.

On each side of the casing, similar channels are fixed, also provided with vanes, thus forming two complete annular channels of elliptical cross-section, the channels being divided into a number of complete compartments by the oblique vanes.

When the rotor is set in motion and the whole internal space filled with water, the water in the cups of the rotor, due to centrifugal force, passes to the outer surface and is thrown with considerable force against the upper part of the fixed cups in the casing.

The water then circulates around the outer surface of the fixed cups and enters the bottom edge of the cups with increased velocity. A whirlpool is thus set up in each cup, the power required to keep the rotor going being mainly used up by these eddies.

The whole of the power used being turned into heat, as in the case of the ordinary Prony brake, a continual supply of cold water is necessary to keep the machine cool.

In using the machine, the rotor is lined up with the engine or motor shaft and connected to it, and the supply of water to the machine regulated according to the load.

The friction of the water tends to cause the casing to rotate with the impeller or the rotor, this tendency being resisted by a lever fastened to the casing and bearing on the platform of a scale.

The horsepower is calculated the same as for the Prony brake:

$$\text{H.P.} = \frac{2\pi LN(W—W_1)}{33{,}000}$$

where

L = length of the brake arm in feet.
N = revolutions per minute.
W = Total weight on scale.
W_1 = Tare weight on scale.
W—W_1 is thus the net weight on the scale.

The friction of the shaft bearings acts in the same direction as the water in the rotor, thus introducing no error in the readings.

Water should be supplied under pressures from 10 to 30 lb., and for water at 70 deg. F., about 3 gallons per brake horsepower hour are required.

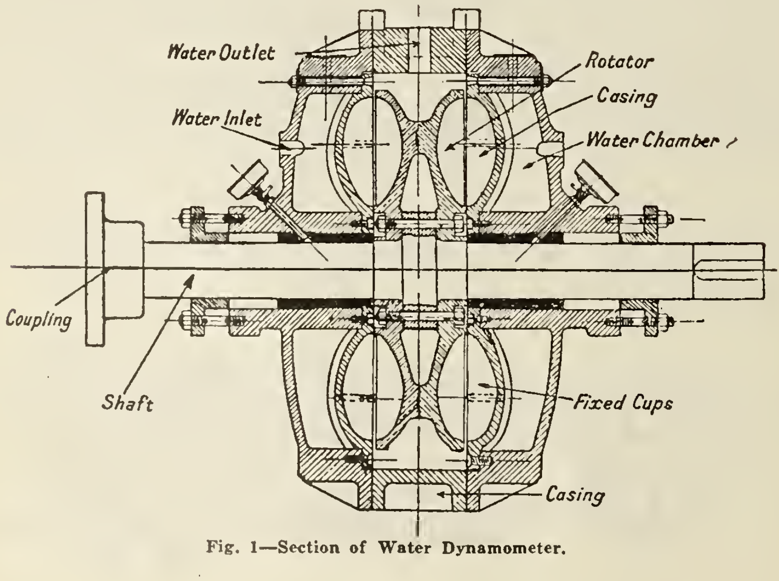


Fig. 1—Section of Water Dynamometer.

* * * *

LOSSES IN ELBOWS

A boiler rated at 30 h.p. is connected to a 10 x 10 steam engine running at normal speed of 310 r.p.m. Steam is conveyed to the engine through a 2½ in. pipe, 16 ft. long. The pipe line contains 6 90-deg. elbows. The steam pressure carried is about 90 lbs. gauge. Would the engine give any more power if the pipe line contained no elbows?

—CORNELIUS MURPHY,
Melrose, N. B.

Answer:—From the information you have given, it is not possible to work out with any degree of accuracy the gain in power if all the elbows were eliminated from the pipe line, from the boiler to the engine.

You do not give the load on the engine nor do you say whether the steam pipe is covered with a good heat insulating material or whether it is exposed.

In the first place, a 10 x 10 engine is capable of using much more steam than a 30 h.p. boiler can produce, especially if the engine is in bad shape and the boiler is dirty or scaled up badly.

Suppose the engine is using the full 30 h.p. from the boiler. One boiler h.p. is equivalent to 34.5 lbs. of water evaporated from and at 212 deg F.

Using a steam pressure of 90 lbs. gauge, the boiler would be using 30 × 29 or 870 lbs. of water per hour. At 90 gauge 4.23 cu. ft. of steam weighs one pound. The volume of the steam per minute flowing through the pipe is

$$\text{then about } \frac{870 \times 4.23}{60} = 61.3 \text{ cu. ft.}$$

The area of a 2½ in. pipe is about 1-30 of a sq. ft., so the velocity of the steam through the pipe must be about 61.3 × 30 = 1,840 ft. per min. This is rather low and at such velocity the loss due to elbows would be small.

It would be advisable, if you have a spare pressure gauge, to place it in the pipe line next the engine, then you could find directly the loss in pressure. A point to be remembered is that all pressure gauges do not read the same. It would be well to check the two gauges before using them, as the drop in pressure will only be a few pounds at best.

Even if there is a considerable drop in pressure in the pipe line, it does not follow that there will be much reduction in power. The drop in pressure has a tendency to superheat the steam and if the pipe is properly covered to retain the superheat due to drop in pressure, better expansion will be secured than with the wet steam, in this way giving back most of the power which is apparently lost due to the reduction in pressure.

The real cause of your trouble is that the boiler is not capable of keeping the engine supplied with steam.

For cut-off at ⅝ stroke, with the ordinary D slide valve engine and steam pressure 90 lbs. gauge, the mean effective pressure is about 63 lbs. per sq. in.

Assume that we have a m.e.p. of 60 lbs. per sq. in. and using the formula,

$$\text{H.P.} = \frac{PLAN}{33{,}000}$$

where P = M.E.P.
A = Area of piston.
L = Length of stroke.
N = R.P.M.

In this case, with the 10 x 10 engine the h.p. developed would be,

$$144 \times 60 \times \frac{10}{12} \times \frac{.7854}{33{,}000} \times \frac{100}{144} \times 310 = 37$$

* * * *

VALVE OPENING

What is the minimum lift required in the ordinary globe valve to give the full opening? In a globe valve, when the lift of the valve is ¼ of the diameter of the opening, is the valve wide open?

—A. L., H. Vancouver.

Answer:—Assume that the diameter of the opening in the valve is one inch.

The area of a circle is .7854 × D^2.

The area of the one inch circle is then .7854 sq. in.

The circumference of a circle is 3.1416 × D.

Now, if the lift of the valve is ¼ in., the area of the opening is then,

¼ × 3.1416 × 1 = .7854 sq. in.

This is the same as the area of the circular hole in the valve, thus, when the lift of the valve disc is ¼ of the diameter of the hole in the valve, it is wide open.

The minimum lift required for the valve to be wide open is clearly shown.

HEATING SURFACE

What is the number of square feet of heating surface in a horizontal return-tubular boiler 72 in. in diameter and 14 ft. long, containing 127 three-inch tubes? —WALTER HUDSON.

Ans: Allowing as heating surfaces, two-thirds of the shell, the internal area of the fire tubes and two-thirds of the area of the heads after deducting tube holes and taking all dimensions in inches, there would be:

In the shell:

Heating Surface sq. in.

Circumference = 72″ × 3.1416 = 226.195″.
2/3 of circumference = 2/3 of 226.195 = 150.796″.
Length 14 ft. × 12 = 168″.
Heating surface in shell = 150.796 × 168″ = 25,333

In the tubes:

Internal dia. of 3″ tube = 2.782″.
Internal circum. = 2,782 × 3,1416 = 8,740.
For 127 tubes 168″ long, 8.74 × 127 × 168 = 186,476

In the heads:

Gross area of two-thirds of two heads = 72 × 72 × 0.7854 × 2 × 2/3 = 5,428 sq. in.
Twice combined area of 127 three-inch tube holes = 2 × 127 × (3 × 3 × 0.7854 = 1,795 sq. in.
5,428 − 1,795 = ...3,633

Total Heating surface 215,442
or 215,442 ÷ 144 = 1,496.12 sq. ft.

* * * *

GAUGE FLUCTUATIONS

What causes water to rise and fall in the glass gage of a boiler?

—A. HOLMES.

Ans: The water rises and falls because there is an actual wave of water within the boiler, or surging due to the circulation.

When there is generation of steam, the circulation of the water has a tendency to drive it higher at one end than the other end of the boiler, which results in a glass gage indication of higher or lower water than the actual average water level. Activity of boiling has a tendency to increase the steam pressure and lower the water level in its vicinity, and near points where the steam pressure is reduced by discharge of steam from the boiler there is a tendency of higher water level.

When a boiler is in operation, these disturbances always are present to greater or less extent, causing the glass gage to indicate higher or lower water than the true or average level.

* * * *

EXPLOSION TEMPERATURES

What is the highest temperature attained in the cylinder of an internal-combustion engine at explosion?

—O. E. WYLIE.

Ans: The maximum temperature that occurs in an internal-combustion engine at the time of explosion varies with the compression that is carried in the engine and also with the amount of fuel added. In the ordinary gas engine, carrying from 80 to 90 lbs. compression, the maximum temperature will be in the neighborhood of 2,700 deg. F.

On the other hand, with oil engines where the compression pressure is carried much higher, the maximum temperature often is as high as 3,500 to 3,600 deg. F. Theoretically, the temperature should reach about 4,500 deg. F., figuring the amount that is normally added to the air charge.

However, there is a very rapid radiation of heat during the period of combustion, and this serves to keep the temperature much below the theoretical value.

* * * *

MOTOR SPEED

Can a 220-volt 5-h.p. 60-cycle induction motor be operated at 1,500 or 2,500 r.p.m? —C.A.S.E.

Ans: A 220-volt 5-h.p. 60-cycle induction motor cannot be changed to operate at 2,500 r.p.m. The speed of an induction motor is fixed by the frequency of the circuit and the number of poles in the motor.

The speed of the motor is equal to 120 times the frequency (cycles per second) divided by the number of poles. On 60 cycles, a two-pole motor will run at 120 × 60 ÷ 2 = 3,600 r.p.m.

A four-pole motor would operate at half this speed, or 1,800 revolutions per minute, and a six-pole motor at one-third this speed or 1,200 r.p.m. From this it will be seen that the three highest speeds that the motor can operate at are 1,200, 1,800 and 3,600 r.p.m.

Of course these are theoretical values, and the actual speed will be about 5 per cent. less than the theoretical.

* * * *

WATER COOLING

How many gallons of water can be cooled per hour from 75 deg. F. to 55 deg. F. per ton of refrigerating capacity? —W. M. T.

Ans: The unit of capacity of a refrigerating machine is taken as the abstraction of an amount of heat equal to the heat of fusion of 1 ton (2,000 lb.) of ice per day (24 hours).

The average heat of fusion is about 143.33 B.t.u. per lb., which is equivalent to 286,660 B.t.u. per ton, or the taking up of heat in a machine of unit capacity at the rate of 199.07 B.t.u. per min. This is so close to the convenient round figures of 200 B.t.u. per min. = 12,000 B.t.u. per hour that these figures are always used for rating refrigerating capacity.

For cooling water from 75 deg. F. to 55 deg. F., each pound of water would require the removal of 75 — 55 = 20 B.t.u., and a ton of refrigerating capacity would cool 12,000 ÷ 20 = 600 lb. of water an hour, and allowing 10 lb. of water per gallon, there would be 600 ÷ 10 = 60 gal. cooled per hour.

Booklet 300 of the Wright-Austin Co., Detroit, describes separators and exhaust heads.

The separators are for oil, gas, or steam, both saturated and superheated, high or low pressures and for vacuum service. Depending on the service, cast-iron, semi-steel, cast steel or boiler plate is used in the construction.

The bulletin also describes exhaust heads, steam traps and low pressure oil traps.

Announcements

James Howden & Co., Glasgow, Scotland, announce the appointment as their sole Canadian representatives of the Combustion Engineering Corporation with offices in Montreal, Toronto, Winnipeg and Vancouver.

Messrs. Howden are well known throughout the engineering world, having been established since 1854. Their manufactures include: The Howden-Zoelly Steam Turbines in all sizes; Vertical High Speed Enclosed Forced Lubrication Engines up to 2,500 B.H.P.; Howden Weir Steam Condensing Plants, and various auxiliaries such as centrifugal circulating pumps and forced draft apparatus, of which latter specialty installations aggregating more than 26,000,000 I.H.P. have been effected to date.

This company have also been the first within the British Empire to adopt and manufacture the Howden-Ljungstrom Air Preheater, which is now said to be one of the most far reaching inventions that has been brought out in years, and is attracting wide-spread attention in all centres.

Messrs. Howden already have a thorough understanding of the Canadian field, having operated in this market for some years, and latterly through their branch works located at Wellsville, N.Y., from which centre they have been enabled to give prompt service. Their most recent large Canadian contract has been an order from the City of Winnipeg for two 5,000 K.W. and one 1,000 K.W. turbo-alternators, complete with condensing equipment which are to be installed in the Municipal Hydro-Electric Steam Standby Station.

The Combustion Engineering Corporation are well known as manufacturers of boiler room specialties, including all types of mechanical stokers, pulverized fuel and oil burning equipment, coal and ash handling apparatus, etc., and the combination in Canada of these two firms for the purpose of meeting both engine room and boiler room requirements is interesting at this time.

The Combustion Engineering Corporation also announce the appointment on the board of directors, with headquarters in Montreal, of F. S. B. Heward, who, for the past five years, has been vice-president and managing director of the Howden Company in America.

The Sanford Riley Stoker Co., Worcester, Mass., have published a new 64-page catalog describing the Riley underfeed stoker.

This stoker is of the multiple retort inclined underfeed type with continuous automatic ash discharge. Beyond the end of the underfeed retorts are the overfeed grates extending across the entire width of the stoker.

Movement of the fuel bed and the dumping of the ash is controlled by the reciprocating sides of the retorts. Ash is crushed at the rear of the stoker by the rocker dump plates. The travel of the reciprocating retort sides is determined by the stroke adjusters.

The stoker is fitted with a two-speed gear box and a renewable cylinder liner, made of a half section of nine inch standard pipe inserted in a counter bored cylinder.

The claims made for the stoker are: smokeless combustion, high capacity with flexibility and high efficiency, ability to burn all classes of fuel, especially coals having a high percentage of ash.

Miscellaneous

Coming back strong after a twelve years' absence from the baseball field Jenkins Bros., stepped right into front place in Montreal amateur baseball.

The Jenkins team playing in the Spalding Intermediate League smashed their way to victory through the regular season at the end of which they found themselves tied with the team of the Grand Trunk Car Shops for first position. The play-off on the grounds of the Imperial Tobacco Co., proved the superiority of the Jenkins men, the final score—after a very keenly contested game—being 11-7 in favor of the valve makers, who thus secured the championship.

In This Issue

Editorial Point of View 21
By Campbell Bradshaw

Power—Their All! 22
By R. Manly Orr

Respect a Lump of Coal 23
By K. L. Dowson

Steam Generation Facts 27
By Charles L. Hubbard

Repairing Electrical Instruments .. 30
By Victor H. Todd

Steam Quality 32
By M. Barry Watson

Soldering Joints 34
By J. A. Burnett

Practical Ideas 35
Latch Hook Spring
Eye Protection
Flue Beading Tool

Questions and Answers 36
Water Dynamometer
Losses in Elbows
Valve Openings
Heating Surface
Gauge Fluctuations
Explosion Temperatures
Motor Speeds
Water Cooling

Pipe Lines 38
Announcements
Miscellaneous

C.A.S.E. Notes 39
M. D. E. A. Doings
Convention Notes
Power Notes

U.C.C. of E. Notes 40

Obituary 40
Charles P. Steinmetz
Leonard P. McClelland

Personals 40
R. Manly Orr

New Power Equipment 41
A Pipe Cutting Machine

PIPE LINES

UNCOVERED IN ANY OLD SPOT

A single-phase induction motor will continue to run in the direction from which it is started. If a split-phase winding is supplied for starting, the connection of either the starting winding or the main winding may be interchanged to reverse the direction of rotation.

* * *

QUESTIONS AND ANSWERS

I am engaged and being married next week to a wealthy young engineer—what should I weigh?—Trixie.

Answers:—One can do nothing in a week—after that, why worry?

* * *

If a main journal or crankpin becomes scored, it can be remedied by careful lapping with a canvas strip coated with emery paste. If it persists in running hot, white lead coated over the surface will often smooth it up.

* * *

Old King Cole is a merry old soul,
And I'll tell you why he's that way;
He likes his pipe and he likes his bowl,
And he reads Power House every day.

* * *

In cleaning pistons, a brass scraper should be used; emery cloth is never advisable save in cases of extreme scoring. Pistons should be pulled at least every nine months for cleaning. If the oil is a heavy residuum, more frequent cleaning will be necessary.

* * *

The Windsor fireman was so ignorant—he thought that overhead meant the cost of the roof.

* * *

Many engineers try to weld fractured piston heads. This is seldom, if ever, successful. The only feasible method of repair is that of "sewing" which is successful only in cases where the fracture is not of any great extent. Threaded brass rod makes the best kind of plugs to use in the sewing process.

* * *

Overheard by Walter Hudson on a C.P.R. diner at Winnipeg, between the head chef and another chef who was sent on an errand. Being gone longer than the head chef liked, the latter said to his assistant on his return: "Well, nigger, you can go the fudderest the quickest, and stay the longest, and do the lessest of any nigger I know."

* * *

The specific heat at constant volume in an oil engine is about 0.169. That is, if one pound of air is heated in a confined space (at constant volume) 0.169 B.t.u. are required to raise the temperature one degree Fahr. As the temperature rises, this specific heat changes, but for all practical purposes the value 0.169 may be assumed to be constant for all temperatures.

C. A. S. E. Notes

London No. 30, C.A.S.E., held their regular meeting Oct. 5. President Mott urged every member to do his best to bring No. 30 back to its old standard of membership. Grand Doorkeeper Jos. H. Ward visited St. Thomas last week and expects to have that lodge on the list again with a good working membership.

Having had the honor to be elected door keeper in the executive council C.A.S.E., I take this opportunity of writing a few words to all members in general.

As we are on the eve of a membership campaign and impressive educational lectures, etc., I would say that if each member will put out his best effort I believe we can double our present membership. Why not set the goal for the year at 1,000? I believe it can be done; so let us all do our best and see what we can do to make the next Convention the best ever.—JOSEPH WARD, Secretary Treasurer, London No. 30, Grand Door Keeper.

M.D.E.A. Notes

A regular meeting of the Montreal & District Engineers Association was held on Oct. 26 at the Royal Arcanum Chambers. At the close of the meeting, W. H. Rose, the treasurer, was presented with a handsome club bag.

Mr. Rose has been for many years chief engineer of the Lovell & Christmas cold storage plant but has now severed his connection in Montreal to accept the position of mechanical superintendent of The Thomas Gold Mines Co., South Porcupine. In a few words which were heartily endorsed by all the members present, A. Hall, acting on behalf of the president, made the presentation and wished Mr. Rose bon voyage, assuring him that the Association would welcome his return at any time, providing he brought the bag with him filled with nuggets.

Mr. Rose leaves Montreal with the best wishes of all the stationary engineers who ever came in contact with him, and particularly the members of the Montreal & District Engineers Association, as the financial affairs of the association were never in a more promising condition as a result of his careful and energetic handling of same.

Convention Notes

The National Exposition of Power and Mechanical Engineering, to be held at the Grand Central Palace, New York, from Monday, Dec. 3, through Saturday, Dec. 8, is planned in co-operation with the national societies interested in the economy of fuel and in the production and use of power.

The Exposition will parallel the annual meeting of The American Society of Mechanical Engineers, which will be held at the Engineering Societies Building, 29 West 39th Street, the first four days of the week.

To avoid conflict between the two events, the sessions of interest to those who will attend the power exposition have been set for the mornings of the meeting and the exposition will not open until one o'clock each day. This arrangement will give engineers an opportunity to enjoy both events to the greatest possible degree.

Some of the subjects to be discussed at the Annual Meeting of the A.S.M.E. are: Heat Transfer for Fluids Flowing Inside Pipes, by Wm. H. McAdams and T. H. Frost; A Steam Loss Prevention Plan in a Textile Finishing Plant, by Henry M. Burke; A Graphical Study of Journal Lubrication, by H. A. S. Howarth. Factors in the Spontaneous Combustion of Coal, by O. P. Hood; Economic Phases of Coal Storage, by F. G. Tryon; Coal Handling and Coal Storage, by H. E. Birch and H. V. Coes; Economy Characteristics of Stage Feed Water Heating by Extraction, by E. H. Brown and M. K. Drewry; High Pressure, Reheating and Regenerating for Steam Power Plants, by C. F. Hirschfeld and F. O. Ellenwood; Reheating in Central Stations, W. J. Wohlenberg; Margins of Improvements in Central Station Steam Plant, by E. L. Robinson; Boiler Plant Economics by N. E. Funk and F. C. Ralston; Economic Status of the Oil Engine, by L. H. Morrison; Salt Velocity Method of Measuring Water, C. M. Allen and E. A. Taylor; The Gibson Method and Apparatus for Measuring the Flow of Water in Closed Conduits as Applied in Testing the Efficiencies of Water Wheels in Hydro-Electric Power Plants, by N. R. Gibson.

GOLDIE & McCULLOCH AND BABCOCK WILCOX IN MERGER

Announcement is made that a new company has acquired the manufacturing business of the Goldie & McCulloch Co., with the exception of that section engaged in the production of safes and vaults. The new organization is known as the Babcock & Wilcox and Goldie & McCulloch Co.

The head office and plant will be located in Galt, with R. O. McCulloch as president, A. R. Goldie, vice-president, and A. G. Pratt, vice-president of the Babcock & Wilcox Co., New York, as chairman of the board. Thus two prominent concerns have joined forces for the production of boilers, engines, pumps and other engineering equipment.

The Goldie & McCulloch Co. are one of the oldest firms in Canada, having been organized as a joint stock company in 1891, but, as a firm, it was founded in 1859 by the fathers of the president and vice-president of the new company.

R. Potter, Matheson, Ont., is having plans prepared for rebuilding a sawmill recently destroyed by fire, and is in the market for a steam power plant, etc.

Power Notes

The city of Belleville contemplates the erection of a pump house and the installation of a gasoline-driven fire pump of about 3,000,000 gallons' capacity. Estimated cost, $25 000. Gore, Nasmith and Storrie, Confederation Life Bldg., Toronto, engineers.

The Port Arthur Arena Co. contemplate the erection of a skating arena, including steam heating system. Estimated cost, $150 000. C. D. Howe & Co., Port Arthur, engineers.

The Town Council, Port Colborne, Ont., contemplate the erection of a $90,000 waterworks plant, including storage basin, pump house, two 750-gal. motor-driven pumps, one 1,500-gal. gasoline-driven pump, three pressure filter units, 12-in. main and 2,000,000-gal. elevated tank. H. Darling, Home Bank Bldg., Hamilton, mgr.

L. N. Huard, 129 Commerciale St., Levis, Que., plans the development of 17,000 h.p. on the River Megiscane, Temiscamingue County, and the erection of a $2,000,000 pulp and newsprint mill.

Tilson Co., Tillsonburg, Ont., are receiving prices and information on a $15,000 steam heating system to be installed this fall. Purchasing agent, E. V. Tilson, Tillsonburg.

The Foundation Co., 233 Broadway, New York, have been awarded the general contract by the Southern Canada Power Co. for a concrete dam and power house in connection with a 2 500,000 power development (approximately 30,000 h.p.) 3 miles from Drummondville, Que., on the St. Francis River.

Canadian Vickers, Ltd., Montreal, have been awarded the contract for one 4,000 h.p. turbine, 360 r.p.m., 64 ft. heading in connection with Portneuf hydro-electric development.

Silverwoods Ltd., London, contemplate the installation of a cold storage plant and equipment for the manufacture of ice cream at Lucknow. Estimated cost $35,000.

Canadian Vickers, Ltd., Montreal, have been awarded the contract for turbines and governors by the city of Winnipeg for a plant at Point du Bois at a cost of $18,800. Swedish General Electric Ltd., Toronto, received the contract for alternators, at $213,000, together with an order totalling $5,275 for spare parts.

The Gates Engineering Company, Montreal, have completed the installation of three 150 h.p.—H. R. T. boilers equipped with their furnaces for burning waste fuels in the Knox Bros. mills at Bickerdike Pier, Montreal. The above company have also been awarded the contract for the installation of four 150 h.p.—H.R.T. boilers to be installed in the new court house.

The Township of Etobicoke contemplates extensions to the hydro-electric power lines near Islington at an expenditure of $40,000.

The work is to be done by day labor; engineer N. McNicol; Clk., S. Barratt.

E. V. Buchanan, manager of the Utilities Commission, Hydro Offices, London, is having plans prepared for remodeling the main substation and installing additional equipment. At an estimated cost of $30,000.

The Canadian Packing Co., 3 Bathurst St., Toronto, is in the market for cold storage equipment, boilers, pumps, motors, etc., for a proposed meat packing house, including steam heating system, to be erected at an estimated cost of $1,000,000. Engineer or architect has not been selected.

The Queen's Hotel, Montreal, J. A. Raymond, Mgr , contemplates the erection of a ten story addition at an approximate cost of $500,000. Engineer or architect not selected.

The Hydro Electric Commission, Yonge and Shuter Sts., Toronto, is in the market for substation equipment, lines and service transformers, oil switches, switches and meters, for a proposed sub-station to be erected on Danforth Ave. Estimated cost $150,000.

The Mental Hospital, Essondale, B.C., contemplates the installation of a modern central heating plant. Tenders will be called by the provincial government.

The North Shore Power Company, Quebec, has obtained the lease of the *Chute de la Cheminee* on the Batiscan river and will probably construct a dam.

The Canadian Heating Apparatus Foundry Ltd., Montmagny, Que., has been incorporated with an authorized capital of $200,000.

The Richwell Brush Co. are establishing a plant in New Westminster for the manufacture of wire and fibre brushes.

The Canadian Ingot and Iron Co. are establishing a plant in Vancouver.

W. H. Yates, Hamilton, has been awarded the contract for the construction of a Hydro-Electric substation at Ottawa St. and Beach Road. Estimated cost $40,000.

The Back River Power Co., 35 Common St., Montreal, have started work on a $7,000,000 power development at Rivieres Des Prairies, Que. Preliminary work is being done by William I. Bishop, 10 Cathcart St., Montreal.

U.C.C. of E. Notes

Officers and members of the Universal Craftsmen Council of Engineers of Hamilton on Oct. 23, entertained a number of engineers from Canada council No.27, Toronto. Worthy Chief Alex. Leckie was in charge and short speeches were delivered by Past-President W. C. Terry and Worthy Chief Holmes. At the next regular meeting papers will be presented by two prominent engineers in the refrigerating profession.

Obituary

Statement by B. G. Lamme, Chief Engineer of the Westinghouse Electric & Manufacturing Company, upon the death of Dr. Charles P. Steinmetz, consulting engineer of the General Electric Company:

"I deeply regret the loss of Dr. Steinmetz as a personal friend and because his death means the passing of a brilliant analytical engineer. He was a very able man, who contributed much to the electrical industry, which will mourn his passing.

"As a personal friend, I knew him to be a witty, sociable man, quite human in his dealings with his fellow men. The public, to which he was known as a man of mystery, would have found, as I did in personal contact, a real human being.

"Dr. Steinmetz and I entered the electrical business within a month of each other in 1889. He was associated with the Eickomyer Company of New York for several years after he first came to this country. In this time his writings on engineering subjects attracted much attention in electrical circles and he soon joined the General Electric Company.

"He entered the electrical industry at the start of what engineers call the analytical period, when mathematical analysis took the place of 'cut and try' experiment. His greatest fame was achieved during this period of rapid electrical expansion, during which he contributed greatly to scientific analysis of electrical phenomena.

"Unlike many brilliant engineers, he left a record of his work in his numerous writings, so that his contributions to science will live in engineering journals. He was a prolific writer on diversified subjects and his keen mind was no more clearly displayed anywhere than in his contributions to scientific journals.

"Dr. Steinmetz will always be remembered in the electrical industry, and I will always remember my personal contact with this very able man."

Leonard Palin McClelland, divisional superintendent of the metropolitan division of the Hydro-electric Railways, died Oct. 29, at his home, 121 Eglinton Ave., Toronto, after a six months' illness. Mr. McClelland was one of the best known railway men in the city, having been connected with the old Toronto Street Railway, the Scarboro division of the Toronto and York Radial Railway, and later with the Metropolitan.

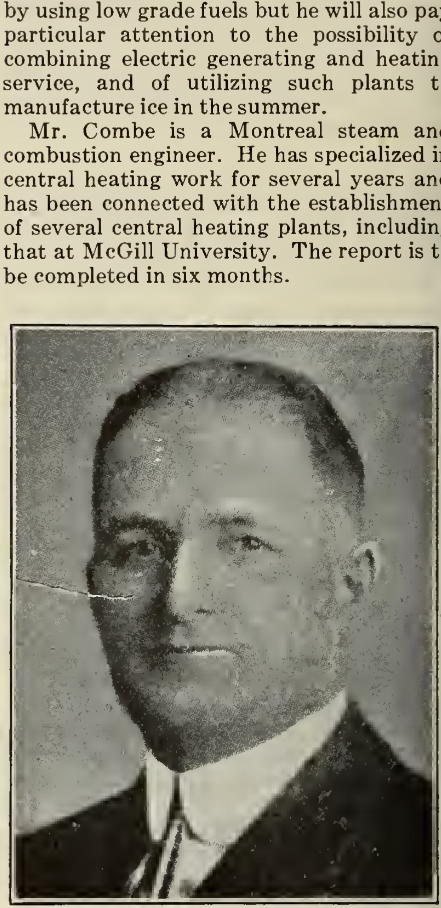
Personals

Thos. Rusk, recently of Hamilton, has taken charge as Chief Engineer of the Fort William Paper Co's. plant at Fort William.

Prof. C. R. Young, chairman of the Toronto Branch of the Engineering Institute of Canada, gave an interesting address in the Mining Building of the University of Toronto, Oct. 18, on "The Rise of the Engineer."

F. A. Combe, chairman of the fuel committee of the Engineering Institute of Canada, has been appointed by the Federal government to make an exhaustive report on the feasibility of establishing central heating plants in Canada as a fuel economy measure. Mr. Combe will not only investigate the saving that can be effected by using low grade fuels but he will also pay particular attention to the possibility of combining electric generating and heating service, and of utilizing such plants to manufacture ice in the summer.

Mr. Combe is a Montreal steam and combustion engineer. He has specialized in central heating work for several years and has been connected with the establishment of several central heating plants, including that at McGill University. The report is to be completed in six months.



R. MANLY ORR.

R. Manly Orr, chief engineer, Pacific Coast Pipe Co., Vancouver, had charge of the power plant of the Adams Wagon Co. at Brantford for nine years, leaving there for the west so that he might be near his aged father. Mr. Orr has been in his present position for eleven years and in 1922 had the honor of occupying the pulpit 63 times in greater Vancouver and district—his activities in religious circles taking him into 21 different churches of five denominations in the year.

Mr. Orr, a firm booster of "Power House," is proud of his profession as he believes no man can be an engineer who is not a student and thinker. Commenting on the biography of John Quinlan, "on the job," in the Sept. 20 Power House, Mr. Orr says Mr. Quinlan's genial smile bounded by the oil can, pipe wrench, overalls and factory fence, is a sermon in itself.

"It is the living demonstration of a great truth, that honest toil is a wholesome thing, neither killing the smile on a man's face nor souring his life."

The Sisters of the Holy Name of Jesus, Notre Dame St., E., Montreal, contemplate the erection of a five story mother house on Maplewood Ave. Estimated cost $600,000. S. Duchostel, Outremont, Engineer.

Progress in New Power Equipment

PIPE CUTTING MACHINE

A NEW machine, to meet a long-felt want in the pipe cutting and threading field, has been placed on the market by the Williams Tool Corporation, of Brantford. This machine has been designed to fill the gap that has long existed between the heavy and immobile power machine and the light hand threading and cutting equipment. It is called a Portable Pipe Cutting, Threading and Reaming Machine.

The manufacturers point out that the machine weighs less than 500 pounds and may be dismantled in less than three minutes and there is every indication that it will have an extensive sale to steam fitters, manufacturers and engineering concerns who do not require the heavy machine but have found their equipment inadequate for rapid and efficient service.

Portable and Demountable

It is perfectly designed, for weight and strength, to cut smooth and clean threads, either right or left hand, within its capacity, and can be dismantled in two minutes and fifteen seconds.

The small oil trough or cutting box under the carriage lifts off, allowing the carriage and head to slide off the round ways and by releasing two screws the Shelby tube steel ways can be pulled out of the head stock, thus leaving only the pedestal and head stock as a unit which two men can easily lift.

Its capacity is as follows: Threading, pipe ¼ to 2 in. inclusive, bolts ⅜ to 1¼ in.; cut-off, pipe or tubes ¼ to 2 in. inclusive, bolts and rods ⅜ to 1½ in.; reaming inside or chamfering outside, pipe or tubes ¼ to 2 in.; longest running thread at one chucking 10½ in.

Motor Belt and Hand Driven

The machine is driven by a standard ¾-h.p. motor by means of belt from motor to drive pulley enclosed in the base of machine and mounted on a hinged table which allows tightening of the belt instantly by screwing down on a thumb screw. Current is supplied from an ordinary lamp socket through a standard cord with push socket. A button control switch for start and stop is mounted on the machine at the operator's left hand.

Since the drive from motor to machine is through a belt, this insures protection to the dies and other working parts should excessive strain be placed on any part of the machine. The slippage of belt in this case would act as a safety factor.

The machine can be converted to belt drive by simply taking off the motor belt and driving from a line or counter-shaft.

Provision has also been made to operate the machine by hand. To do so, it is only necessary to shift gears to neutral position when the crank handle can be fitted on to the worm shaft which is directly connected to the spindle through worm and worm wheel.

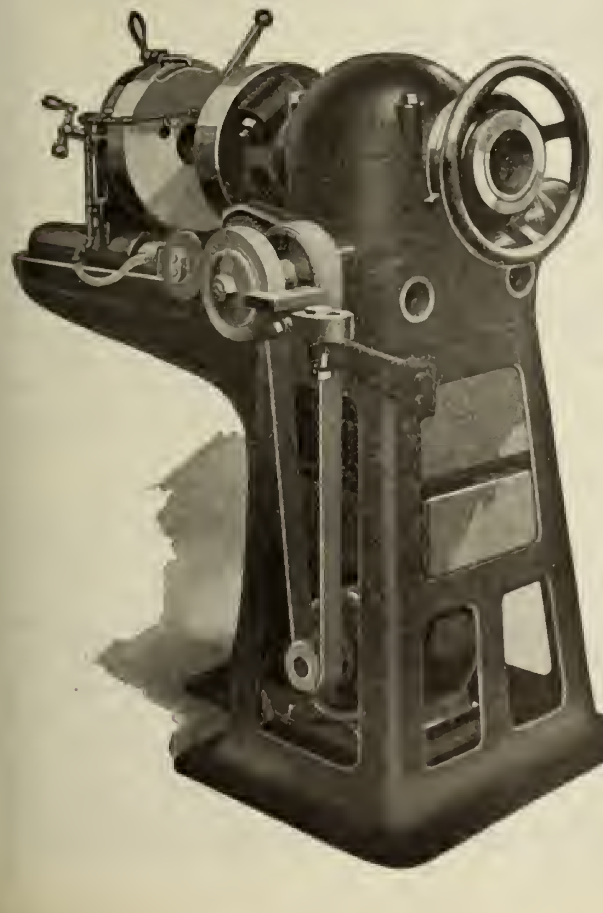
Two Speeds

The spindle has two speeds arranged similar to automobile sliding gear, which also gives a neutral position for the purpose of starting and stopping spindle without shutting off current. It is operated by small knurled push button at operator's left hand.

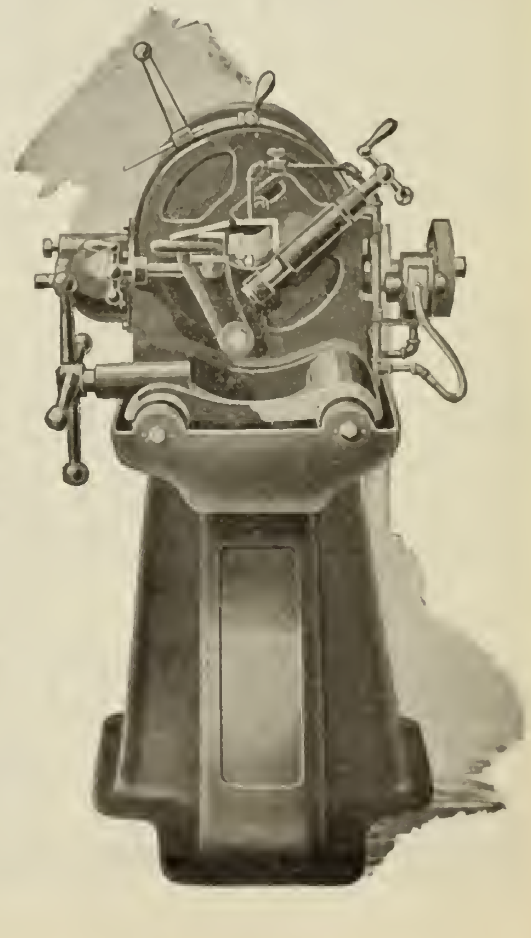
All gears are made of steel, machine cut. Sliding gear driven by standard Woodruff keys. The drive to spindle is through a quadruple worm and worm wheel with ball thrust. All gears and worm are lubricated by oil from a special oil sump.

All bearings in the machine are equipped with standard Bunting bronze bushings, lubricated from a special oil sump. The driving shaft has three bearings and the worm shaft two.

The spindle is made of standard Shelby steel tubing, extra heavy, and has a bore of 2⅞ in. which allows a 2-in. coupling to pass through. The spindle rests in a box type head stock which has



Two views of the Portable Pipe Cutting, Threading and Reaming Machine placed on the market by the Williams Tool Corporation of Brantford.



wide face bearings lubricated by splash system from special oil sump.

The front gripping or driving chuck is Williams standard three-jaw universal self centring. The chuck worm and worm wheel are steel packed in grease, while the chuck jaws are tool steel tempered. On the rear of the spindle is a standard Williams three-jaw self-centring scroll chuck for centring long lengths of pipe and operated by a hand wheel.

The carriage ways on which the carriage slides are standard Shelby steel tubing, extra heavy, accurately sized to one-thousandth part of an inch and highly polished, thus insuring a long wearing surface.

Die Head

The die head and carriage are cast in one piece, thus eliminating any possible chance of the head getting out of alignment. The part of the carriage resting on the Shelby tube ways is babbitted with extra hard babbitt.

The carriage has six bearing parts on the ways, three on each side. This makes it possible for the carriage to be re-babbitted and lined up at little expense after years of hard usage. Operation of head and setting of dies is very much similar to that used on all the standard machines.

The dies are operated by cam and lever and are interchangeable, adjusted to all variations of fittings. A graduated die head makes unnecessary the use of blank gages for setting the dies. Whenever several pieces of the same size pipe are to be cut, a cam stop is used to stop the cam lever at the right place for that particular size.

Three sets of dies are furnished with the machine as standard equipment, one set cutting ¼ and ⅜, one set ½ and ¾, and one set 1 to 2 in.

To change the dies it is only necessary to slack off two nuts on the face of the die head, when the die plate can be shifted a fraction and lifted right away from the head.

Cut Off and Ream

The cut-off attachment is mounted on the rear of the die head and is operated by a screw and hand wheel. A quick-operated V slide steadies pipe when cutting off. The V slide is equipped with hardened tool steel facings insuring a lasting wearing surface on the steady rest. This enables the operator to cut all sizes of pipe and bolts as required.

The blade is double bevel high-speed, set at an angle, which means that the machine can be run at its highest speed for all cutting-off purposes.

On the cutting-off attachment is pivoted the reamer holder operated by a lever. It is so arranged that all sizes of pipe can be reamed inside, or if necessary a slight chamfer can be made on the outside.

The tool bit used for this purpose is ⅜ in. square, the same as used in any standard tool holder.

A Brown & Sharpe rotary geared oil pump is located on the rear side of the machine near the driving pulley. It is gear driven direct from the intermediate shaft. All gears are enclosed in a gear case. The oil is pumped from the reservoir in the base of the machine through a specially constructed strainer to the pump. From there it is forced through a flexible hose to the die head, thus insuring an ample supply of cutting oil to the dies and cut-off tool when operating.

A small independent valve is provided for each operation.

After flushing the dies and cut-off tool, the oil drains back into the small oil pan under die head. Before leaving the pan it is strained, after which it flows back into the reservoir and is used over continuously. But each time it must pass through the strainer in the oil pan, and the fine strainer on the end of the suction pipe eliminates any possible chance of grit or dirt getting into the pump.

Place to Store Dies

A special die cabinet is cast in the top of the pedestal, providing a safe and convenient place to store dies as well as any small tools used on this machine.

Each part used on this machine has been manufactured from specially designed jigs and fixtures which insure all parts being accurately machined and interchangeable.

Emery Wheel Special Feature

An outstanding feature of this portable threading machine is a high-speed emery wheel which is driven from a pulley shaft at the back of the machine.

Every user of a pipe machine has long felt the want of a small emery stone, for in every shop there comes a time when it is necessary to touch up a die, sharpen a chisel or take a burr off some tool, and in designing this portable pipe machine, the manufacturers had in mind the purchasers' requirements in this connection as well as a high-class pipe machine.

This emery wheel is driven from the pulley shaft at approximately 1,000 r.p.m. and the machine is so designed that when the operator desires to use the emery stone the gears on this shaft can be thrown into neutral and no other part of the machine is running except the motor and emery wheel which allows him full use of the motor horse power for grinding purposes.

Of Norton Manufacture

The stone is of Norton manufacture, 5¾ in. diameter, ¾ in. face and proper grade for general grinding purposes. The shaft carrying the stone is of extra large diameter and equipped with three Bunting bronze bushings with all the bearings running in oil.

STEAM QUALITY

(Continued from page 33)

In the operation of the throttling calorimeter, it is assumed that no heat is lost. Therefore, the total heat content of the wet high pressure steam is taken as equal to the total heat content of the superheated low pressure steam. If the quality of the steam is represented by X, then the total heat in one pound of wet steam will be represented by h + XL, where h represents the "heat of the liquid," and L represents the "Latent heat" at main steam pressure. These are found from the steam tables. The total heat as expressed above is equal to the total heat in one pound of the low pressure superheated steam which is expressed by the formula H + 0.48(T — t) where H represents the total heat of a pound of saturated steam at exhaust pressure; 0.48 is the specific heat of superheated steam, or the amount of heat required to raise one pound of superheated steam through one degree Fahr.; T represents the temperature read on the thermometer in the exhaust chamber of the calorimeter; and t is the temperature of saturated steam at exhaust pressure. H and t can be found from the steam tables, or, if exhausting at atmospheric pressure, t may be taken as 212 degrees.

Therefore $h + XL = H + 0.48\ (T - t)$

$$\text{or } X = \frac{H + 0.48\ (T - t) - h}{L}$$

Example:—Let us suppose that thermometer at the inlet reads 361 deg. From the steam tables we find h = 332.9 and L = 861. The temperature in the low pressure side is 233 deg., and the pressure in the gauge is 1.3 pounds gauge, or 16 pounds per square inch absolute, then t = 216.3, and H = 1,152.

$$X = \frac{1152 + 0.48(233 - 216.3) - 332.9}{861}$$

$$= \frac{1152 + 0.48 \times .16.7 - 332.9}{861}$$

$$= \frac{1152 + 8 - 332.9}{861} = \frac{827.1}{861} = .967$$

Thus the quality of this steam is .967, or 96.97 per cent., or 3.3 per cent. wet.

Obviously this type of calorimeter is suitable only when there is enough heat available to evaporate all the moisture present. It is found, by experience, that with more than 5 per cent. moisture this calorimeter is inaccurate, and with low initial pressure even less moisture than this makes the instrument inoperative.

ERECTING DIESELS

In erecting a Diesel,engine the foundation should be thoroughly reinforced with old rails, reinforced bars, etc. The best concrete mixture depends on the character of the sand and gravel. A ratio of 1 part cement, 2½ parts sand and 3 parts crushed rock or gravel is well balanced. The concrete should not be too wet. It should not be rammed to any great extent. A rod should be used to push the concrete into the corners, etc. After finishing the concrete, the foundation should stand at least ten days to ripen. During this process the surface is best covered with wet sand.

POWER
PLANT
EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA { TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK & WILCOX, LIMITED

Toronto Office
Bank of Hamilton Building

ST. HENRY—MONTREAL

DON'T TREAT A LUMP OF COAL WITH CONTEMPT!

(Continued from page 26)

cinders. Their business is primarily the manufacture and sale of gas, a fuel from which heat is most readily available.

They desire to be free from the production and sale of a solid fuel which complicates their plant and puts them in a business of larger dollars and cents annual turnover than their gas business. Their problem would be much easier if the general public knew more concerning the use of fuels and this is where the Engineering Institute of Canada has undertaken to help a little through its fuel committees.

A great deal of work has been and is being done on the development of a process for the complete gasification of coal. All the processes reported on are in the experimental stage and it is not possible to predict from the data available when any of them will become a commercial success.

At the same time a cheap way to prepare the gas from high sulphur coals is being sought with partial success in some of the larger plants. Much interesting and valuable research can be and should be begun and encouraged along this line.

In connection with coal itself recent investigations show that the distribution of organic sulphur on the vertical span of a coal bed is quite uniform. On the other hand intense irregularity of distribution is characteristic of the pyritic sulphur in coal. This offers a possibility of securing a low sulphur product by separate mining of parts of the seam.

Analyses of typical gas coals show roughly:

	U.S.	Cape Breton
Moisture	2%	2%
Volatile Matter	38%	37%
Fixed Carbon..	55%	55%
Ash	5%	6%
Sulphur	0.6–1.25%	1.8–2.2%

In general the thermal efficiency of a gas plant may be conservatively considered as 75 per cent., some approach 80 per cent.

Average Efficiency

A ton of coal treated in the gas works will produce 11,000 cubic feet of gas containing 520 British heat units per cubic foot or a total of 5,720,000 heat units. Assuming that the average efficiency in the consumption of coal is 30 per cent. and that the original coal contains 13,500 heat units per pound, the quantity of useful heat from a ton of coal is then 5,100,000 units, a quantity less than that in the gas which might have been obtained from the raw coal.

In modern coke oven practice the aim is to obtain as much coke as possible from a ton of coal. Because most of it is used for metallurgical purposes where it is required to support heavy weights during all the time in which it is being consumed, such coke must be able to resist crushing at the same time as it burns readily. For best results the coke should be capable of being broken into large lumps approximating cubes. Coals extremely high in volatile matter may produce excellent results in gas works from which the coke is used for a different purpose. In coke ovens they will usually give a coke which breaks into needle-shaped lumps which are not desirable. Coals too low in volatile matter may produce no coherent coke at all.

As a general thing coals containing 16 to 40 per cent. of volatile matter can be coked but coke oven practice demands 18 to 33 per cent. Two coals, one high in volatile matter and the other low, neither of which will produce a good coke when alone, may give an excellent coke when intimately mixed.

Limit Retort Sizes

In gas works the aim is to produce gas and some of the residual coke is consumed to provide the necessary heat. At the coke oven the opposite holds. Coke is desired, gas is not, therefore some of the gas produced is burned to supply the heat. Perhaps 50 to 60 per cent. of the gas is consumed in this way while the remainder is available for any purpose to which it can be adapted.

The chief difference between the method of carbonizing in the coke ovens and in the gas works is in the size of the unit in which the coal is treated. In the gas works the retorts are of limited size, holding from 400 to 2,000 pounds which is exposed to the heat during six to eighteen hours; at the coke ovens the oven is of comparatively unlimited size holding from five to twenty tons, which is heated during period of from 18 to 72 hours.

At the same time as he produces a strong suitably sized coke the engineer is faced by the fact that he must have it low in sulphur and ash. To secure this he purchases only such coal as is naturally comparatively free from these evils, then he attempts their further reduction by crushing and washing it. Depending upon the condition of the coal and distribution of the sulphur a reduction of from 40 to 50 per cent. in the ash and 15 per cent. in the sulphur may be obtained. His objective is to keep the quantity of sulphur in his coke down below 1.25 per cent.

Enough has been said to show that in gas works and coke ovens the kinds of coal carbonized must be of the very finest quality, and consequently must of necessity be the most expensive. For gas works and coke ovens of this continent an enormous quantity of coal is needed every year.

Those who know are uttering a continuous warning that the supply is not inexhaustible. Their percentage of sulphur more than their percentage of ash is the factor which shuts out cheaper coal from these industries. It is obvious then that those who search for a way to eliminate the troubles of sulphur from the carbonization of coal and the manufacture of gas deserve international recognition, support and reward.

Lack of Volatile Matter

Probably the chief distinctions between coal and coke are the almost entire lack of volatile matter in the latter and its porous structure, which qualities enable it to be consumed in a single stage and at a high temperature to carbon dioxide.

Chemically considered, coke consists of the carbon together with all the mineral constituents of the coal from which it is made. It contains only a trace of hydrogen. The amount of carbon varies from 85 to 90 per cent. and the ash from 5 to 15 per cent.

When fired in furnaces under correct conditions of balanced draft, the formation of carbon monoxide can be largely avoided. The admission of secondary air is therefore unnecessary; and this fact permits the minimum of suction or chimney draught being maintained over the fire, the whole of the air necessary for combustion being taken under the fuel bed. The inleakage of air through faulty boiler brickwork and economizer settings, also the by-passing and short-circuiting of hot gases, may thus be reduced to a minimum. With coke fired on these lines experience has proven that efficient combustion and a high calorific intensity are much easier to secure than in the case of coal firing.

That coke has a higher calorific intensity than coal—which is not inferable from its analysis—is evidenced by the fact that it is used for metal-melting and other high temperature processes. The explanation probably is that the process of combustion being already far advanced by the heat absorbing process of distillation, less heat is required to gasify it than is necessary in the case of coal. Also the quantity of heat which is required to raise the temperature of one pound of coke through one degree is less than that required for coal.

This last statement gives the reason that coke does not have the chilling effect of fresh coal when thrown upon an incandescent fire. In addition, as hydrogen is almost entirely absent there is no formation of water with its accompanying loss of heat which deprives coal of four and a half per cent. of its original heating value.

A Fair Output

Recent tests show that an evaporation of seven to eight and a half pounds of water per pound of run-of-oven gas coke may be considered a fair output to be attained in practice with the same degree of care as is generally met with in good hand-fired boiler-room operation.

For a considerable time much difficulty was experienced in adapting coke to effective use with automatic chain-grate stokers. This has now been overcome by the "Sandwich" system of blending coal and coke, invented by E. W. L. Nicol, engineer of the London Coke Committee, London, England.

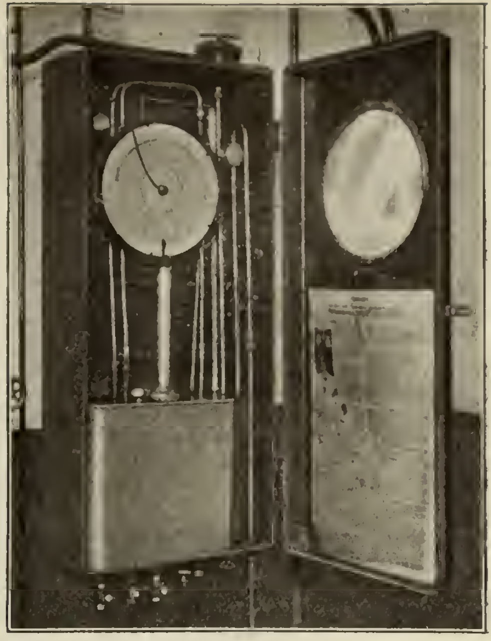
The fuel is fed to the grate in such a way that the coke is between two much thinner layers of a poor grade of coal.

Amongst the solid fuels in use coke has no equal for cleanliness. None other can equal it in rapidity of response to any change in the conditions of draught.

Last winter the British Empire Steel Corporation found no difficulty in selling its surplus of coke, about 6,000 tons per month, to consumers in the Maritime Provinces. During the month after the first appearance of the Besco product in Halifax the sales of coke jumped from 400 to 2,000 tons, good evidence of its popularity. This year a still larger quantity will be consumed if it can be obtained. Used properly it is giving value ton for ton equal to hard coal and there is usually a considerable price differential in favor of the ton of coke.

When coal is used for steam-raising under the best known conditions, it is

FOXBORO
Two-Pen Recording Thermometer



FOXBORO
Recording Gauge

Judge an Instrument by its Records

We'd like to have you judge Foxboro Instruments by their records.

The Foxboro-Heath CO_2 Recorder, for example, produces reliable records year after year. It has only three moving parts and is of all metal construction, no glass to break or rubber to leak.

Judge this instrument by the record in the right hand margin.

The Foxboro Recording Thermometer and Recording Gauge are as dependable. The new, improved helical tube movement that is permanent in calibration and capable of years of severe service without loss of accuracy is the reason for their dependability.

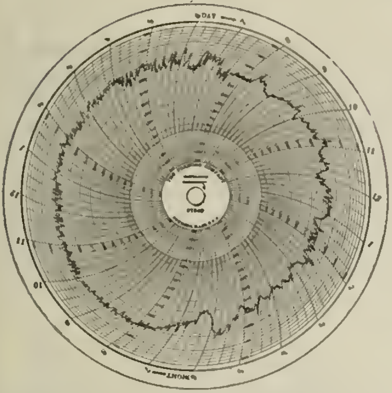
Let us send you Foxboro Bulletins CF-114 and CF-104-1.

THE FOXBORO CO., Inc.
FOXBORO, MASS., U.S.A.

New York Chicago Boston Philadelphia Pittsburgh
Cleveland Rochester Birmingham Tulsa
Los Angeles San Francisco Portland, Ore.

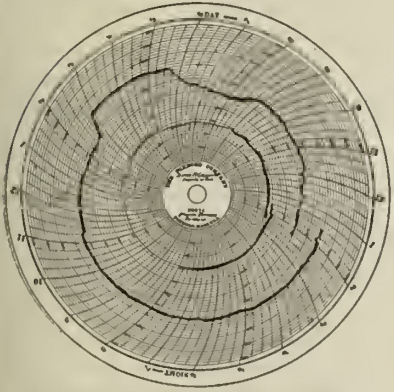
Peacock Brothers, Limited, 179 Delorimier Avenue,
Montreal, Canada

FOXBORO
REG. U. S. PAT. OFF.
THE COMPASS OF INDUSTRY

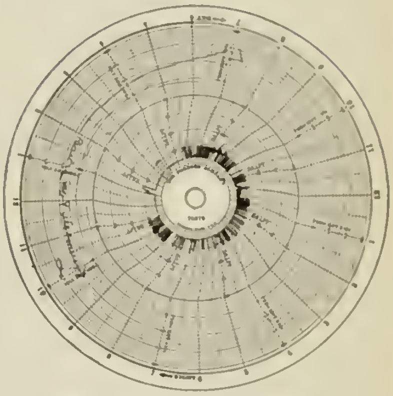


Record of feed water temperature made by a Foxboro Recording Thermometer in a textile mill power plant. Load variations during the day and uniformity of load at night are plainly shown.

The fidelity with which the slightest temperature variations are recorded is characteristic of all Foxboro charts.



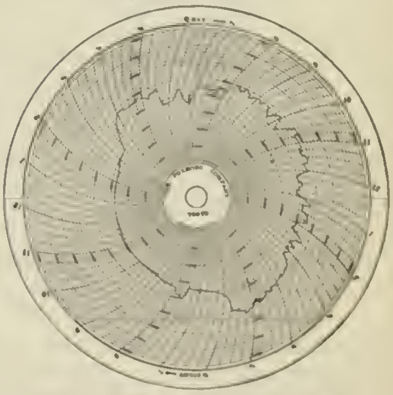
Record of inlet and discharge water temperature of a condenser at the Atlantic Refining Co., provides a positive check on condenser operation, insuring high vacuum and increased efficiency.



Combined CO_2 and draft record made at the plant of the City of Norwich, Conn.

The chart is an example of how well combustion can be controlled with the Foxboro chart as a guide. During the load period CO_2 is maintained at from 13 to 15%.

Note how quickly the CO_2 picks up when the load is put on the boiler in the morning.



Record of flue gas temperature made at the National Blank Book Co.'s Plant, Holyoke, Mass.

The even maintenance of temperature between 400 and 500 degrees Fht. during the load period indicates that very little heat is wasted up the stack in this plant.

obvious that there is little to be gained by any preliminary sorting of the thermal units of the coal into fuels of higher availability such as gas and coke. It is well known that an efficiency of 75 to 80 per cent. is attainable in steady practice. But best known conditions pertain to only five per cent. of the steam plants in the country. An increase of ten per cent. in overall efficiencies of the remaining 95 per cent. would reduce the national coal bill $9,000,000 per year.

Domestic purposes account for the use of one-fifth of the annual national consumption. For 1922 the actual figures would be one-fifth of 31 million tons, 6.2 million tons. If we compare a liberal household efficiency of 35 per cent. with the average efficiency of the best steam plants we at once see the extravagance of the waste involved in such use of coal.

In this Dominion, often spoken of as containing unlimited resources, we are inclined to take things as they come and not look too far into the future. The position of Central Canada in relation to her fuel supply should awaken us to added interest in and support of research which will bring curtailment of our wastefulness. Due to the transportation distances the present problem is, and the future problem will be, one of utilization. Certainly the people in the central provinces are the ones most vitally interested and it is to be expected that they will take the lead in the technical and economic solution of their difficulties, invoking the assistance of new legislation if necessary.

Contain Population

Those provinces contain the bulk of Canada's population and manufacturing plants, therefore, they will benefit most from any savings which can be accomplished. We can learn many lessons in the economic use of domestic fuel from countries like Norway and Sweden which must import from foreign countries the bulk of their coal and coke.

When we consider the number of combinations which are possible of different primary products, if the temperature and pressure can be varied it is obvious that a great amount of work can be done usefully in following up the distillation of coal.

Great progress may be expected along these lines and greater developments than any heretofore accomplished. For the present let us assist the national welfare by advocating the wider use of those fuels derived from a lump of coal by distillation for reasons of economy, efficiency, expediency and hygiene.

FACTS YOU SHOULD KNOW ABOUT STEAM GENERATION

(Continued from page 29)

865 B.t.u. and $q_1 = 330$ B.t.u. From data given above—$r_2 = 972$ B.t.u. and $q_2 = 180$ B.t.u. From the thermometer reading ts = 262 deg. Substituting these values in the formula and solving, we have

$$x = \frac{972 + 180 + 0.47(262 - 212) - 330}{865} =$$

0.965 or 96.5%. That is, the steam contains 100—96.5 = 3.5% of moisture.

When the amount of entrained moisture exceeds the limits of the throttling calorimeter, the separating calorimeter should be used. This is shown in section in Figure 5 and is in effect a small separator which mechanically separates the entrained water from the steam and collects it in a reservoir "A," where its weight may be indicated by a graduated gage glass. or it may be drawn off and weighed. The weight of dry steam passing from the calorimeter in a given time through the orifice "B" may be determined by knowing the area of the orifice and the pressure in the chamber "C."

This type of instrument is often provided with a pressure gage graduate to show the weight of steam passing through the orifice in pounds per unit of time. Knowing the weight of water collected in the reservoir in a given time, and the rate of steam flow through the orifice, it is a simple matter to compute the quality of the steam.

HOW TO REPAIR ELECTRICAL INSTRUMENTS

(Continued from page 31)

5.268 Mmg. for 360 degrees, and these are the terms in which the spring should be ordered from the manufacturer.

If it is desired to increase the instrument capacity 100 per cent. then springs one-half as strong or 2.635 Mmg. should be ordered or if it is desired to decrease the capacity to one-half, then springs twice as strong or 10.536 Mmg. should be obtained.

This discussion of course refers only to instruments in which torque is proportional to the current or voltage applied. If a dynamometer type meter is used, the torque increases as the square of the current or voltage and in changing the capacity, the torque at the desired current or voltage calculated.

For instance, if we have a five ampere induction type instrument and wish to change the full scale capacity to six amperes due to an increase in load, assume that the full scale torque (300 degrees) is 12 Mmg., then the torque at five amperes, would be

$$(5)^2 : (6)^2 = 12 : X$$

Solving this would give 17.3 Mmg. But this is for 300 degrees. Consequently the torque for one revolution, or 360 degrees, would be

$$300 : 360 = 17.3 : X$$

Solving this, would give 20.7 Mmg., which is the strength of spring to be ordered from the factory.

Rewind Main Coil

Care must be taken in changing capacities that the winding is not overloaded. If great changes are to be made, the main coil should be rewound. When lowering a capacity, care must be taken not to put a very weak spring in the instrument as the friction may cause very unsatisfactory results.

In actual operating practice there are two kinds of errors in any instrument; first, errors of observation due to parallax, width of divisions, etc., which are a percentage of the full scale and independent load; second, errors caused by calibration or effects which vary the constants of the instruments, which are percentages of the actual readings.

For simplicity, however, the accuracy at all points of the scale of electrical instruments is stated merely as a percentage of full scale capacity; therefore, the percentage of reading error increases as the load is decreased.

Electrical measuring instruments are necessarily delicate mechanisms which require care in handling and correct installation to avoid damage and to obtain accurate and reliable results.

It is important, however, to distinguish between the qualities which produce the highest accuracy necessary in laboratory instruments and the quality of ruggedness which is of greater importance in switchboard instruments. For this service what is desired is not so much an instrument which is accurate within a fraction of a per cent. when installed, as one which will retain a fair degree of accuracy, as for example, within two per cent., indefinitely, an instrument which will withstand the conditions met with in service and one which can easily be repaired if damaged.

DIESEL OPERATION

Most Diesel engines run best with a clearance of 0.004 to 0.006 inch between the shaft and top bearing shell. This should be checked at intervals by means of lead wires placed on the shaft before the bearing cap is pulled down. It is necessary to draw the cap snug. Upon removal the thickness of the wire will indicate the clearance. If excessive, part of the shims should be removed. With pressure oiling systems the shims must fit the shaft very snugly at each end of the bearing.

DIESEL ENGINES

The distinguishing feature of the Diesel engine is that the air charge is compressed to a high pressure such that the resulting temperature of the air is above the self-ignition point of the fuel oil. As a consequence the oil when introduced into the cylinder is ignited by the high temperature. The fuel is introduced at such a rate that the pressure does not rise above the compression pressure.

Originally Dr. Diesel contemplated introducing the oil at a rate that allowed the heat created by the burning fuel to just equal the work done on the piston. If this had been possible, the temperature during combustion would have been constant. As it is, the temperature rises while the pressure is either constant or experiences a slight drop.

For this reason the Diesel engine is known as a constant pressure engine; i.e., heat admission at constant pressure. The exhaust or heat discharge is theoretically at constant volume, although part of the heat is thrown out during the exhaust stroke at constant pressure.

The Universal Oil Burner Co., Windsor, has been incorporated for $40,000 to manufacture oil burners, by Norman A. McLarty, Albert Eastman and Mary Cooke.

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads set in border, are at the card rates.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you witb your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines; UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see thu books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________________

Occupation ____________________

Employed by ____________________

Residence ____________________

Reference ____________________

Consult
Buyers' Guide Pages
50 - 52 - 54

POSITIONS WANTED

NIGHT ENGINEER WITH 3rd CLASS CERTIficate. Must be widower or bachelor and good worker. Apply Box 118, Power House.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—with house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

POWER PLANT FOR VILLAGE OF TIGNISH About 18 kil. hour capacity 110 to 220 volting alternating current. Apply to John A. Hackett, Box 67, Tignish, P. E. I.

PISTON RINGS

EVER-TYTE and ZELCO Piston Rings with Patented Zelco Process Save Gasoline, Oil, Increase Capacity, Prevent Cylinder from Wearing Out of Round, Lessen Carbon; after using, make arrangement with us to sell them; made up to 80-inch; used in Locomotives, Boats, Engines, Compressors, Ice Machines, Autos, Trucks, Tractors, etc.; are looking for distributors with mechanical knowledge; all or part time; real opportunity. Ever-Tyte, St. Louis, Mo.

EQUIPMENT FOR SALE

FOR SALE—ONE CANADIAN GENERAL belt driven, direct current generator, 115 to 125 volts, capacity 360 amperes, speed 975 R.P.M's.; also a quantity of used shafting and pulleys. Apply to Box, Power House.

SAW MILL MACHINERY FOR PORTABLE medium and heavy mills, band or circular; we build everything for the saw mill from haul-up to sorting table. The Waterous Engine Works, Ltd., Brantford.

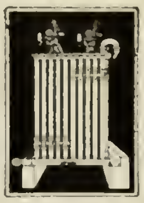
TAYLOR SAFE FOR SALE—INSIDE DIMENsions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110 Power House

For Quick Sale

Self-oiling high speed engine, single cylinder, 17 in. bore x 16 in. stroke Engine develops 200 H.P. when running at 235 R.P.M. with 100 lbs. steam pressure. There are two heavy leather belts 18 in. wide. The engine has two fly-wheels, each 78 in. diameter x 18 in. face. Apply Box 112, Power House.

M. BARRY WATSON
B. A. Sc., C. E., M. E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W

J. A. BURNETT,
M.E.I.C., P.E.Q.
CONSULTING
& APPRAISAL
ENGINEER
Room 301—205 St. James St.
Telephone Main 6737. Montreal.



A Fuel Economizer PLUS

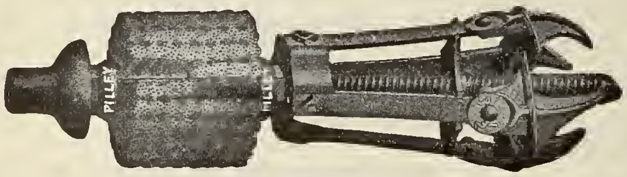
The Sturtevant Fuel Economizer's most important function is to save fuel, and this it does in a very effective manner. But additionally gratifying are the five other distinct savings that are just as positively provided.

Full details in Folder 609.

B. F. STURTEVANT CO.
of Canada, Limited
Montreal Galt Winnipeg Toronto

HINTS TO BUYERS

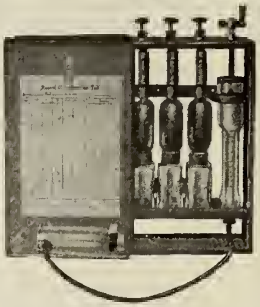
The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo
Eastern Office: 71 Fulton St., New York.



Hays Improved Gas Analyzer

Hays Improved Gas Analyzer

compact — rugged — accurate, employs the Hays patented steel wool method of breaking up the gas and presenting a large absorption surface—the most accurate and rapid known. CO2 analysis can be made in 30 seconds, complete analysis for CO2 O2 and CO in 4 minutes.

No troublesome pinch clamps and rubber connections, no glass cocks to stick. We use a special needle valve with renewable seat.

Neat leather carrying cases for Consulting and service engineers.

Better send for Literature.

AGENTS: P. A. Goepel, Vancouver, B.C.; Wm. A. Goold, Winnipeg, Man.; H. N. Brown, New Glasgow, N.S.; General Engineering Co., Reg'd., Montreal, Que.; The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
1034 E. Eighth Street
MICHIGAN CITY, INDIANA

McDaniel Improved STEAM TRAP

FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

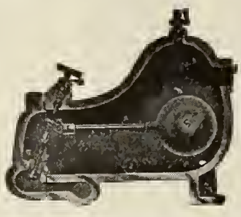
May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Heads
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.



Read "Power House"
for
Articles of Merit on
Refrigeration, Equipment
and Management

BOICO BOILER COMPOUND

routs the most stubborn cases of boiler formations, quickly, thoroughly and economically. Hurts nothing but scale.

ANTI-CLINKER SHELL BAR GRATE

Ample air space gives perfect combustion ensuring maximum heat, without waste, from the last bit of fuel.

ONE-PIECE JOINTLESS FURNACE LINING

"Plibrico" gives your furnace greater resistance. Lasts longer and installed quicker than brick.

TIP-IT PATENT WELDING PROCESS

Tools with shanks of carbon and high-speed steel tips save time and money.

SHELL-BAR BOICO
Supply, Limited
1-15 Saunders Ave., Toronto

Sales Agents: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

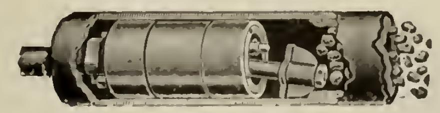
CARHARTT

FROM MILL TO MILLIONS
CARHARTTS
TRADE MARK

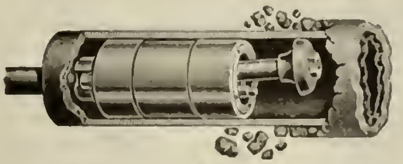
HEAVY TYPE
MASTER CLOTH

OVERALLS

It Will Cost You Nothing—



For removing scale from Water Tube Boilers.



For removing scale from Return Tubular Boilers.

and won't obligate you in any way to have us send an engineer to demonstrate at your own plant the fact that the DEAN BOILER TUBE CLEANER settles the boiler scale question once and for all.

The "DEAN" method is recommended by the highest authorities in boilers in the province. Let us either ship you a Dean Boiler Tube Cleaner on trial, give you a free demonstration in your own plant, or Clean Your Boilers by Contract (distance no object).

Write or phone us for a list of satisfied users.
We have over 100 references in Toronto alone.

GEO. FARROW & SON 17-19 Victoria Blvd. Mount Dennis **TORONTO**
NIGHT, SUNDAY AND HOLIDAY SERVICE
Telephone Adel. 1135

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you.

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

EDWARD

Most vital part positively protected against cutting action by the EDWARD Protected Seat and Disc.

Write for catalogue describing the EDWARD line.

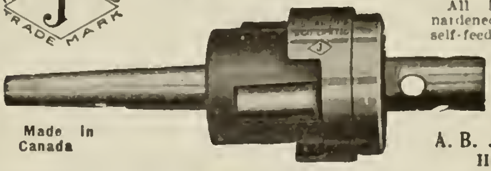
THE EDWARD VALVE & MFG. CO.
General Office and Works: East Chicago, Indiana.

CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal; Valve Engineering Co., Toronto.

VALVES

Jardine's Self-feeding Tube Expanders

REGISTERED J TRADE MARK



All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co., Ltd
Hespeler, Ont.

EMERGENCY WORK OVER THE WEEK-END OR AT NIGHT
REPAIRS TO BOILER PLANTS--BOILER SETTINGS. EQUIPMENT--PIPING

Oil Burning Systems Installed

Full line of Power Plant Equipment and Supplies.

LAURIE ENGINE CO.
(The Service Engineering Co., of Canada.)
601 NEW BIRKS BLDG., MONTREAL

BOILER SETTINGS
SPECIALISTS IN
FIREBRICK AND ARCHWORK
FOR EVERY TYPE OF STEAM BOILER

A. E. RULE CO'Y.
122 Garden Av. TORONTO Lakeside 1274

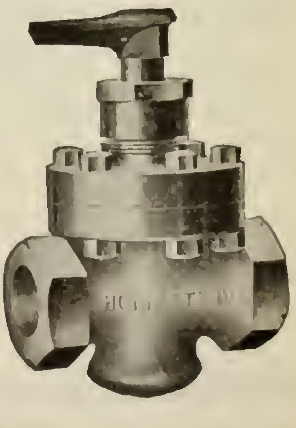
INVESTIGATE THE
ADVERTISEMENTS
APPEARING IN EVERY ISSUE OF
POWER HOUSE

NORTHERN CRANE WORKS, LTD.
Walkerville, Ont.

Direct and Unrestrained Flow
With Simplicity and Durability
Features of HOMESTEAD VALVES

The harder the service the more you need Homestead Quarter-Turn Valves. They always stay tight—because of their seatless construction. For safety, reliability, tightness under all conditions, and simplicity in operation, Homestead Quarter-Turn Valves are unequalled. Made in straightway, threeway and fourway patterns; the illustration shows the straightway style. Write for valve catalog.

HOMESTEAD VALVE MFG. CO., Homestead, Pa.
NEW YORK OFFICE - 242 LAFAYETTE ST.



Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
H. Mueller Mfg. Co., Ltd., Sarnia, Ont.

AIR COMPRESSORS
Laurier & Lamb Co., Montreal.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal,
American Steam Pump Co., Battle Creek, Michigan.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto.

AIR FILTERS
Midwest Canada, Ltd., Montreal.

ALARMS (LOW WATER)
Bristol Co., Waterbury, Conn.
James Morrison Brass Mfg. Co., Ltd., Toronto.

AMMETERS
Bristol Co., Waterbury, Conn.

AMMONIA COMPRESSORS
The Vitter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

ASH CONVEYORS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal, Que.
Heat Automatic Damper Control.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BEARINGS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Supply Co., Montreal, Que.

BELT LACING
Bristol Co., Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
D. K. McLaren Ltd., Montreal.
Dominion Belting Co., Hamilton.
L. F. Smidth & Co., New York.

BELTING LINK
Can. Fairbanks-Morse Co., Ltd., Montreal.
Link-Belt Ltd., Toronto, Ont.

BELTING, ROLLER
Hans Renold of Canada, Ltd., Montreal and Toronto.

BELTING, RUBBER
Can Fairbanks-Morse Co., Ltd., Montreal.
Dunlop Tire & Rubber Co., Ltd., Toronto.
Gutta Percha & Rubber Co., Ltd., Toronto.

BLOWERS, TURBINE
Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton. New Jersey.
Turbine Equipment Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BLOWERS, FAN
De Laval Steam Turbine Co., Trenton, New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
Canadian Blower & Forge Co., Kitchener, Ont.
De Laval Steam Turbine Co., Trenton New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BOILER TUBE CLEANERS
Pilley Packing & Flue Brush Co., St. Louis, Mo.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd. Toronto.

BOILER COMPOUNDS
G. F. Sterne & Sons, Ltd., Brantford.
H. P. Stephens, Toronto.
Shell Bar Bolco Co., Toronto.
Refinite Co. of Can., Ltd., Toronto.
Kirby & Co., Toronto.

BOILER TUBES
Babcock & Wilcox, Ltd., Montreal.

BOILER SETTINGS
A. E. Rule Co., Toronto.
Beveridge Supply Co., Montreal, Que.
Gates Engineering Co., Ltd., Montreal.
Celite Prodcuts, Ltd., Chicago, Ill.
Shell Bar Boico Co., Ltd., Toronto.
Sterne & Sons, G. F., Brantford, Ont.
W. R. Sexton Boiler Setting Co., Toronto.

BOILERS, HEATING
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Waterous Engine Works, Brantford.

BOILERS, RETURN TUBULAR
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOILERS, VERTICAL WATER TUBE
Geo T. Ladd Co., Pittsburgh, Pa.

BOILERS, WATER TUBE
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOXES, STEEL, FOR ELECTRIC SERVICE
Canadian Drill & Electric Box Co., Ltd., Toronto.

BREECHINGS
Engineering & Machine Works of Canada, St. Catharines, Ont.

BRICK, FIRE
Goldie & McCulloch Co., Ltd., Galt, Ont.
Elk Firebrick Co., Ltd., Hamilton, Ont.
Sexton Boiler Setting Co., W. R., Toronto. Ont.

BRICK, INSULATING
Celite Products, Ltd., Chicago, Ill.

CABINETS, LIGHTING
Canadian Drill & Electric Box Co., Ltd., Toronto.

CALORIMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

CASTINGS, BRASS & IRON
Canadian Steam Boiler & Equipment Co., Ltd., Toronto.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Kerr Engine Co., Ltd., Walkerville, Ont.
Gollie & McCulloch Co., Ltd., Galt, Ont.

CASTINGS, GREY IRON
Velter Mfg. Co., Milwaukee, Wis.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CEMENT, ASBESTOS
Sterne & Sons, G. F., Brantford, Ont.

CEMENT, IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

CEMENT, FIRE BRICK
Sterne & Sons, G. F., Brantford, Ont.

CHAINS (See sprockets and chains)
Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, DRIVING
Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, ROLLER
Hans Renold of Canada, Ltd., Montreal and Toronto.

CIRCUIT BREAKERS
Dominion Engineering Agency, Ltd., Toronto.

COAL AND ASH HANDLING MACHINERY
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COAL CRUSHERS
Babcock & Wilcox, Ltd., Montreal.
Canada Stoker Company, Ltd., Toronto and Galt.
The Canadian-Fairbanks Morse Co., Ltd., Montreal.

COAL PULVERIZING EQUIPMENT
Combustion Engineering Corp., Ltd., Toronto.

COCKS, BRASS & IRON
Homestead Valve Mfg. Co., Homestead, Pa.
James Morrison Brass Mfg. Co., Ltd., Toronto.

COCKS, GAGE
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COCKS, STEAM
James Morrison Brass Mfg. Co., Ltd., Toronto.

CO2 RECORDERS AND FLUE GAS ANALYSIS INSTRUMENTS
Sarco Co., Inc., N. Y.
Foxboro Co., Inc., Foxboro, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal.

CONDENSERS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine, Toronto.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

CONDENSERS (JET)
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Galt, Ont.

CONDENSERS (SURFACE)
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CONVEYORS (SEE COAL AND ASH HANDLING MACHINERY)
Babcock & Wilcox, Ltd., Montreal.

COUPLINGS, FLEXIBLE SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

COUPLINGS, SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

CRANES
Babcock & Wilcox, Ltd., Montreal.
John T. Hepburn, Ltd., Toronto.

DEALERS (MACHINERY)
Can. Fairbanks-Morse Co., Ltd., Montreal.

DISTILLING APPARATUS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.

DISTRIBUTING BOARDS
Can. Drill and Electric Box Co., Ldt,. Toronto.

DRILLS
Can. Fairbanks-Morse Co., Ltd., Montreal.

EJECTORS
Laurie & Lamb Co., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ELECTRIC GENERATING SETS (STEAM ENGINE)
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton, Ont.
Laurie & Lamb Co., Moutreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC GEN. SETS—(Steam Turbine)
Can. General Elec. Co., Ltd., Toronto.
Can. Westinghouse Co., Ltd., Hamilton.
Laurie & Lamb Co., Montreal.
E. Laurie & Co., Montreal.
De Laval Steam Turbine Co., Trenton,
Turbine Eulpment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC MOTORS
Can. General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

ENGINES, DIESEL
Laurie & Lamb Co., Montreal.

ENGINES, CORLISS
Laurie & Lamb Co., Montreal.
Frick Co., Wanesboro, Pa.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, GAS & OIL
Laurie & Lamb Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, PUMPING
Laurie & Lamb Co., Montreal.

ENGINES, STEAM
Can. Sirocco Co., Ltd., Windsor, Ont.
Laurie & Lamb Co., Montreal.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ENGINES, UNA-FLOW
Vilter Mfg. Co., Milwaukee, Wis.
Frick Co., Waneaboro, Pa.

ENGINE REPAIRS
Goldie & McCulloch Co., Ltd., Galt, Ont.

EXPANSION JOINTS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FANS (SEE BLOWERS, FAN)
Can. Sirocco Co., Ltd., Windsor, Ont.

FEED WATER HEATERS
Arthur S. Leitch, Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Sims Company, Erie, Pa.

FEED WATER PURIFIERS
Sterne & Sons, G. F., Brautford, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

FILTERS, FEED WATER
Babcock & Wilcox, Ltd., Montreal.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

FILTERS, OIL
Babcock & Wilcox, Ltd., Montreal.
Turbine Equipment Co., Ltd., Toronto.

FILTERS, WATER
Laurie & Lamb Co., Montreal.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

FIRE BRICK ARCHES
Combustion Engineering Corp., Ltd., Toronto.

FITTINGS, AMMONIA
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

FITTINGS, PIPE
International Malleable Co., Guelph, Ont.

FITTINGS, STEEL
Reading Steel Casting Co., Bridgeport, Conu.

FITTINGS, CAST IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

FLOATS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FUEL OIL SYSTEMS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
T. J. Cunerty Co., Toronto.

FURNACES
Can. Sirocco Co., Ltd., Windsor, Ont.

FURNACE ARCHES, FLAT SUSPENDED
Canada Stoker Co., Ltd., Toronto and Galt.
Bell Fire Brick Co., Toronto.
Shell Bar Bolco Co., Ltd., Toronto.
Gates Engineering Co., Ltd., Montreal.

FURNACE LININGS
G. F. Sterne & Sons, Ltd., Brantford, Ont.

GAGE COCKS (SEE COCKS GAGE)
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASS GUARDS
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASSES
Durabla Mfg. Co., New York City.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, DIFFERENTIAL
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

GAGES, DRAFT
Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

FOR INSTANCE—

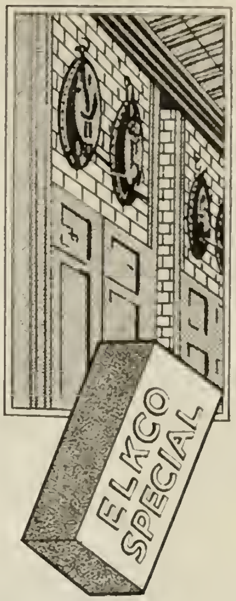
One large Canadian paper mill had this fire brick problem.

10 B and W boilers 500 H.P.; fired with fuel oil.

When this plant was built we recommended ELKO SPECIAL for this equipment.

They have had such complete satisfaction they have used ELK FIRE BRICK exclusively ever since.

This is only one little instance. Mill reference on request.



What's Your Problem?

Write for this—Refractory Efficiency Engineering

Elk Fire Brick Co. of Canada.
Hamilton, Ontario

Boiler Setting
Service

THE Gates Engineering Co., Limited, are in a position to contract for and specify on all boiler brick work with the least possible delay. Our Engineering Department is qualified to look after your interests, having made a close study of Combustion Problems.

Our Motto—Service and satisfied clients. The confidence of those who use Gates' Patented Air-Cooled Arch, etc., is unqualified, and is retained, because of the low maintenance cost and the guaranteed results.

Ask for our Descriptive Catalog.

Gates Engineering Co., Limited
314 Notre Dame Street W., Montreal

SIL-O-CEL
It's Insulation that does it

A TINY FLAME keeps the Eskimo's igloo warm and comfortable, despite the fact that the outside temperature may be many degrees below zero.

It's insulation that does it. Millions of microscopic air cells formed between the particles of tightly packed snow break up heat penetration and hold it within the hut. Large air spaces are not as effective, as the U. S. Bureau of Standards have decisively proved, and the perfect heat insulation only needs in addition to its countless minute air cells, a composition which withstands high temperatures, and sufficient structural strength.

All these requirements are found in SIL-O-CEL Heat Insulation—in world-wide service on all types of high temperature equipment. Tests by the Bureau of Standards prove it to possess a lower heat conductivity than any other insulation suitable for high temperatures. Furnished in forms which withstand without shrinkage, direct heats of 2000° F., SIL-O-CEL has ample structural strength, is easily applied and permanently effective.

A type for application to boilers, furnaces, ovens, kilns and similar heated units without change in design — Brick, C-22, Block, C-3, Powder, Cement.

Write nearest office for complete information given in Bulletin W-6C, or mail the coupon.

A CORRECTION

The crushing strength of SIL-O-CEL Insulating Brick was incorrectly reported in last month's advertisement as being 400 lbs. per square foot. This should read "400 lbs. per square *inch*" or 28 tons per square foot.

BARRIERS
SIL-O-CEL
FILTER-CEL
CELEITE
FRAXITE

CELITE PRODUCTS LIMITED
New Birks Building
Montreal, Que.

CELITE PRODUCTS COMPANY—
Gentlemen: Send blueprints and Bulletin W-6C on SIL-O-CEL
Heat Insulation for ______________________
(Give type of equipment)
Name ______________________
Company ______________________
Address ______________________

GAGES, PRESSURE

Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, RECORDING

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd.; Toronto, Ont.

GAGES, STEAM

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
Babcock & Wilcox, Limited, Montreal, Que.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, VACUUM

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, WATER

The Bristol Co., Waterbury, Conn.
The James Morrisson Brass Mfg. Co., Limited, Toronto, Ont.

GAS EXHAUSTERS

Can. Sirocco Co., Ltd., Windsor, Ont.

GASKETS

Jenkins Bros., Limited, Montreal, Que.

GEARS

E. Laurie & Co., Montreal, Que.
Turbine Equipment Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Limited, Montreal, Que.

GEARS, CUT

Hans Renold, of Canada, Ltd., Montreal and Toronto.

GEARS, ROLLER CHAIN

Hans Renold of Canada, Ltd., Montreal and Toronto.

GEARS, SILENT CHAIN

Hans Renold of Canada, Ltd., Montreal and Toronto.

GENERATORS, ELECTRIC

Laurie & Lamb Co., Montreal, Que.

GENERATORS, HOT WATER

The Sims Co., Erie, Pa.
Arthur S. Leitch Co., Toronto.

GOVERNORS, PUMP

Canada Stoker Co., Ltd., Toronto and Galt.
Northern Equipment Co., Erie, Pa.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

GRATES

Beveridge Supply Co., Montreal, Que.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Can. Steam Boiler Equipment Co., Ltd., Toronto, Ont.

GRATE BARS

Canadian Steam Boiler Equipment Co., Toronto, Ont.
Engineering & Machine Works of Canada, Limited, St. Catharine, Ont.
Babcock & Wilcox, Limited, Montreal, Que.
John T. Hepburn Ltd., Toronto, Ont.
Goldie McCulloch Co., Ltd., Galt, Ont.

GREASE EXTRACTORS

Babcock & Wilcox, Limited, Montreal, Que.

HEATERS, FEED WATER

Goldie & McCulloch Co., Ltd., Galt, Ont.

HEATING SYSTEMS

Can. Sirocco Co., Ltd., Windsor, Ont.

HOISTS, ELECTRIC

Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

HOPPERS, COAL & ASH

Combustion Engineering Corp., Ltd., Toronto, Ont.

HOSE, AIR

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

HOSE, RUBBER

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Babcock & Wilcox, Limited, Montreal, Que.

HOSE, STEAM

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

HOSE, WATER

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

ICE AND REFRIGERATING MACHINERY (SEE REFRIGERATING MACHINERY)

Jamieson Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
Can. Ice Machine Co., Toronto, Ont.
York Mfg. Co., York, Pa.
Frick Co., Waynesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.

INDICATORS, SPEED

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INDICATORS, STEAM ENGINE

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INJECTORS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

LUBRICATORS, CYLINDER

The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, FORCE FEED

The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, SIGHT FLOW

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

MACHINE WORK, SPECIAL

Engineering & Machine Works of Canada, Limited, St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

METERS, BOILER

Laurie & Lamb Co., Montreal, Que.

METERS, FLOW

Canada Stoker Co., Ltd., Galt and Toronto.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

OILING DEVICES

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PACKING, ASBESTOS

Durabla Mfg. Co., New York City.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.

PACKING, METALLIC

Laurie & Lamb Co., Montreal, Que.

PACKING, SHEET

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Durabla Mfg. Co., New York City.
The James Morrison Brass Mfg. Co., Ltd., Toronto Ont.

PACKING, VALVE STEM PIPE

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

PIPE, BRASS & COPPER

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE BENDING

Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE COILS

Can Ice Machine Co., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE CUTTERS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PUMPS, BOILER FEED

Albany Pump Co., Toronto.
American Steam Pump Co., Battle Creek, Mich.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CENTRIFUGAL

Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
E. Laurie & Co., Montreal, Que.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CONDENSER

Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

PUMPS, FORCE FEED

Laurie & Lamb, Montreal, Que.

PUMPS, OIL

Turbine Euipment Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Westco Mfg. Co., Toronto.

PUMPS, POWER

American Steam Pump Co., Battle Creek, Mich.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, ROTARY

Turbine Equipment Co., Ltd., Toronto, Ont. Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Westco Mfg. Co., Toronto.

PUMPS, STEAM

Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
John T. Hepburn, Ltd., Toronto, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
F. L. Smidth & Co., New York.
Turbine Euqipment Co., Ltd., Toronto, Ont.

"PUMPS-SUMP"

Albany Pump Co., Toronto.

PUMPS, TURBINE

Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto, Ont.

PUMPS, VACUUM

Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Young Pump Company, of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Arthur S. Leitch Co., Toronto.
Nash Engineering Co., (Hytor) South Norwalk, Conn.

PYROMETERS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

REFRACTORY MATERIAL

G. F. Sterne & Sons, Ltd., Brantford.

REFRIGERATING MACHINERY

Jamison Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.
Frick Co., Wanesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

REGULATORS, DAMPER, DRAFT & FAN

Laurie & Lamb, Montreal, Que.
Julian D'Este Company, Boston, Mass.

REGULATORS, FEED WATER

Canada Stoker Co., Ltd., Galt and Toronto.
Northern Equipment Co., Erie, Pa.

REGULATORS, TEMPERATURE

Sarco Co., Inc., New York.
The Bristol Co., Waterbury, Conn.
Julian D'Este Company, Boston, Mass.
The Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

REGULATORS, PRESSURE

The Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, AIR

Can. Sirocco Co., Ltd., Windsor, Ont.

SEPARATORS, AMMONIA

York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.

SEPARATORS, OIL

Anderson Co., V. D., Cleveland, Ohio.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, STEAM

Anderson Co., V. D., Cleveland, Ohio.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SMELTING LININGS

G. F. Sterne & Sons, Ltd., Brantford.

SODA ASH

G. F. Sterne & Sons, Ltd., Brantford. Ont.

SODA SILICATE

Diamond Specialty Mfg. Co., Windsor.

SOOT BLOWERS

Diamond Specialty Mfg. Co., Windsor.
Pilley Packing & Flue Brush Co., St. Louis, Mo.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SPRAY NOZZLES

Can. Sirocco Co., Ltd., Windsor, Ont.

SPROCKETS AND CHAINS

Hans Renold of Canada, Ltd., Montreal and Toronto.

STACKS, METAL

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STACKS, RADIAL BRICK

Combustion Engineering Corp., Ltd., Toronto. Ont.

STEEL PLATE WORK

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STOKERS, CHAIN & TRAVELING GRATE

Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que Que.

STOKERS, OVERFEED

Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.
Detroit Stoker Co., Detroit, Michigan.

STOKERS, UNDERFEED

Detroit Stoker Co., Detroit, Mich.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.

STOKERS, HAND OPERATED

Combustion Engineering Corp., Toronto, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

STRAINERS, WATER

Sarco Co., Inc., New York.

SUPERHEATERS

Babcock & Wilcox Ltd., Montreal, Que.
Goldie & McCulloch Co., Ltd., Galt, Ont.

SWITCHES, ELECTRIC

Canadian Drill & Electric Box Co., Ltd., Toronto.
Canadian General Electric Co., Ltd., Toronto.

TACHOMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Laurie & Lamb, Montreal, Que.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TANKS

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

THERMOMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

THERMOMETERS, FLUE GAS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

THERMOMETERS, RECORDING

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.

TRANSFORMERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

TRAPS, NON-RETURN

Anderson Co., Inc., V. D., Cleveland, Ohio.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Sarco Co., Inc., New York.

TRAPS, RADIATOR

Sarco Co., Inc., New York.

Twelve Good Reasons Why You Should Use "SAFETY" PLASTIC METALLIC PACKING

In Bulk.

1—The ease and quickness with which it is used.
2—No waste—all remnants used.
3—Lasts fully ten times as long as Fibrous packing.
4—Costs only one-third as much as other metallic packing.
5—Does not soil machinery—no friction.
6—Stands any pressure.
7—Unaffected by heat or cold.
8—Requires little lubrication.
9—Never becomes too hard.
10—Requires no change of stuffing box—fills the packing place by pressure.
11—It's a natural lubricator—holds no moisture.
12—Can't wear a rod and put it "out of true."

Guaranteed to last three years without renewal.

Send for full particulars, also about our "Safety" Superheat Sheet Packing.

In Cotton Tubes.

STEEL MILL PACKING CO. - WINDSOR, ONTARIO

ESTABLISHED 1899

AGENTS WANTED

PRATT & CADY VALVES

P. & C. Swing Checks are made in the regrinding type and with renewable asbestos, rubber or leather discs. They have a full port opening and may be used in either the vertical or horizontal position.

The Swing Type of check valve was first patented by Pratt & Cady in 1878.

Reading Steel Casting Co., Inc.
Pratt & Cady Division
General Sales Office: Bridgeport, Conn.
929 Connecticut Avenue

CANADIAN REPRESENTATIVES—CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.

BETSON'S PLASTIC FIRE BRICK

REG. U.S. TRADE MARK PAT. OFF.

Eliminate Loose Brick and Fallen Arches

by using BETSON PLASTIC FIRE BRICK for repairs and for building complete, seamless, monolithic furnace linings, including front and rear arches, side walls, bridge wall and baffles. No more Fallen Arches—No more In-leakage of cold air, but More Power with Less Expense.

Shipped either mixed ready for use, or dry to mix with water (the cost is the same), from our warehouses in principal cities.

Write for valuable booklet

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6 Rome, N.Y.
Canadian Distributors
INTERNATIONAL CHEMICAL CO.
26-28 Adelaide St., Toronto, Ontario, Canada.

EXTRAORDINARY BARGAINS

STEAM ENGINES

1 Goldie & McCulloch heavy duty, cross compound, latest type Corliss condensing engine with rope drive, line shaft pulley and idlers complete, equipped with Dean condenser. Cylinders are 20"x40"x42" stroke. Water heater included.
1 Robb-Armstrong, 18"x18" high speed automatic engine.
1 Robb-Armstrong 11"x14" high speed automatic engine, direct connected to a Westinghouse 70 k.w., 3 phase, 60 cycle, 220 volt generator, complete with exciter and marble control panel.
Also several smaller automatic engines and some air hoists from 4" to 10½".

CHAIN BLOCKS—
2 15-ton Herbert Morris chain blocks with trolleys.
1 10-ton Herbert Morris chain block with trolley.

WATER TUBE BOILERS--
2 250 h.p., 175 lbs. working pressure, government certificate. Everything complete and in first-class condition.

GET FULL PARTICULARS AND REMARKABLY LOW PRICES FROM

WILLIAM COATES
MAIL BUILDING PHONE GLAD. 1947 TORONTO, ONT.

Having Any Furnace Trouble

?

There's bound to be trouble in any furnace or fire-box soon after the edges of the brick start to disintegrate—it's the weakest spot. The only remedy is to eliminate all edges and build a one-piece lining with

STERNSON
No. 40 Monolith

A ceramic mixture of plastic and calcined refractories which can be molded into a jointless, gas-tight furnace or fire-box lining by inexperienced men. It is a positive protection up to 3,000 deg. F. as, when vitrified, it forms one great fire brick. The saving in price alone, compared with brick and mortar, is worth considering.

"Let a Technical Firm Do a Technical Job."

G. F. STERNE & SONS, LIMITED
Chemical Manufacturers,
Consulting Chemical Engineers.
BRANTFORD : : CANADA

Power House
Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

$2.00 PER YEAR — Every Power Plant employee should read Power House

TRAPS, STEAM
Can. Sirocco Co., Ltd., Windsor, Ont.
Farrfhern Steam Services, Ltd., Toronto.
Laurie & Lamb, Montreal, Que.
Sarco Co., Inc., New York.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TRAPS, VACUUM
Anderson Co., Inc., V. D., Cleveland, Ohio.

TUBE CLEANERS, BOILER
Pilley Packing & Flue Brush Co., St. Louis, Mo.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal, Que.

TURBINE BLADING
De Laval Steam Turbine Co., Trenton, New Jersey.

TURBINES, STEAM
Ioppus Engineering Corp., Worcester, Mass.
Laurie & Lamb Co., Montreal, Que.
E. Laurie & Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Arthur S. Leitch Co., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

TURBINES, WATER
De Laval Steam Turbine Co., Trenton, New Jersey.

UNIONS & UNION FITTINGS
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVE DISK
Kerr Engine Co., Ltd., Walkerville, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, AIR
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BACK PRESSURE
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jenkins Bros. Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BALANCED
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto.

VALVES, BLOW-OFF
Arthur S. Leitch Co., Toronto.
Babcock & Wilcox, Ltd., Montreal, Que.
Homestead Valve Co., Homestead, Pa.
Jenkins Bros., Ltd., Montreal, Que.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BRASS & IRON BODY
Reading Steel Casting Co., Bridgeport, Conn.
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BYPASS
Kerr Engine Co., Ltl., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, CHECK
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, EXHAUST RELIEF
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES FLOAT
The Fisher Governor Co., Inc., Marsballtown, Iowa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, GATE
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, GLOBE
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, HYDRAULIC
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, NON-RETURN STOP
Babcock & Wilcox, Ltd., Montreal, Que.

VALVES, SAFETY POP
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, PUMP
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, RADIATOR
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.

VALVES, REDUCING
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, REGRINDING
Jenkins Bros., Ltd., Montreal, Que.

VALVES, REGULATING
Northern Equipment Co., Erie, Pa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, RELIEF
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, SAFETY
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, STOP
Babcock & Wilcox, Limited, Montreal, Que.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, SUPER-HEATED STEAM
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Reading Steel Casting Co., Bridgeport, Conn.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, THROTTLE
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, VACUUM
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VENTILATION
Can. Sirocco Co., Ltd., Windsor, Ont.

WASHERS, AIR
Can. Sirocco Co., Ltd., Windsor, Ont.

WATER COLUMNS
The James Morrison Brass Mfg. Co., Toronto, Ont.

WATER SOFTENING APPARATUS
Laurie & Lamb Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Babcock & Wilcox, Ltd., Montreal, Que.
W. J. Westaway Co., Ltd., Hamilton, Ont.

WHISTLES
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

WRENCHES
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

U. S. Patent, 1,387,901.

Latest installation tool in air hammer for use on large jobs.

Condenser Packing

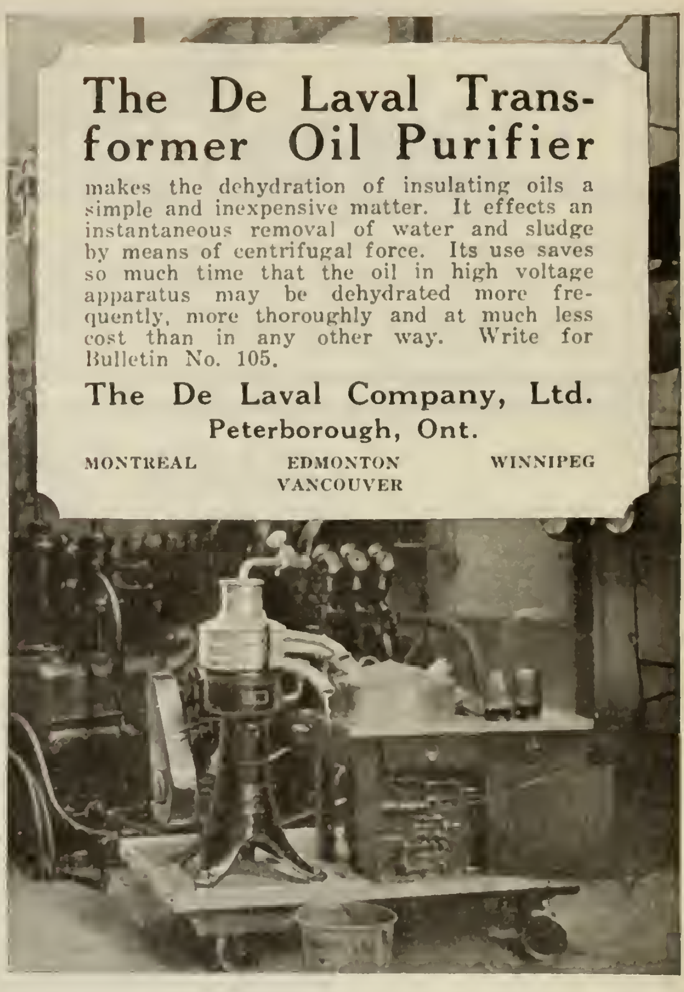
Hundreds of condensers in the United States and on the high-seas are now using "JOHN CRANE" Metallic Packing. Prevents failures due to electrolytic disintegration of tube ends, compression and lateral stresses.

WRITE:—Results of our very interesting analysis of this subject as accepted by condenser users and operators in book form sent upon request.

FLEXIBLE METALLIC PACKING CO.

WINDSOR, ONTARIO, CANADA.

BELDAM'S ASBESTOS Packing and General Manufacturing Company, Ltd., Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, British Columbia.



The De Laval Transformer Oil Purifier

makes the dehydration of insulating oils a simple and inexpensive matter. It effects an instantaneous removal of water and sludge by means of centrifugal force. Its use saves so much time that the oil in high voltage apparatus may be dehydrated more frequently, more thoroughly and at much less cost than in any other way. Write for Bulletin No. 105.

The De Laval Company, Ltd.
Peterborough, Ont.
MONTREAL EDMONTON WINNIPEG
VANCOUVER

The Cash Value of AIR

Write for bulletin describing highly developed Canadian Sirocco Equipment and its efficiency and economy when applied to any of the following lines:

- Mechanical Draft
- Heating and Ventilating
- Generator Cooling
- Air Washing
- Fans and Blowers
- Steam Engines

The Canadian Sirocco Company offers the co-operation of a competent engineering department for the solution of any Industrial problem involving the handling of air. Correspondence on any subject is invited.

CANADIAN SIROCCO CO., LTD., WINDSOR, ONT.
BRANCH OFFICES IN ALL PRINCIPAL CITIES

(333)

"Sirocco" Products

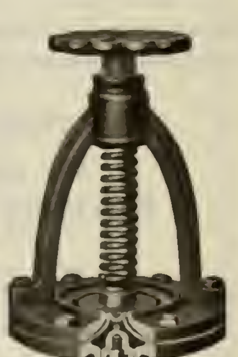
TRADE MARK

BLOWERS EXHAUSTERS VENTILATING
FANS · AIR WASHERS ENGINES

FOR HEATING, VENTILATING, DRYING,
AIR CONDITIONING, MECHANICAL DRAFT

CURTIS ENGINEERING SPECIALTIES

Comprise a line of devices that have stood the test of years for the utmost in efficiency. They are built for dependable and enduring service. Scrupulous care in the selection of material and in construction, with adherence to the highest engineering standards, have won them a commanding position. The



CURTIS WATER-PRESSURE REGULATOR

will deliver water into service pipes at any desired pressure, regardless of any fluctuations of outside pressure.

Trouble with rust or clogging with sediment is prevented. Waste of water in domestic use by flying or spattering is avoided by the reduced pressure. This also prevents water hammer or concussion and prevents wear and tear on all packings and seats in valves and faucets, thus eliminating frequent plumbing bills. Adapted for use in pulp and paper mills, hotels, public buildings and dwelling houses. For ¾ in. to 2½ in. pipe, screwed. For 3 in. to 8 in. pipe flanged.

The Curtis Line of Steam Specialties contains many other notable devices. They are fully described in our No. 50 catalogue. Write for a copy.

JULIAN D'ESTE COMPANY
26 Canal Street, Boston, 14, Mass.

Established 1907 **POWER HOUSE** Member A.B.C.

B. G. NEWTON, Manager
S. S. MOORE, Advertising Manager

CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740. **Montreal:** A. E. Guidal, 128 Bleury St., Tel. Plateau 946. **Winnipeg:** 810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—**New York:** J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. **Chicago:** A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. **Boston:** C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—**London:** The MacLean Company of Great Britain Limited. 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada, $2.00; United States $2.50; Great Britain and other countries in Postal Union, 14s. per year. Australia and other countries not in Postal Union, 19s. per year.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

Anderson Co., V. D. 10
Armstrong Cork and Insulation Co., Ltd. 16
Audel Co., Theo. 47
American Steam Pump Co..... 6
American Schaeffer & Budenburg Corp. 9
Babcock & Wilcox 43
Beston Plastic Fire Brick Co... 53
Bristol Co., The 18
Buyers' Directory 50, 52, 54
Bird-Archer Co., The 4
Burnett, J. A. 47
Can. Fairbanks-Morse Co. 8
Can. Ingersoll-Rand Co. 17
Celite Products 51
Classified Adv. Section 47
Conveyors Corp. of America ....Front Cover
Can. Sirocco Co. 55
Carhartt Co., Hamilton......Inside Front Cover
Crane, Ltd. 48
Crane Packing Co. 55
Coates, Wm. 53
DeLaval Steam Turbine Co..... 12
DeLaval Co., Ltd., The 55
Dart Union Co., Ltd., The 56
D'Este Co., Julian 55
Diamond Specialty, Ltd. 12
Durabla Mfg. Co. 8
Elk Fire Brick Co. 51
Engineering & Machine Works of Canada 2
Edward Valve Mfg. Co. 49
Foxboro Co. 45
Flexible Metallic Packing Co... 55
Frick Company 16
Farrow & Son, Geo. 49
Garlock Packing Co. ....Inside Back Cover
Garth Co., The 48
Goldie & McCulloch Co. 20
Greene, Tweed & Co. 3
Gutta Percha & Rubber, Ltd... 11
Green & Sons, Ltd., E. 6
Gates Engineering Co. 51
Hints to Buyers 48
Hepburn, John T., Co. 10
Hays Co., Jas. W. 48
Homestead Valve & Mfg. Co... 49
Jardine, A. B. 49
Jenkins Bros. 13
Jointless Firebrick Co. 14
Kerr Engine Co. 14
Laurie Engine Co. 49
Laurie & Lamb 4
McLaren, D. K., Co. 7
Magnolia Metal Co. 14
Moncrieff, Ltd., John 15
Morrison Brass Mfg. Co., Jas Outside Back Cover and Page 19
Northern Crane Works 49
National Exposition of Power and Mechanical Engineering. 9
Pilley Packing & Flue Brush Mfg. 48
Pratt & Cady Co. 53
Reading Steel Casting Co. 53
Refrigeration Dept. 15
Refrigerating Engineers 15
Rule, A. E. 49
Smooth-On Mfg. Co. 10
Superheater Co. 56
Sturtevant & Co., Ltd., B. F. 47
Shell Bar Boico Co. 48
Sterne & Sons, G. F. 54
Stephen Chemical Co. 49
Steel Mill Packing Co. 53
Underfeed Stoker Co. of Canada, The 5
Wall, W. J. 15
Waterous Engine Works Co. .. 1
Watson, M. Barry 47
Watson & McDaniel Co. 48
Wilson & Sons, J. L. 15
Yarnall-Waring Co. 18
York Mfg. Co. 15

Bronze to Bronze **DART** **At the Joints**

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

SUPERHEATERS ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA **THE SUPERHEATER CO., LIMITED,** **Transportation Bldg., Montreal** **WORKS AT SHERBROOKE, QUE.**

Are You Getting Service?

— If not —

This

Trade Mark

REG. U.S. PAT. OFFICE

Stands for

Service

And Service Means

Dependability — Durability
Efficiency — Economy
Quality — Satisfaction

THE GARLOCK PACKING COMPANY, HAMILTON, ONTARIO

Branches:

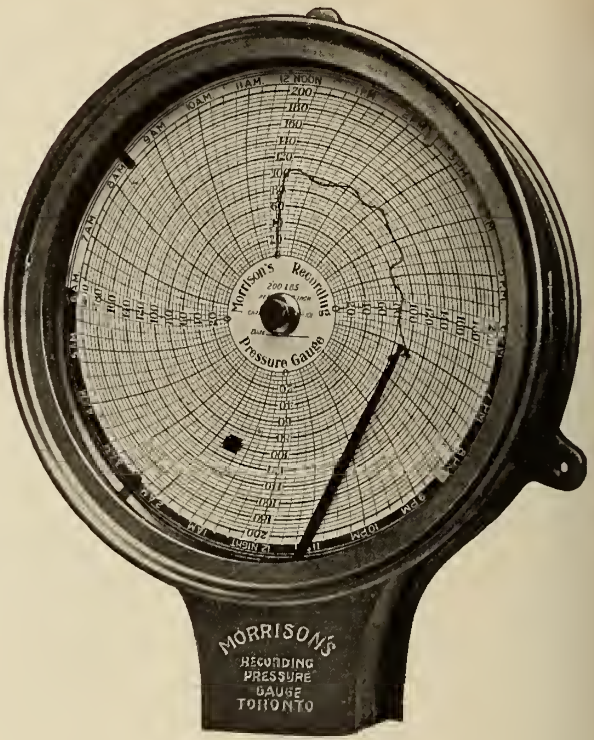
Montreal, Que.
Calgary, Alta.

Toronto, Ont.
St. John, N.B.

Winnipeg, Man.
Vancouver, B.C.

Don't waste your fuel

Morrison
RECORDING
Pressure Gauges



remove the worries of "trying to keep track" from the shoulders of the busy executive.

To the plant superintendent Morrison Recording Pressure Gauges are a simplified form of cost accounting. To the fireman they are a true guide to economical firing. They are indispensable to both.

All steam pressure variations that occur for every hour of the day are indicated with precision on easily read charts. The fireman can tell immediately when more coal is required or other attentions needed. Consequently all waste is cut to the lowest figure.

In choosing Pressure Gauges always specify **"Morrison's"**. There's nearly half a century's experience at your disposal. Write us for further particulars.

Other lines we manufacture are Valves, Injectors, Ejectors, Inspirators, Clocks, Whistles, Bells, Pipe Fittings, Lubricators, etc.

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Company Limited

93-97 Adelaide St. W. - TORONTO

POWER HOUSE

Fostering Economy in Steam, Oil and Hydro-Electric Power Development

Vol. XVI—No. 22

Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.

November 20, 1923

A Jenkins Disc is Quickly Renewed

—without removing valve from line

A Jenkins Disc in a Jenkins Valve is the right combination—a tight-closing valve is assured. The disc has very long life and, when necessary, it can be quickly renewed with the valve left in the line.

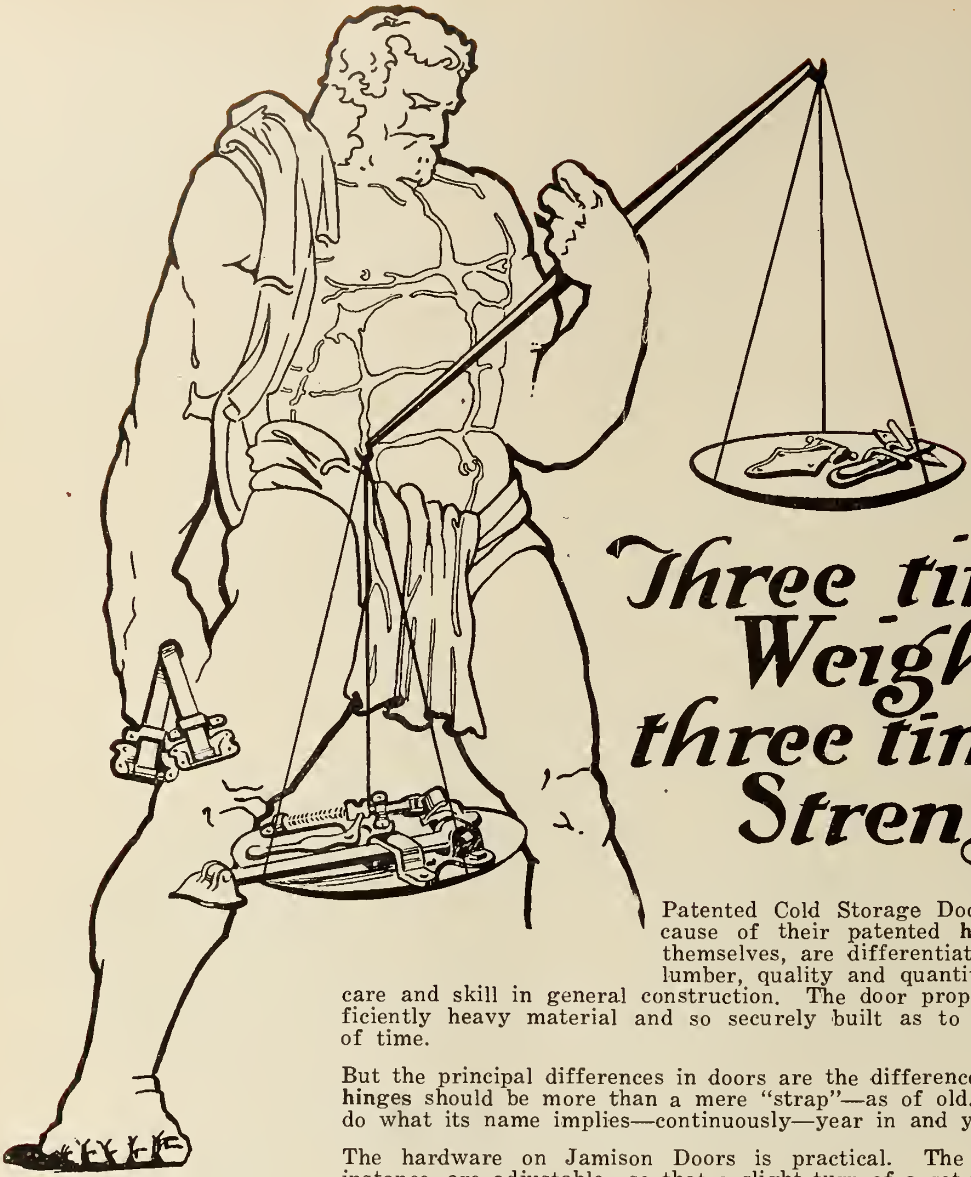
The compositions of the various Jenkins Discs are the result of constant study and 58 years' experience in disc manufacture. Each is exactly suited to the particular service for which it is intended.

Use the disc ONLY in the particular service for which it is recommended. If in doubt as to the kind of disc you need, let us know what work it is intended to do, and we will recommend the right one or prepare a special composition to suit your requirements.

JENKINS BROS., LIMITED
HEAD OFFICE AND WORKS: 103 St. Remi St., Montreal
SALES OFFICES: Toronto, Vancouver
EUROPEAN BRANCH: London, W.C. 2, Eng.
FACTORIES: Montreal, Bridgeport, Elizabeth

A Jenkins Valve fitted with a Jenkins Disc—assurance of perfect valve performance.

Always marked with the "Diamond"
Jenkins Valves
SINCE 1864



Three times the Weight— three times the Strength!

Patented Cold Storage Doors are so-called because of their patented **hardware.** Doors, in themselves, are differentiated by the quality of lumber, quality and quantity of insulation, and care and skill in general construction. The door proper should be of sufficiently heavy material and so securely built as to withstand the grind of time.

But the principal differences in doors are the differences in hardware. The **hinges** should be more than a mere "strap"—as of old. The **fastener** must do what its name implies—continuously—year in and year out.

The hardware on Jamison Doors is practical. The Spring Hinges, for instance, are adjustable—so that a slight turn of a set-screw will keep them 100% efficient—as good as new—by forcing the door tight against its seals of contact. The fasteners are "sure"—they eliminate any possibility of rebound through compression when the door is **slammed.** In fact, the **harder** the slam, the **tighter** it grips.

These patented features are perfect—proven so for 17 years. Probably one reason they stand the gaff so successfully is because of their **weight.** Experience tells that science combined with strength always wins. Which brings us to this: the hardware on Jamison Doors is **three times the weight** of hardware on other doors.

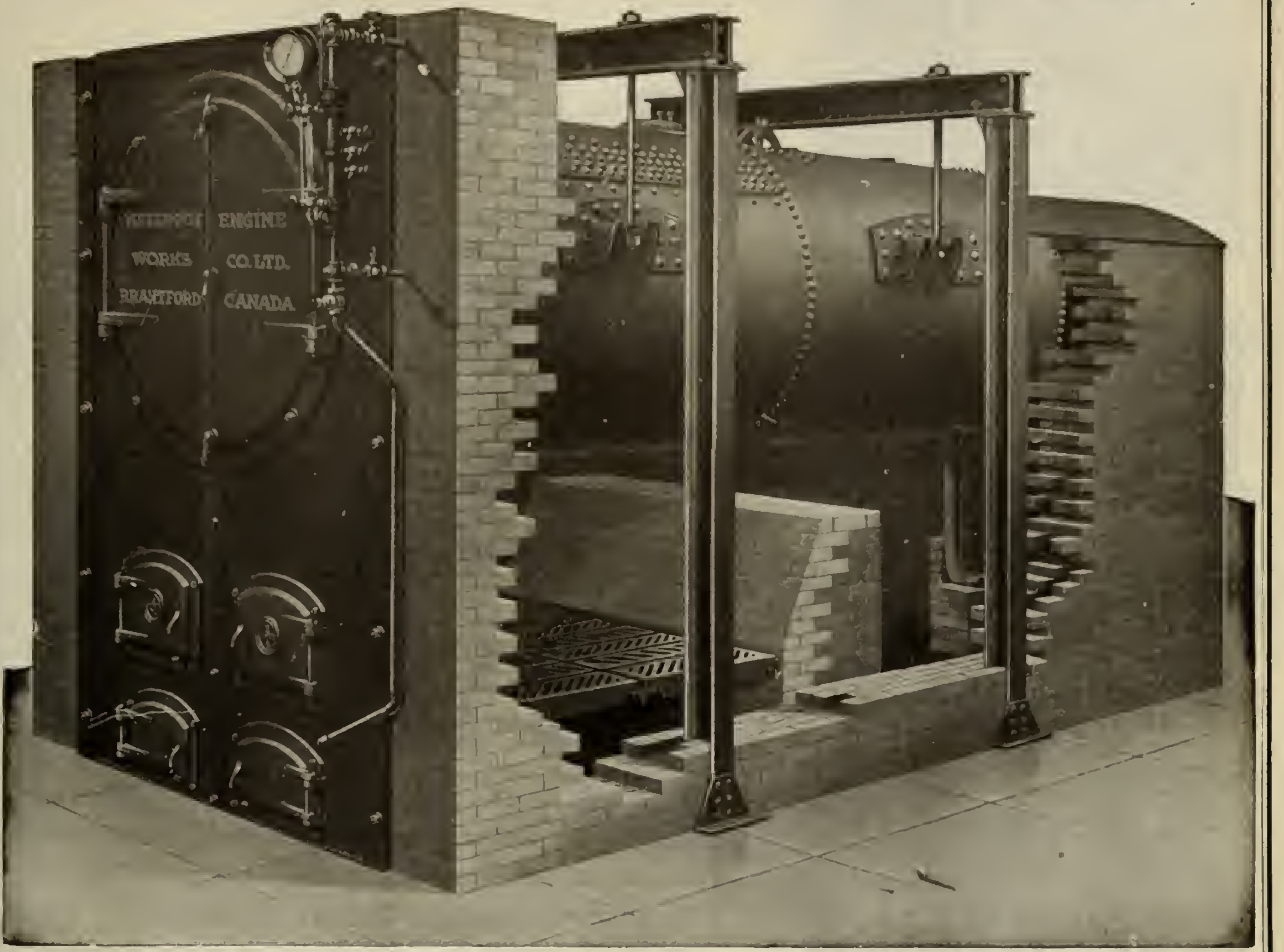
Learn all about Jamison Products. Write for our Catalogue No. 10. You'll find it interesting. Address Desk No. 11.

JAMISON COLD STORAGE DOOR CO.

Hagerstown, Md., U.S.A.

Jamison Doors

for better refrigeration



BOILERS

All Types - All Sizes

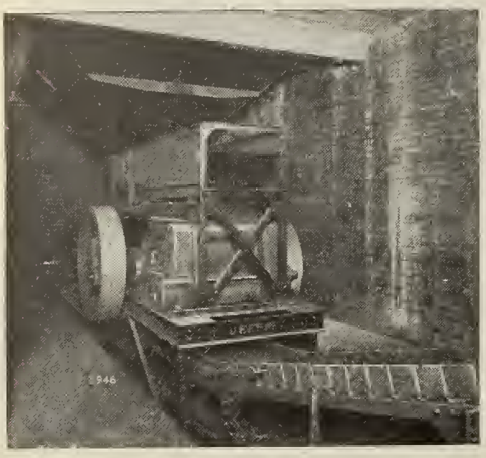
We Also Manufacture

- Pressure Tanks
- Storage Tanks (*Rivetted or Welded*)
- Bins
- Stacks
- Steel Plate Work of all Kinds
- High Speed Automatic Engines
- Heavy Duty Mill Engines
- Portable Engines
- Stationary Engines
- Power Transmission Machinery
- Gray Iron Castings up to 15 tons

Waterous

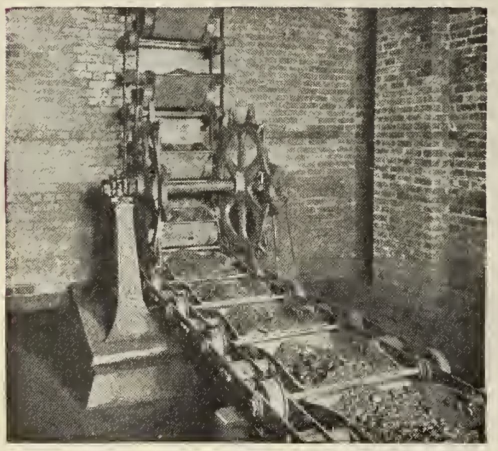
BRANTFORD, ONTARIO, CANADA

When Your Coal Comes Here's The Way To Handle It



Here is pictorial evidence of how hundreds of large and medium sized power plants are handling their coal expeditiously, mechanically, and at lowest cost.

From Gondola Car to Receiving Hopper—to Reciprocating Plate Feeder—to Single Roll Crusher (which reduces coal to desired stoker size)—to Apron Conveyer—to Pivoted Bucket Carrier—to Bunkers. (The carrier also distributes ashes to bin or railroad cars.)



If the capacity of your plant does not justify the use of a Pivoted Bucket System, there are other types of Jeffrey Coal and Ashes Equipments to fit the requirements and conditions.

Our trained Engineers are at your service to assist in the selection of the equipment you could most profitably install.

The Jeffrey Manufacturing Co.
Canadian Branch and Warerooms, Montreal

JEFFREY
MATERIAL HANDLING MACHINERY

CANADIAN ALLIS-CHALMERS

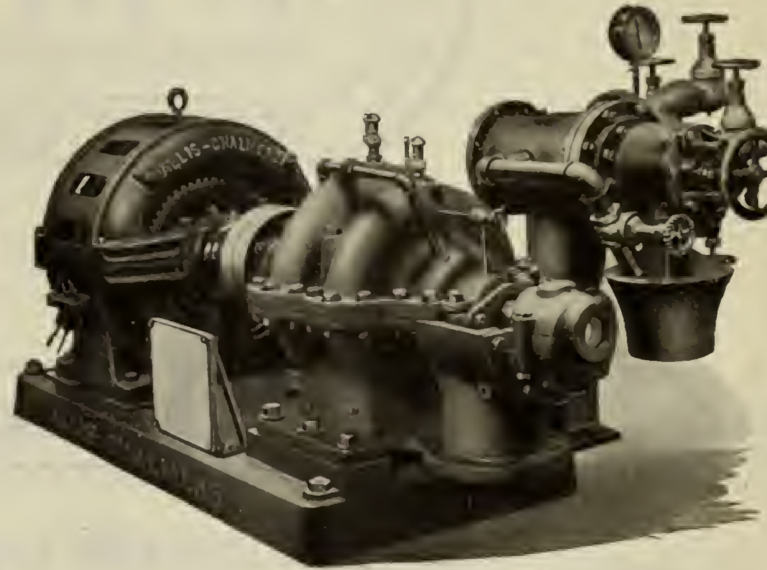
Underwriters

Centrifugal Fire Pumps

These pumps are built in four sizes, viz.,

500—750—1,000—1,500
U.S. G.P.M.

They are for operation at 100 lbs. per square inch and may be driven by various means, such as Electric Motors, Gasoline Engines, etc., etc.



1000 Gal Pump and Motor, showing complete fire fittings.

THESE pumps comply with the "National Standard" specifications; have been approved by the Underwriters Laboratories and the Associated Factory Mutual Fire Insurance Companies in the 1,000 G.P.M. size.

We shall be pleased to furnish specifications for complete units and prices upon request.

We Carry a Number of These Sizes in Stock and Can Make Prompt Shipment.

CANADIAN
ALLIS-CHALMERS
PRODUCTS
Hydraulic Turbines
Centrifugal and Steam Pumps
Steam Power Plant Equipment
Mining Machinery
Crushing and Cement Machinery
Flour and Saw Mill Machinery

CANADIAN ALLIS-CHALMERS LIMITED

Head Office—KING AND SIMCOE STREETS, TORONTO

BRANCH OFFICES: HALIFAX, SYDNEY, ST. JOHN, MONTREAL
QUEBEC, OTTAWA, HAMILTON, LONDON, WINDSOR, COBALT, SOUTH PORCUPINE
WINNIPEG, CALGARY, EDMONTON, VANCOUVER, NELSON AND VICTORIA

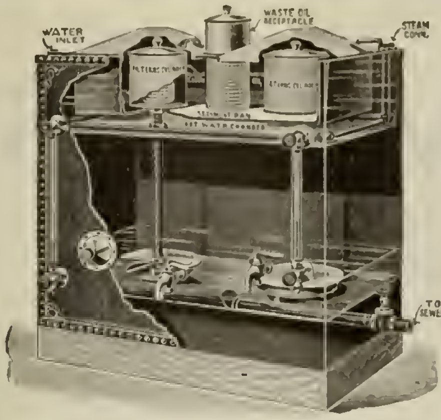
GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast



BURT OIL FILTER

Dirty oil enters waste oil receptacle and passes through small perforations, flowing thence horizontally to the two filtering cylinders. Heavy impurities fall by gravity into sediment pan and do not clog up filtering cloths. Each cylinder wrapped with cloth through which oil must pass before entering filtering cylinder. Oil passes through animal bone black, and down through the two tubes into bottom of filter. Oil is spread out in thin film by means of plates attached to bottom of tubes, and is thoroughly washed by water. Any remaining impurities in the oil drop to the bottom of the filter and can be flushed out when desired by opening gate valve which connects with sewer.

Oil costs cut 50% by Filtration

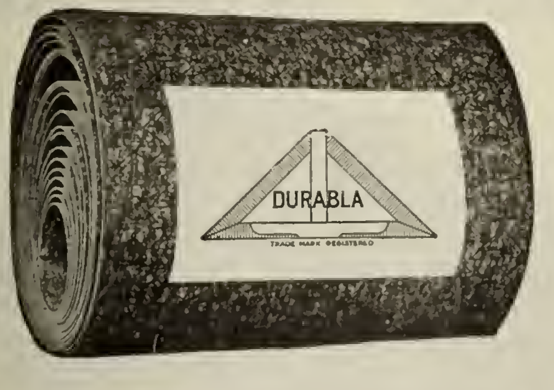
1. Oil Filters can be supplied in capacities from 5 gallons per 24 hours up.
2. Capacity can be increased at any time by adding additional units.
3. Filters can be used with or without an oiling system.
4. Guaranteed to clean heavy as well as light oils.
5. The result of many years' experience in building thousands of Oil Filters.
6. Will save 50% of oil consumption as oil can be used many times.

The Canadian
FAIRBANKS - MORSE CO.
LIMITED

St. John Quebec Montreal Ottawa Toronto Windsor
Winnipeg Regina Calgary Vancouver Victoria

103

Durabla Gaskets Make Tight Joints



Withstanding all Temperatures and Pressures

Wherever a permanent Gasket is required, use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids.

Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla Trade Mark which guarantees strength and quality.

Made in Canada in Stock Sizes 36" wide x 150" long, in thicknesses of 1/64, 1/32, 1/16, 1/8".

Let us send you a trial shipment

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

BOILER CHEMICALS

Made in Canada for You

Do it Now

Not a hit-and-miss ready-made compound, but made for you on scientific principles.

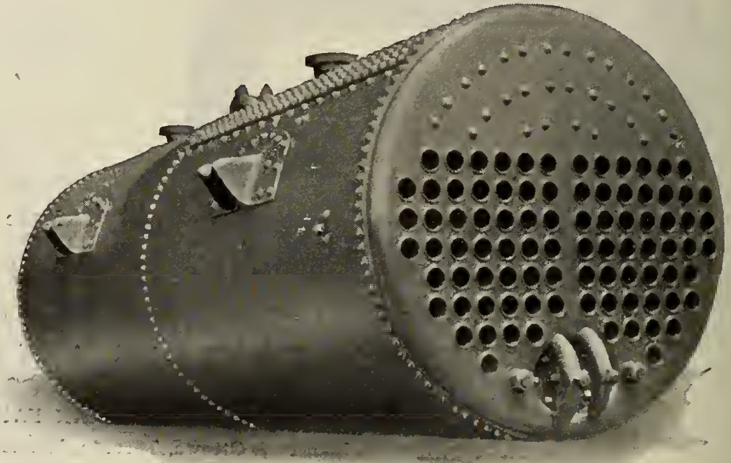
Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal **Factory: Cobourg**

Buy your new Boiler from us

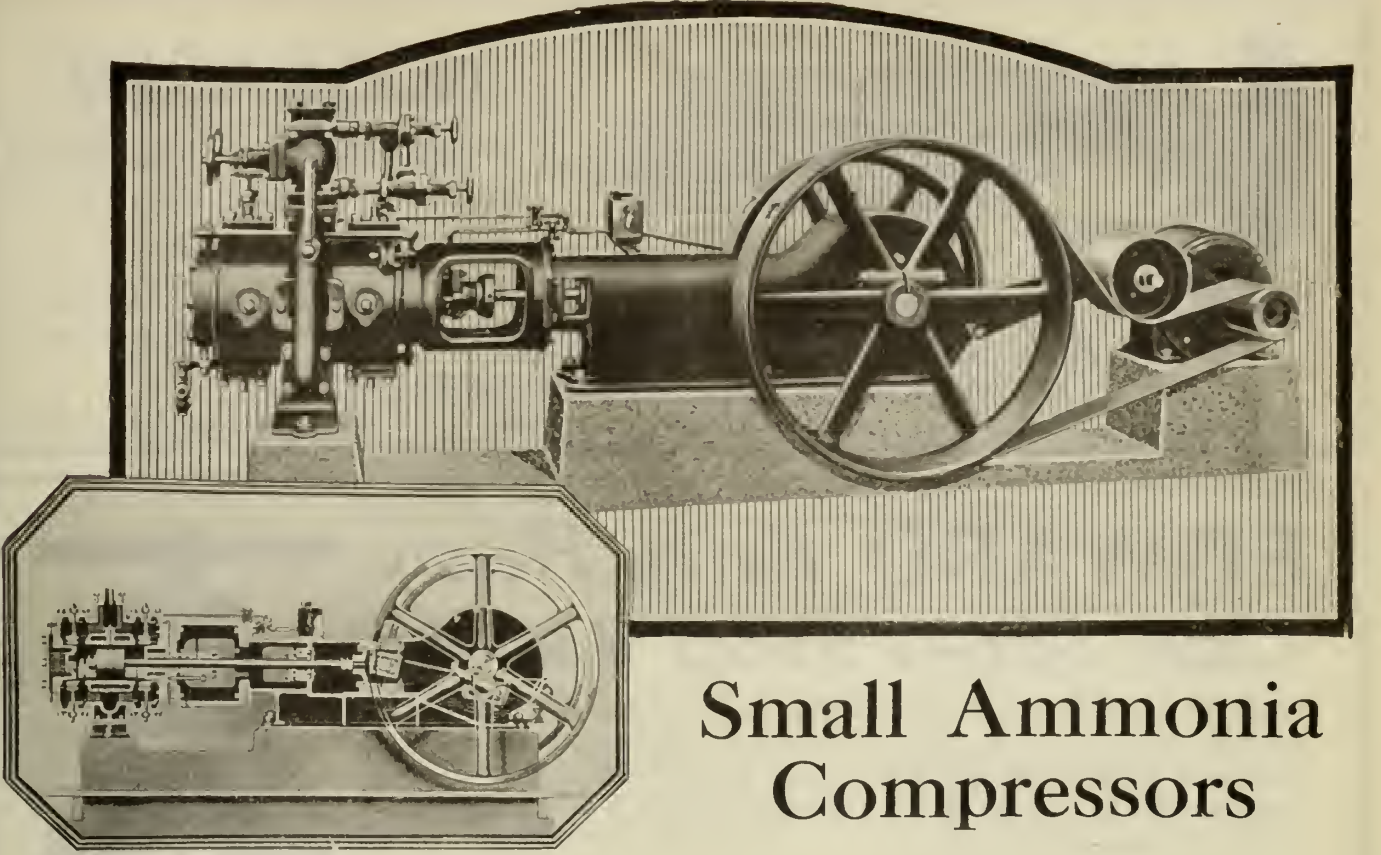
- —35 years of experience
- —time-tried methods mixed with modern practice
- —latest machinery—some of it exclusive to us
- —skilled workmen
- —we build all types and sizes to Interprovincial Code



Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: HALL MACHINERY CO., Sherbrooke, Quebec, and Birks Bldg., Montreal



Small Ammonia Compressors

In Class ER-A and FR-A Ammonia Compressors are found features of advanced design and construction. These horizontal, double-acting units represent a step forward in ammonia compressor practice, giving to plants of comparatively small tonnage a modern, reliable and efficient compressor.

The unusually large port and lift openings of Ingersoll-Rand Plate Valves and the unrestricted gas passages in the cylinder, result in the most efficient compression of gas.

Lubrication is entirely automatic, cylinder and stuffing box having separate feeds from force-feed lubricator. Bearings, crosshead pins, connecting rod and crosshead are oiled by the enclosed splash system.

Bypass connections for starting, relief valves, stop valves, and pump-out piping are all bolted to the cylinder casting resulting in a self-contained machine.

Class ER-A Belt Driven Compressors can be furnished complete with short belt drive and electric motor—an arrangement insuring better belt contact and a material saving in floor space. Class FR-A Steam Driven Units have Balanced Piston Steam Valve and Wide Range Automatic Cut-off Fly-Wheel Governor.

Bulletin K-314 contains illustrations and descriptions of both types. Send for a copy now. It will pay you later on.

Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

Refer U.S. enquiries to Ingersoll-Rand Co., 11 Broadway, New York

Ingersoll-Rand

Air Gas and Ammonia Compressors Vacuum Pumps

"BURN ALL"

A Child Can Operate It.

NONPAREIL

Shaking and Dumping Grates

Their 65% air space and 95% underdraft cuts fuel bills at least 10%. Do you doubt it? We can prove it and guarantee our statements. Investigate.

SEXTON'S FIREBRICK WORK

We use only the best high tension fire cement in our Firebrick Work—and furthermore, our work is high above the average; it is built to endure.

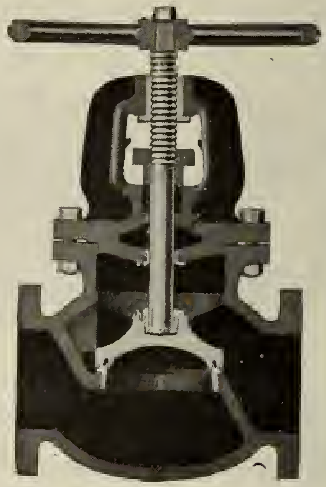
Whether it's building-in boilers, general repair work (renewals and repairs for all kinds of shaking and dumping grates)—see SEXTON first.

THE W. R. SEXTON BOILER SETTING CO.

Established 1900 114 Grenadier Road, Toronto *Phone: Junc. 2765W*

EDWARD *Extra Heavy* Cast Steel Stop Valves

Designed to offer the least resistance to the flow, with full sized opening through seat, with body, bonnet and gland made of Electric Steel and flanges drilled in accordance with American Extra Heavy Standard of 1914, these EDWARD Stop Valves will give satisfaction under the most severe service.



Superior Valves for Exacting Duty

THE EDWARD PROTECTED SEAT AND DISC

This positive protection of the most vital organ of the valve — the seating surface — is used only in Edward Valves. It prevents cutting from wire drawing, especially under high pressures and temperatures where very small leaks rapidly grow owing to the terrific erosion action.

Send for descriptive catalogue of the Edward line.

The Edward Valve & Manufacturing Co.

General Office & Works: **East Chicago, Ind.**

CANADIAN AGENTS: Lytle Engineering Co., Limited, Montreal; Valve Engineering Company, Toronto.

Why Individual Boiler Feed Water Treatment

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)

Distributors: William C. Wilson & Co., 21 Camden Street, Toronto

Phone Adel. 1054 or write for full particulars.

The Most For Your Money

WHEN YOU HAVE A COMBUSTION ENGINEERING PROBLEM CONSULT THOSE WHO HAVE THE WIDEST EXPERIENCE AND BEST FACILITIES FOR GIVING YOU COMPLETE SERVICE.

IN CANADA THE COMBUSTION ENGINEERING CORPORATION LIMITED IS IN A POSITION TO GIVE YOU THE MOST FOR YOUR MONEY.

THIS SERVICE INCLUDES:

Type E Stokers *New Frederick Stokers* *Quinn Oil Burning Equipment*

Coxe Stokers *Green Chain Grate Stokers* *Green Cast-Iron Hoppers*

Type K Stokers *Lopulco Pulverized Fuel Systems* *Custodis Chimneys*

Self Contained Stokers *Combusco Water Seal Ash Conveyor*

Detrick Flat Suspended Arches *Beaumont Coal and Ash Handling Equipment*

Elliott De-Aerators and Condensers *Uehling CO_2 Recorders*

Howden Steam Turbines, High Speed Engines
and
Ljungstrom Patent Air Preheaters

A COMPANY WITH INTERNATIONAL AFFILIATIONS WHICH INSURES CORRECT EQUIPMENT AND SOUND ENGINEERING

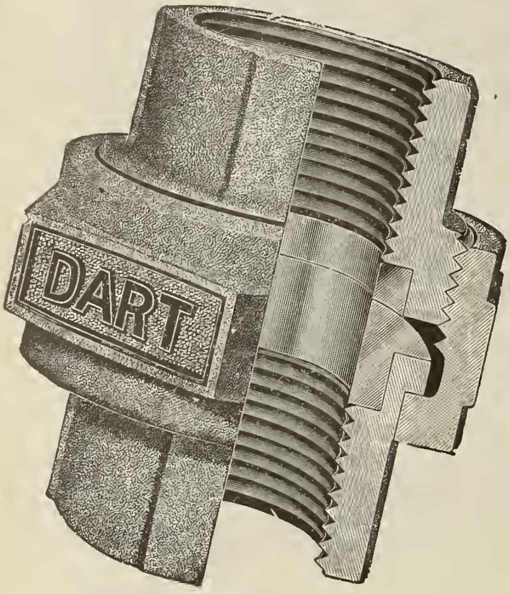
COMBUSTION ENGINEERING CORPORATION
LIMITED

MAIN OFFICE: TORONTO

MONTREAL WINNIPEG VANCOUVER

" Everything in the Boiler Room except the Boilers "

DART UNIONS



Stay Tight Permanently

No Upkeep Cost
No Replacement Cost
No Loss from Leaks

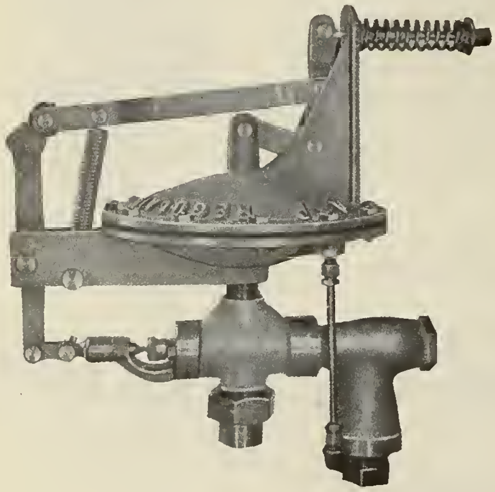
Because—THEY ARE BRONZE TO BRONZE AT THE JOINT

Your Jobber Sells Them

Manufactured by
DART UNION CO., LIMITED, TORONTO, ONT.

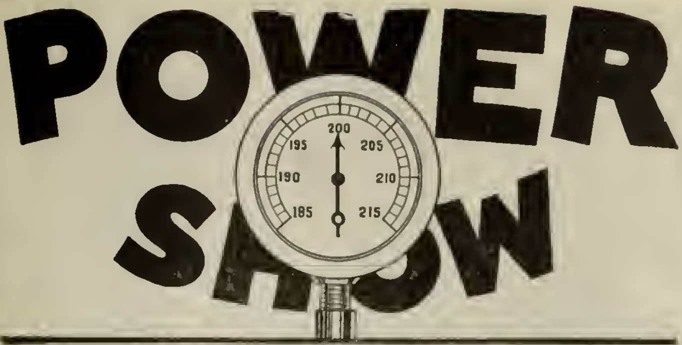
A. & P. Automatic Hydraulic Vacuum Producer

for creating and maintaining vacuum on steam heating systems in churches, schools, theatres, factories, flats, and residences.

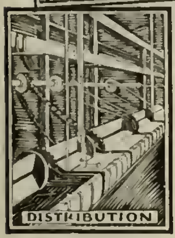


The A & P Vacuum Producer is for removing the air from the heating system and is operated by city water pressure. It is so designed that it completely shuts off the water supply when 3 to 5 inches of vacuum is established and operates again when low vacuum occurs. Maximum capacity with 20-lb. pressure is 2,500 sq. ft. of direct radiation.

Manufactured by
YOUNG PUMP COMPANY OF CANADA
96 Mary Street - - Hamilton, Ont.
Manufacturers of the Young Centrifugal Vacuum and Boiler Feed Outfit



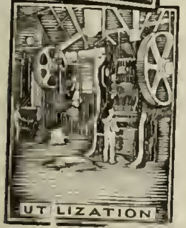
"Steam's Up!"



PREPARATIONS have been made for the greatest show of its kind **in the world!** This is saying a great deal—but it's a fact.

A complete exhibition of the most efficient methods and apparatus for the generation, distribution, control and utilization of power, it will give you definite information of great value in your daily work.

Dec. 3—8, 1923
GRAND CENTRAL PALACE
NEW YORK



The great diversity of exhibits will be a delight to the engineer who likes to "get down to brass tacks." You can turn from one thing to another and see something new every minute.

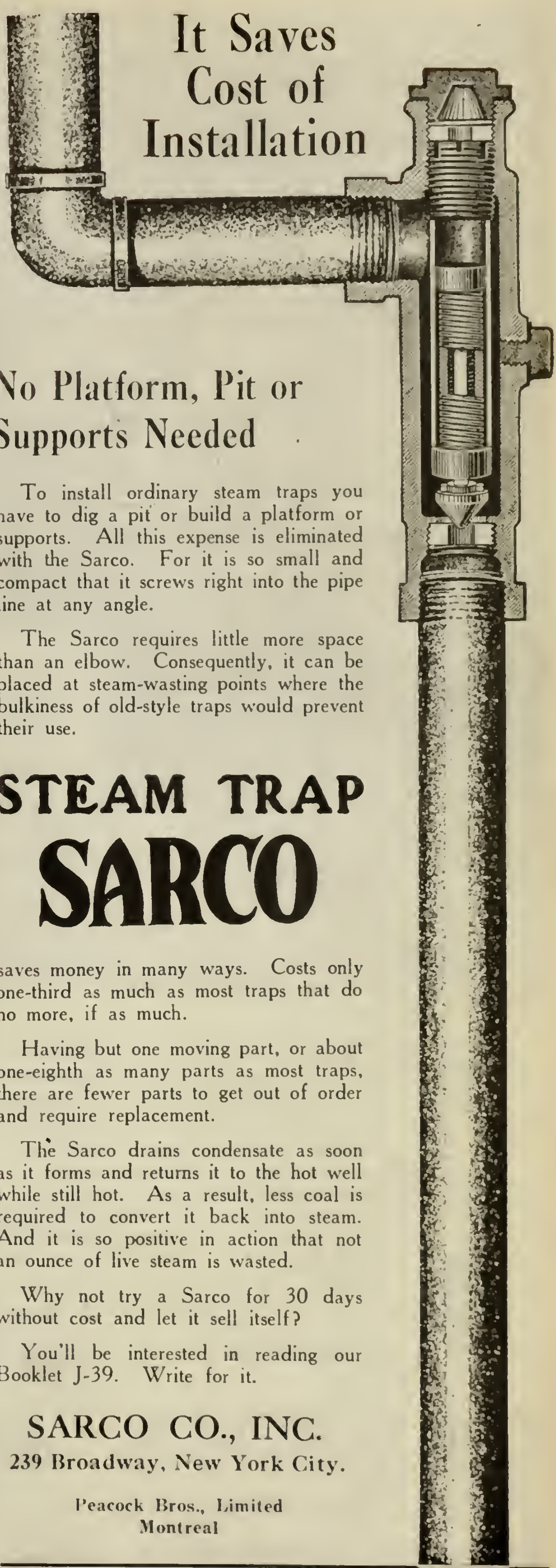
This will be a LIVE show indicative of the importance of Engineering.

Remember the date and come.

To Manufacturers! If you have something of positive merit and capable of comparison which is used either in producing, transmitting or using power or some mechanical equipment, or supply or materials used by the mechanical industry we welcome you as an exhibitor. Every application is subject to Exhibits Committee approval and no article can be exhibited unless it possess real merit.

For further particulars address

NATIONAL EXPOSITION OF POWER
AND MECHANICAL ENGINEERING
Grand Central Palace New York



It Saves Cost of Installation

No Platform, Pit or Supports Needed

To install ordinary steam traps you have to dig a pit or build a platform or supports. All this expense is eliminated with the Sarco. For it is so small and compact that it screws right into the pipe line at any angle.

The Sarco requires little more space than an elbow. Consequently, it can be placed at steam-wasting points where the bulkiness of old-style traps would prevent their use.

STEAM TRAP
SARCO

saves money in many ways. Costs only one-third as much as most traps that do no more, if as much.

Having but one moving part, or about one-eighth as many parts as most traps, there are fewer parts to get out of order and require replacement.

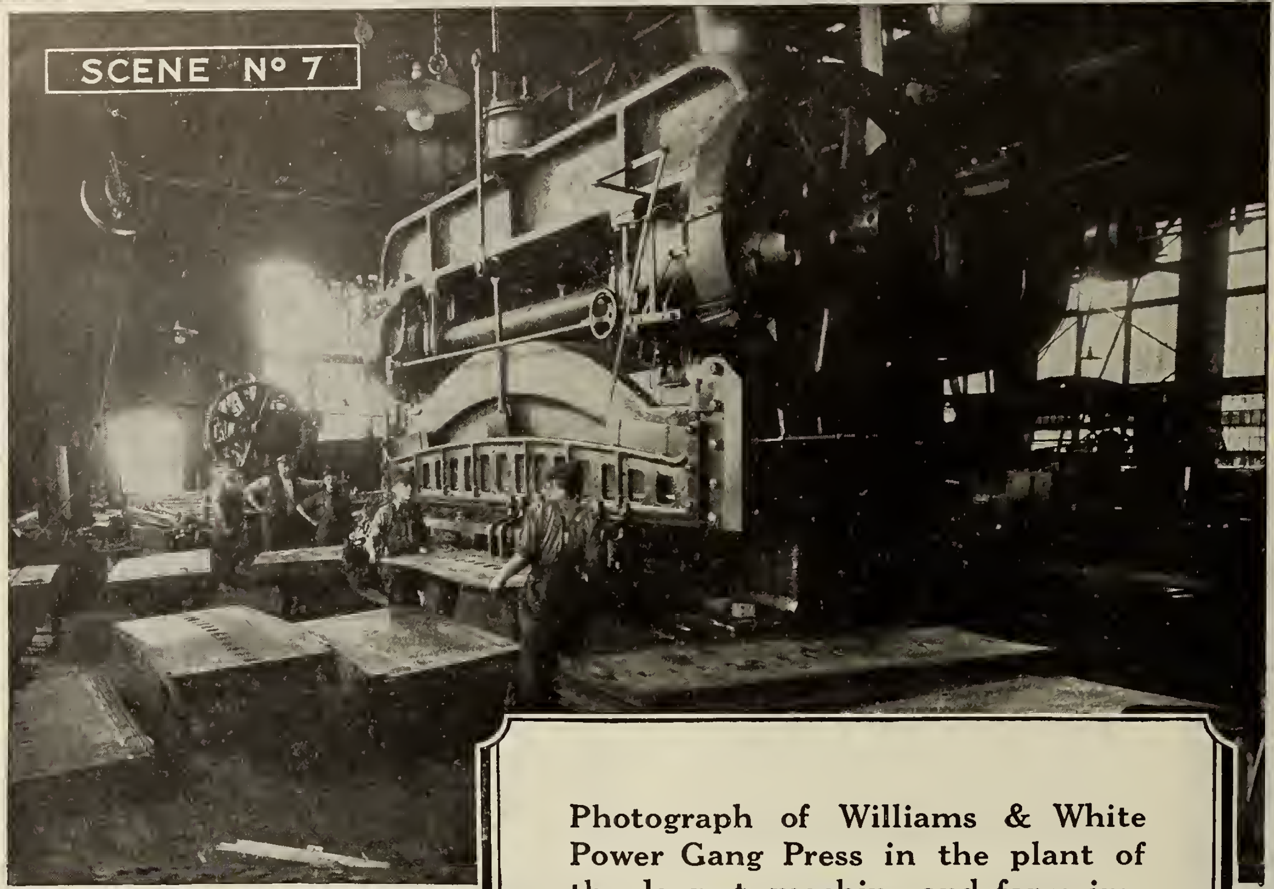
The Sarco drains condensate as soon as it forms and returns it to the hot well while still hot. As a result, less coal is required to convert it back into steam. And it is so positive in action that not an ounce of live steam is wasted.

Why not try a Sarco for 30 days without cost and let it sell itself?

You'll be interested in reading our Booklet J-39. Write for it.

SARCO CO., INC.
239 Broadway, New York City.

Peacock Bros., Limited
Montreal



Photograph of Williams & White Power Gang Press in the plant of the largest machine and farm implement manufacturers in Canada.

Imperial Lubricant used:
Imperial Engine Oil.

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

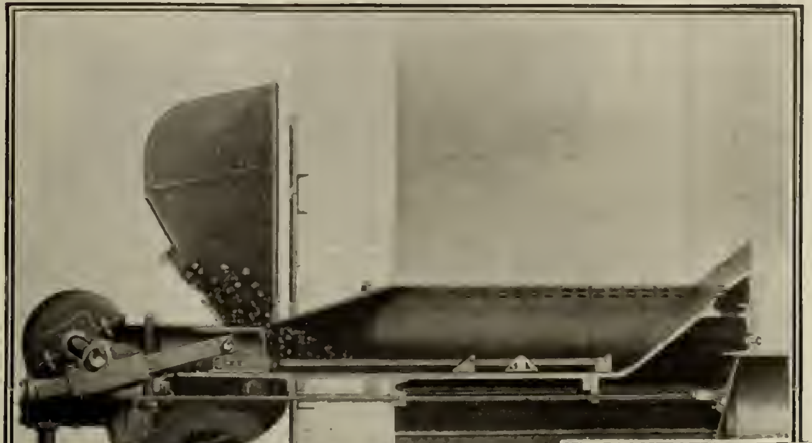
The care and skill which goes into the manufacture of Imperial Lubricants justifies the confidence with which these specialized oils and greases are used in leading Canadian plants.

The right grade of Imperial Lubricants will meet the lubricating requirements of every type of machinery unit, large or small.

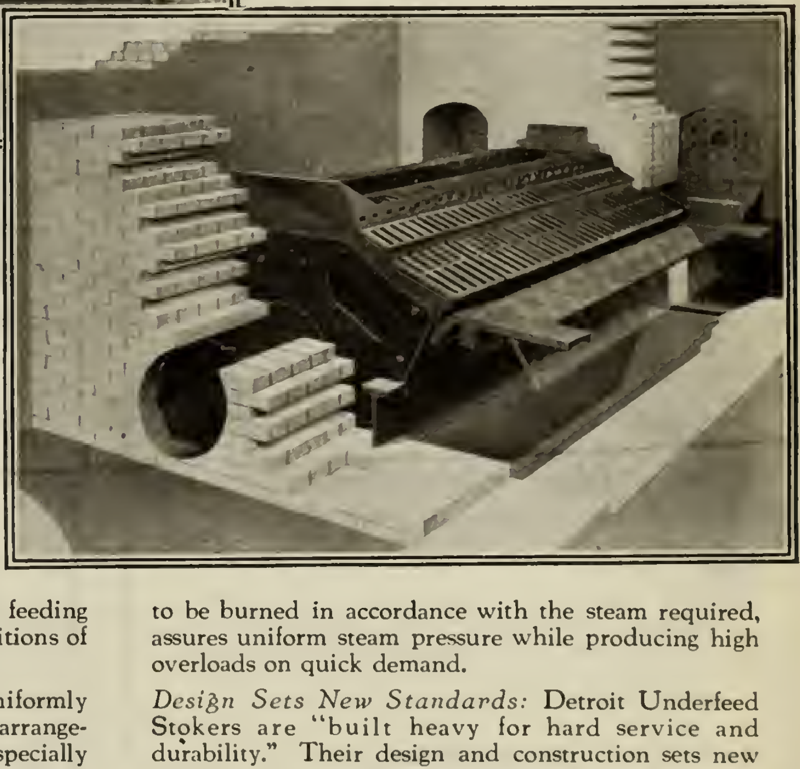
A letter to our nearest branch will bring the advice or services of our expert lubrication engineers.

IMPERIAL OIL LIMITED

Design and Construction of Detroit Single Retort Underfeed Stokers



Assure Complete Control of Combustion



Complete Control of the Fire: The Detroit Single Retort Stoker can be operated from the same engine or motor which operates the fan, and distinct regulation is provided, whereby the feed of the fuel to the furnace may be increased or decreased as desired, without changing the speed of the fan or the air pressure. This is accomplished by changing the position of the sliding block on the connecting rod, in or out, while the stoker is running, thereby feeding more or less coal to suit the requirements.

The ram and pusher rod are connected to the crank through the connecting rod or driving bar, which has a simple lost motion device so arranged that the entire travel of the feeding mechanism may be adjusted to suit the conditions of the fire, and the fuel to be burned.

Regulation: Fuel is delivered below the fire uniformly throughout the entire length of the retort. The arrangement for admitting air under control through specially designed tuyeres at both sides of retort, together with the means provided for regulating the amount of coal to be burned in accordance with the steam required, assures uniform steam pressure while producing high overloads on quick demand.

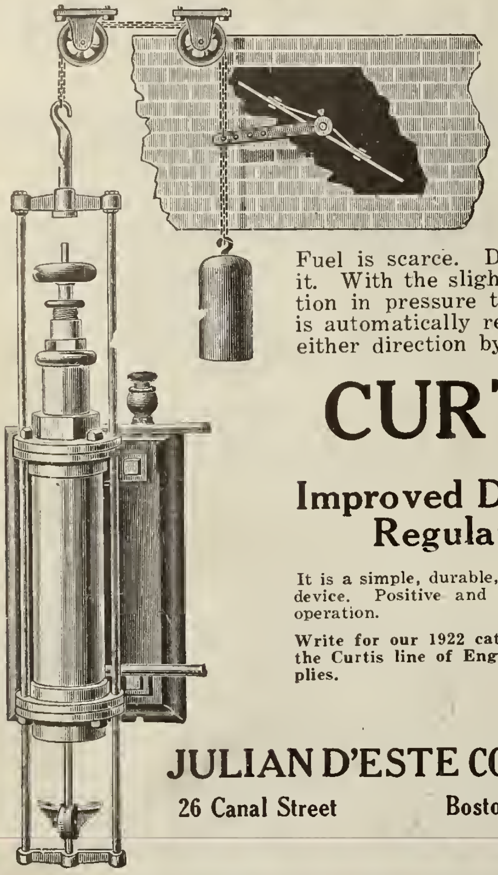
Design Sets New Standards: Detroit Underfeed Stokers are "built heavy for hard service and durability." Their design and construction sets new and higher standards in stoker manufacture. Progress is marked by an ever growing stream of repeat orders.

You will never know what a REAL stoker should and can do until you install a Detroit Underfeed. Ask for Bulletin 228

DETROIT STOKER COMPANY
Underfeed Forced Draft and Overfeed Natural Draft Stokers
228 GENERAL MOTORS BLDG. DETROIT, MICHIGAN

DETROIT UNDERFEED TYPE U SINGLE RETORT STOKERS

ASSURE CHEAPER STEAM PRODUCTION



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable, and effective device. Positive and automatic in operation.

Write for our 1922 catalog showing the Curtis line of Engineering Supplies.

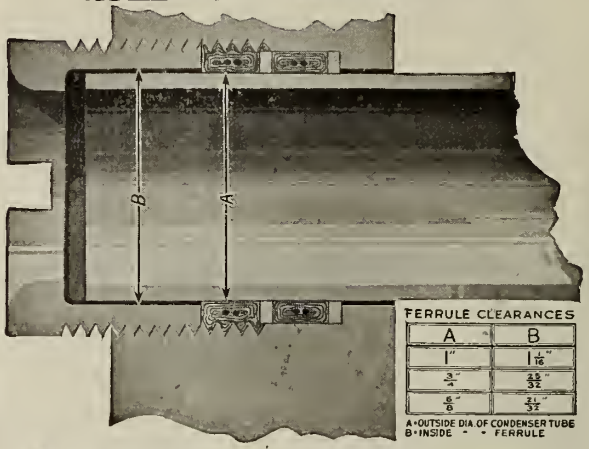
JULIAN D'ESTE COMPANY

26 Canal Street Boston, 14, Mass

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE **METALLIC** PACKING



FERRULE CLEARANCES

A	B
1"	$1\frac{1}{16}$"
$\frac{3}{4}$"	$\frac{25}{32}$"
$\frac{5}{8}$"	$\frac{21}{32}$"

A = OUTSIDE DIA. OF CONDENSER TUBE
B = INSIDE " " FERRULE

Condenser Process

The purchases of millions of rings of "JOHN CRANE" Condenser Tube Packings by manufacturers and operators in the past few months is strong testimony of the effectiveness and practicability of this new metallic packing process. Overcomes tube failures formerly due to expansion of packing, and electrolytic disintegration. Softer tubes may be used.

INVESTIGATE. Our complete illustrated text "Condenser Packings" free upon request.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
Beldam's Asbestos Packing & General Mfg. Co., Ltd., Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B.C.
"MADE IN CANADA"

STERNSON
No. 40 Monolith

As a refractory for industrial furnaces and boiler fire boxes Sternson No. 40 Monolith has proved itself not only more satisfactory and economical but is actually lower in cost than the old method of firebrick and mortar.

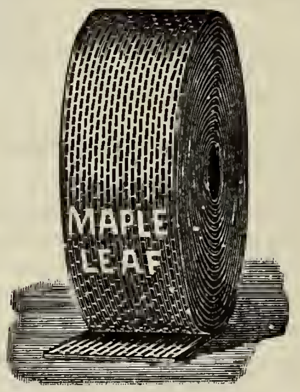
A Solid One-Piece Fire-Brick

It is a plastic ceramic mixture which can be molded by inexperienced workmen into a jointless, gastight furnace or fire-box lining. When vitrified it makes one great fire-brick able to withstand over 3,000 deg. F.
Try it for repair work and you will always use it for construction.

"Let a Technical Firm Do a Technical Job."

G. F. STERNE & SONS, LIMITED
Chemical Manufacturers
Consulting Chemical Engineers
BRANTFORD :: CANADA

"Maple Leaf"
Brand



Stitched Cotton Duck Belting *and* Dressing

It is water-proof and economical; also more efficient than other belting. The standard of quality, "Maple Leaf" Brand, is always maintained. That is why the demand for this belting is steadily increasing. "Maple Leaf" Brand Belting and Dressing make a good combination—use both.

Write for prices and further information.

Dominion Belting Co., Ltd.
HAMILTON, CANADA
Quebec Branch: 51 Duluth Building, Montreal

Flue gases can be reduced 50 degrees by careful firing and clean boiler surfaces

Such is the substantial saving that can be effected by recording and measuring your flue gas temperature with

TRADE MARK
BRISTOL'S
REG. U. S. PAT. OFFICE.

Recording Pyrometers

Of course, the temperature of outgoing gases can be decreased by economizers, or by a change in the baffling — but such changes are costly and the economy depends upon the cost of coal.

The information supplied by Bristol's Pyrometers, as to the temperature of uptake gases leaving the boilers, is of prime importance as an aid to super-efficient plant operation.

Hundreds of Bristol's Pyrometers are recording flue gas temperatures in prominent power plants. Let us tell you more about what they could do in your plant. Our new Catalog O-1401 is waiting for your address.

The Bristol Company, Waterbury, Conn.

Canadian Distributors:
Eastern Territory: Powerlite Devices, Ltd., Toronto and Montreal.
Western Territory: Gorman's, Ltd., Edmonton.

The Livest Firms and Progressive Towns will use

High Powered Gasoline Engines on Centrifugal Pumps, Air Compressors, Shovels, Locomotives and Electric Generators

Sterling
THE ENGINE OF REFINEMENT

Because—

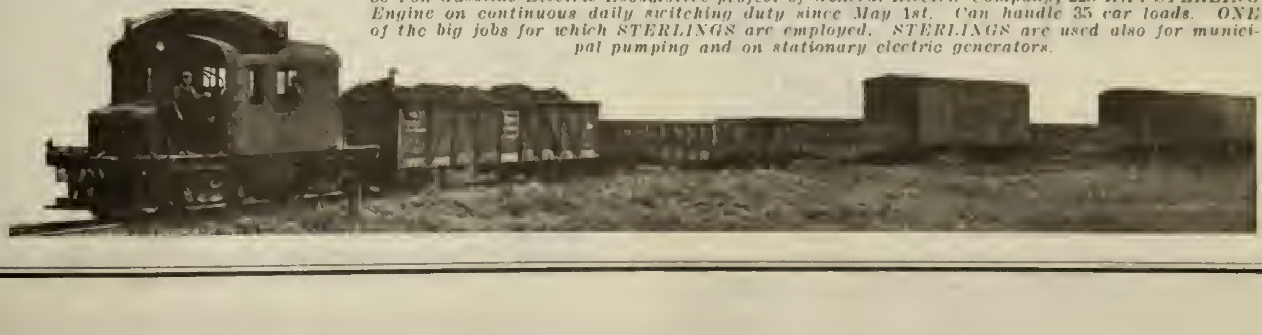
They cost less than any other form of power.
Are cheaper to run than a steam plant, particularly in isolated districts.
Are easily transported, readily installed.
Can be run by any intelligent engineer.
Are built in **large** sizes for big pumps and generators.

The contractor with this equipment carries the smaller investment, can work faster, with less labor, finish the job sooner, underbid the other fellow and handle more jobs at a profit. The city or manufacturer that uses STERLINGS for emergency has an unfailing source of power.

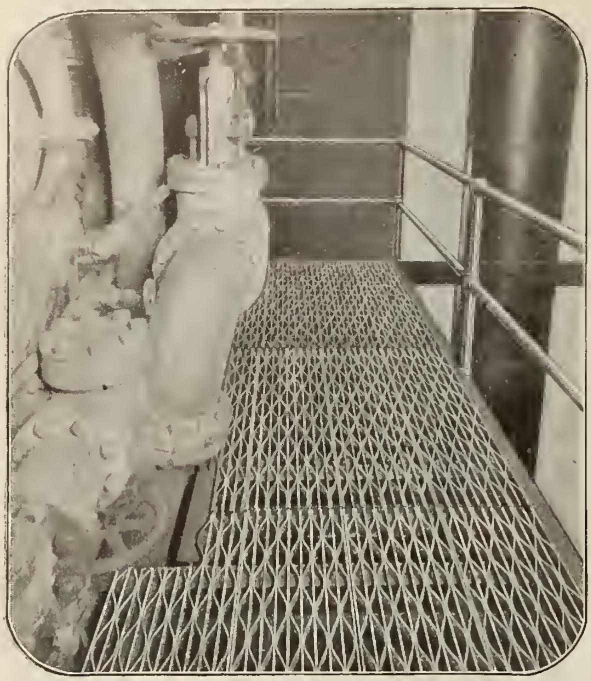
Send for a Catalog.

Sterling Engine Co. (Dept. C4) Buffalo, N.Y., U.S.A.

50 Ton Gasoline Electric Locomotive project of General Electric Company, 225 H.P. STERLING Engine on continuous daily switching duty since May 1st. Can handle 35 car loads. ONE of the big jobs for which STERLINGS are employed. STERLINGS are used also for municipal pumping and on stationary electric generators.



IRVING SUBWAY TRADE (PATENTED) MARK
THE FIREPROOF VENTILATING FLOORING



IRVING SUBWAY TRADE MARK (PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

"Repeat orders" — not "replacement orders" — form a large percentage of the business that recently necessitated adding two more units to the Irving plant. There are no instances of Irving Subway wearing out and needing replacement. Its life is the life of steel—its strength is the strength of a trussed steel structure. Service, satisfaction and economy—and the ever-increasing appreciation of the value of an open steel floor—these explain the increasing demand for Irving Subway. Ask for Catalog 4A50.

Canadian Agents:

Montreal, P.Q., 304 Coristine Bldg., St. Laurent. Winnipeg, Man. 141 Bannatyne Ave. Welland, Ont., Standard Steel Cons. Co.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

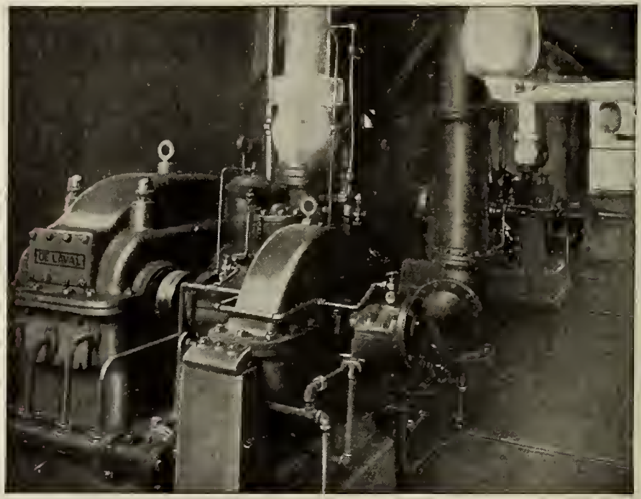
Manufacturers of

IRVING SAFSTEP TRADE MARK (PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS

WITH this jointless furnace lining you can increase furnace life by several years. The new, free book, "Refractories and Furnace Design," tells the story of

FIBRICO
FURNACE LINING
JOINTLESS FIRE BRICK CO
1142 CLAY ST. CHICAGO

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal; Shell Bar Boico Supply Co., Ltd., Toronto; Evans, Coleman and Evans, Vancouver, B.C.; Winnipeg Supply and Fuel Co., Winnipeg; Building Products & Fuel, Ltd., Saskatoon; Dominion Lime & Coal Co., Regina.

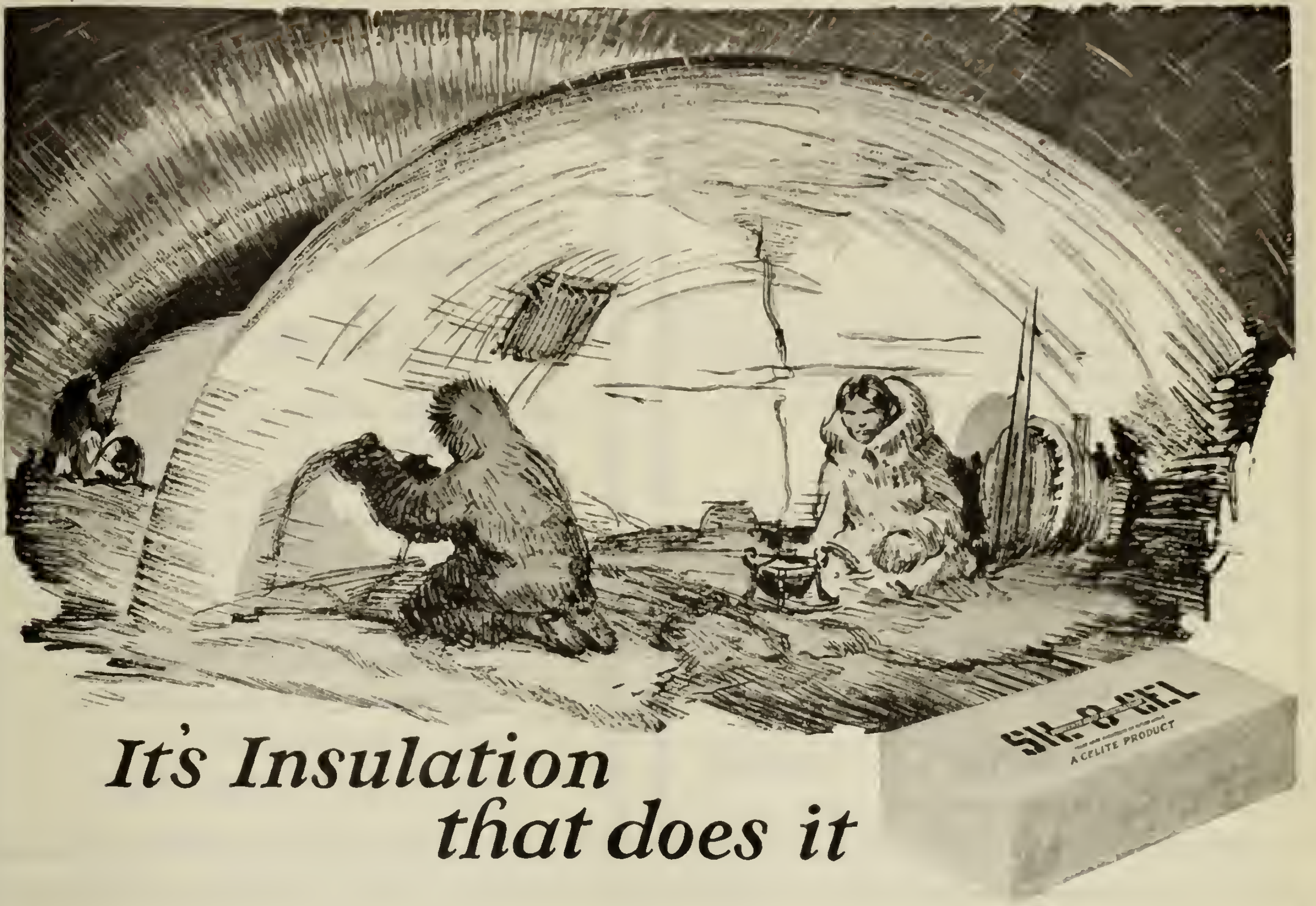


The 300 h. p.
De Laval Geared Turbines
shown above are driving swinging arm coal crushers. They are continuously subjected to considerable amounts of dirt, moisture and carbon dust in the air, which would be unfavorable to the use of either direct current or alternating current motors. Their simple, substantial construction, however, enables them to operate most satisfactorily under such adverse conditions.

If interested in steam turbines for any steam conditions, or for driving any kind of machinery at any speed, in capacities up to 15,000 h.p., ask for our Catalog D-100.

De Laval Steam Turbine Co.
TURBINE EQUIPMENT CO., Ltd., 73 King St W., Toronto
THE E. LAURIE CO., 243 Bleury St., Montreal, Que.

279



It's Insulation that does it

A TINY FLAME keeps the Eskimo's igloo warm and comfortable, despite the fact that the outside temperature may be many degrees below zero.

It's insulation that does it. Millions of microscopic air cells formed between the particles of tightly packed snow break up heat penetration and hold it within the hut. Large air spaces are not as effective, as the U.S. Bureau of Standards have decisively proved, and the perfect heat insulation only needs in addition to its countless minute air cells, a composition which withstands high temperatures, and sufficient structural strength.

All these requirements are found in Sil-O-Cel Heat Insulation—in world-wide service on all types of high temperature equipment. Tests by the Bureau of Standards prove it to possess a lower heat conductivity than any other insulation suitable for high temperatures. Furnished in forms which withstand, without shrinkage, direct heats of 2,000° F., Sil-O-Cel has ample structural strength, is easily applied and permanently effective.

A type for application to boilers, furnaces, ovens, kilns and similar heated units without change in design — Brick, C-22, Block, C-3, Powder, and Cements.

A CORRECTION

The crushing strength of SIL-O-CEL Insulating Brick was incorrectly reported in last month's advertisement as being 400 lbs. per square ft. This should read "400 lbs. per square *inch*" or 28 tons per square foot.

Write nearest office for complete information given in Bulletin W-6C, or mail the coupon.

BARRIERS
TO INDUSTRIAL WASTE
SIL-O-CEL
FILTER-CEL
CELCOTE
FRAXITE

Celite Products Limited

New Birks Bldg., MONTREAL, Que.

CELITE
PRODUCTS
LIMITED

Gentlemen: Send blueprints and Bulletin on SIL-O-CEL Heat Insulation for

....
(Give Type of Equipment)

Name ....

Company ....

Address ....

Boiler Setting

Service

THE Gates Engineering Co., Limited, are in a position to contract for and specify on all boiler brick work with the least possible delay. Our Engineering Department is qualified to look after your interests, having made a close study of Combustion Problems.

Our Motto—Service and satisfied clients. The confidence of those who use Gates' Patented Air-Cooled Arch, etc., is unqualified, and is retained, because of the low maintenance cost and the guaranteed results.

Ask for our Descriptive Catalog.

Gates Engineering Co., Limited

314 Notre Dame Street W., Montreal

Power House

is a dominating factor in maintaining power plant efficiency in equipment and service

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge. Every issue is full of real worth while ideas.

Two Issues per Month

24 Issues (one year) $2.00

Special Offer

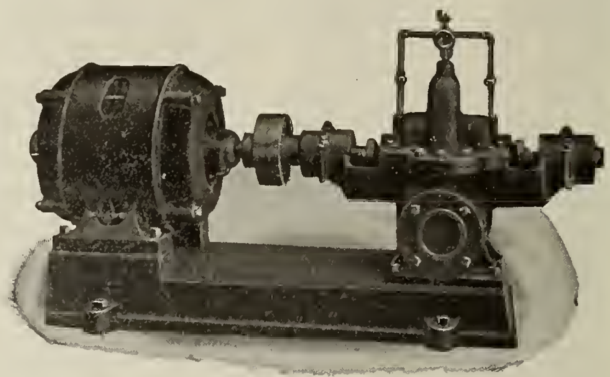
48 Issues (two years) $3.00

Even More Than Satisfactory

We realize that power houses must have a pumping service that will stand all tests.

Smart-Turner Pumps are built according to the needs of Canadian industries, which accounts for their popularity.

Our engineering service assists in getting the best results.



A packed piston pump with brass valve seats screwed in rubber, or brass valves, depending on the service.

Write us For Name of Nearest Representative.

The Smart-Turner Machine Co. Ltd.

Hamilton Canada

One New Plant After Another

Uses

"Canadian"

Apparatus

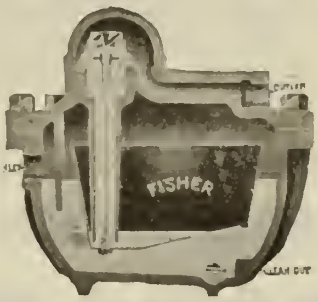
THE latest addition to the Essex Station of Public Service Production Corporation will, like the previous section, have Canadian Stoker Fans and Induced Draft Fans making a total of 18 Forced Draft and 12 Induced Draft Fans in this plant.

For each successive installation our engineers studied space conditions, capacity requirements and pressure-volume characteristics, selecting from among our designs the sizes and types to give the best results. This service is at your command not only for power plant equipment but also for fan system heating, ventilating, air conditioning and drying installations, blowers, conveyor fans and forge shops. Write for Catalog to Dept. 12.

Canadian Blower & Forge Co. Limited

Kitchener - Ontario

Toronto Vancouver St. John
Montreal Calgary Winnipeg



Removes Every Drop of Water

LOSSES amounting to thousands of dollars each year, as well as many serious accidents, are caused where condensation is not properly drained from coils, pipe lines, separators or other apparatus.

Steam traps of many designs are used to remove the condensation. To be efficient they must remove all the water and discharge it as fast as it condenses. They too must avoid any discharge of steam pressure. This is exactly what the Fisher Steam Trap is designed to accomplish—and what it is accomplishing in the many plants where it is installed.

If your present trap is not in every detail satisfactory, you will make no mistake in installing a Fisher Trap.

Fisher Features

The Fisher Trap has many superior features. Valve seats can be changed instantly without disturbing pipe connections. Has intermittent discharge, eliminating wire drawing of valve seat. All parts extra heavy. Float made of cast iron, open bucket type, which is trouble proof. Lifts condensation two feet to each one pound pressure on the trap. It has many other features, too, in which you will be interested. Write for complete description.

The Fisher Governor Co.

951 Fisher Avenue - - Marshalltown, Iowa

Agencies in all principal cities.

FISHER
TRADE MARK REGISTERED

Babcock & Wilcox, Limited, of London, England.
The Goldie & McCulloch Co., Limited, of Galt, Ont.

and

The Babcock & Wilcox Company of New York

wish to announce the formation of a new Company
known as

Babcock-Wilcox & Goldie-McCulloch, Limited

for the manufacture of Steam Power Plant Equipment and Accessories,
With Head Office and Works at Galt, Ontario.

The constituent Companies desire to extend to their clients
grateful thanks and appreciation of the confidence
extended to them in the past and express the hope
that the new Company will continue to
deserve and receive it in the future.

* * *

The Goldie & McCulloch Co., Limited

will continue in business as manufacturers of Safes, Vault
Doors, Vault Linings, Safety Deposit Boxes, etc.,
with Head Office and Works at
Galt, Ontario.

November, 1923.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

J. MACTAGGART
News Editor

Wants His Men to Advance

WHEN Walter J. Hudson, field engineer of Power House, was in Sault Ste. Marie last week one of the family of readers paid Canada's power plant newspaper a compliment by advising seventeen of his assistants to subscribe. He explained to Mr. Hudson that he did this for the good of his organization.

"All my men are interested in new developments in the power plant field and they certainly can't get better dope anywhere than in Power House, particularly in the past six months."

This chief believes that the more his operators know the better it will be for his boiler room as well as for themselves. And he's chief engineer of the huge Spanish River Pulp and Paper Mill plant.

Continuing the compliments, another man, representing a leading stoker manufacturer, recently said: "What you are now publishing in Power House comes nearer to being 'real meat' for the engineer and manufacturer than anything of the kind we have ever had in the industry. Keep up the good work."

That being the case, every executive, superintendent and engineer in Canada should read Power House, for knowledge is an asset; ignorance a liability. You can't keep on taking out of a barrel unless you keep on putting into it. That is to say, an engineer who stores up his knowledge of power plant operation, must constantly draw from that store. Unless he reads and adds to his knowledge, he will soon find himself scratching the bottom of the barrel.

No man can have too much knowledge of the industry on which he depends for his daily bread. When any of us think we know all there is to know—well, we're getting pretty close to the bottom of the barrel. Some one once said, "Ignorance is bliss." It isn't. It's blisters.

Is It Lack of Incentive?

IT IS universally conceded that the good performances obtained during boiler tests are seldom, if ever, duplicated under average daily operation. Yet, if the conditions of load and service during the test were normal working requirements, it must be admitted there is no other reason for performances falling down, except the failure of the operators to carry the work through in the way in which it was done during the trials.

There may be many reasons for shortcoming — lack of means or knowledge—but it would appear that the most common ones are the neglect of the management to assist the men for a long enough time to make the new practice a sort of second nature to them—a habit—or to provide the men with sufficient incentive.

Proof of the truth of this statement is to be found in a report made to Walter N. Pollakov, one of the world's outstanding specialists on power plant work, on a plant where earlier actual results were very far from being obtained after a short time of operation under changed conditions.

To quote the report: "One hundred and eighty thousand pounds of coal were handled by four men in 24 hours. Two men working together 12 hours each day and passing 45,000 pounds each, could not stand the work; it was too hard. This was because the shovel had a short handle and they had to bend too low; the shovel held only 16 pounds of coal instead of 21.5 pounds, causing the men to bend too many times per ton; the wheelbarrow held only 250 pounds, causing too many trips. When a man was given the right kind of a shovel and a wheelbarrow holding 400 pounds, yet throwing less weight on his arm when lifting the load, he handled 65,000 pounds in eight hours and found his job much easier than before."

In a power plant it must not be forgotten that the men can keep a pretty accurate check upon the amount of coal used to carry a certain load. If, as a result of better work and closer attention on their part, they succeed in saving a few tons of coal they know that this saving is only in a measure due to improved facilities provided by the management, for ultimately a considerable part of the saving results from their willingness and exercise of skill. It is therefore but just that under such conditions they should share to some extent in the savings.

Get-Rich-Quick Schemes

THE greatest get-rich-quick scheme in the world is the distribution of ideas, says James E. Noble, of Toronto, in a letter the other day. And the average reader will agree he's right. "Suppose you have an idea that isn't worth more than ten cents. If you give that idea to—well, say, to ten thousand readers, it's immediately worth a thousand dollars."

Continuing the thought of this reader a little further, let's consider this: Every issue of Power House is crammed full of ideas, each one of which is worth more than ten cents. If you get all of these ideas, and make them your own, you get several dollars' worth a month. And if you pass these ideas along to your firemen, for example, and have them use the ones they can use, you will see other dollars showing up on the right side of the ledger—in reduced coal bills for your employer—in wage increases for yourself.

And another point, while we're at it. Every time you pass a ten cent idea to Power House—or a five dollar idea—that you have used—and it passes the idea to the power plant field, thousands of engineers have been enriched just that much. Send in your ideas, please.

Those Meeting Nights

WHEN two men meet, and each has an idea, and they exchange their ideas, each goes away with two ideas. And that's what happens at association meetings. Meeting nights are nights for the exchange of ideas. The man who misses a meeting of the Canadian Association of Stationary Engineers, of the Universal Craftsmen's Council, or of the Montreal and District Association of Engineers, misses all the ideas of the men who answer "present." The man who brings his troubles to the hall, and lays those troubles at the feet of his fellows, carries home a kit full of joys—of practical information.

Then, too, meeting nights are nights for men to get better acquainted. In days of old competitors kept away from each other. Now they are on friendly terms. They get near each other. How much more can engineers profit by such friendliness and nearness?

Cutting Down Losses by Means of Draft Control

*By ROBERT JUNE, A.S.M.E.

In Maintaining Combustion Efficiency There Are Few Factors More Important Than Draft Regulation—With too Little Draft Huge Operating Losses Occur—With Too Much Draft the Losses Are Just as Costly

FOR each individual furnace there is a variable draft loss, which is affected by a number of factors. The air necessary for combustion must pass through the grate and through the fuel bed. With large openings and short passages such as occur when large uniform lumps of coal are thinly spread on a grate, the draft loss is extremely small.

With fine coal, or coal of variable sizes which packs well, and with deep fuel beds the resistance to the passage of the air is much greater.

Should we attempt to supply the same amount of draft for both fuel beds, we would have with the thin fuel bed and the large lumps a condition where the coal would be rapidly burned on certain sections of the grate, leaving the fire thin at these points, and as a matter of fact, uncovering the grates, so that there would be very large losses due to the excessive amounts of air.

With the thick fuel bed offering considerable resistance to the passage of the draft, due both to its thickness and more compact nature, we should have incomplete combustion, with low CO_2 and high CO, and large volumes of dense smoke pouring from the stack.

Coal Needs Vary

Thus we find that for every kind and grade of coal, for every furnace, and for different rates of combustion in the same furnaces, there is a certain draft from which most economical and satisfactory result are secured.

Fig. 1 gives a good general idea of the draft required to burn a number of the most commonly used steam coals at various rates of combustion. These are not absolute figures but simply indicate common experience.

It will be seen that with the free burning bituminous coals a comparatively light draft is most economical. The amount of draft required increases as the fixed carbon increases and the volatile decreases. The highest drafts are thus commonly required for small sizes of anthracite. It should be understood of course that not only the composition of the coal, but the percentage of ash, has a bearing on the draft required.

To sum up: there is one best draft for each boiler with a given fuel and a given rate of combustion. This best draft can be readily determined by experiment.

Draft Gauges Essential

If you are going to operate at a draft best suited to your fuel and your rate of combustion, you must know when you have secured that draft and whether you are maintaining it. This means that the use of a draft gauge is essential.

This is the fourth in a series of articles by Robert June, the well-known authority on power plant management. The articles deal with the dollars and cents end of power plant operation and maintenance. Succeeding articles deal with such live topics as Safe and Efficient Boiler Operation; Stoker Operation and Maintenance; What Management Should Know About Coal and Ash Handling Equipment; Steam Piping; Efficient Turbine Operation, etc. The series is timely and should prove of value to every Canadian engineer.

Let us suppose that your boilers are equipped with draft gauges. Unless the firemen are making use of the information furnished them, you will be surprised at the variety of drafts which you have in your plant as you go from boiler to boiler. The trouble is this, the firemen know that draft is a good thing and their inclination is to make too good use of it.

It is a universal custom in designing power plants to provide for an excess of draft. Then to throttle this down dampers are furnished. Now the great trouble is if the firemen either leave the damper wide open, or else open entirely too wide for the purpose in hand. This is on the assumption that you do not have automatic damper control, of which more later. The point here is that the draft gauge tells the story and the damper controls it.

Use Ash Pit Door

Suppose you have a hand fired plant, and the firemen do not adjust the dampers to the load. What then is their procedure? The answer is that they use the ash pit door for this purpose, and that this is the most expensive procedure.

Close the ash pit doors and you will note that the vacuum on your draft gauge is greatly increased. The result of this is to speed up the inflow of air at all of the cracks, crevices and holes in the boiler setting. Flue gas temperature is reduced and steam production is checked, but the process is a wasteful one.

The answer is—if nothing better can be done at least see to it that manual damper control from the front of the boiler, so arranged that the fireman can get at it as easily as he does the ash pit doors, is provided. Then compel the fireman to use the dampers in preference to the ash pit doors.

Keep Fireman in Mind

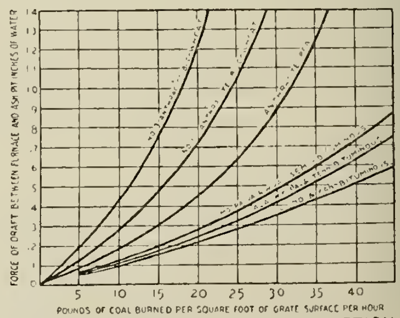
Now getting back to the draft gauge. You are buying this for the fireman, and he is the man to keep in mind. If the gauge tells him what he wants to know and in a way which he can understand and at the moment when he needs the information he will use it—not otherwise. Here are the points to keep in mind:

1. Provide a draft gauge for each boiler furnace.
2. Locate gauges at the most convenient and accessible point. Put them at the front of the boiler at a convenient height so that the fireman does not have to step out of his way a foot to read them.
3. See that the scales are large and easily read. If necessary provide an electric light for the gauge. An unlighted gauge is not much good in a dark boiler room.

Fig. 2 shows a typical draft gauge with a range of 75 hundredths of an inch of water.

Automatic Control

Automatic control as applied to forced draft involves the consideration of three factors: the provision of air supply in-



DRAFT REQUIRED AT DIFFERENT COMBUSTION RATES FOR VARIOUS KINDS OF COAL

Fig. 1.

---

*Specially written for Power House. Copyright 1923, by Robert June.

troduced beneath the fuel bed, the feeding of the fuel, and the draft over the fire.

To govern these factors so that they may be utilized to the best advantage we must control the apparatus which supplies the forced draft under the fire, we must control the rate at which the stoker feeds the fuel, and we must control the damper or it may be the induced draft fan in the boiler breaching, which controls draft over the fire.

Now, first and last, a good many different types of equipment have been developed for the purpose of securing automatic control. Speaking in a general sense this equipment as a class has given effective service and has effected worthwhile economies, which have made it a good investment in the plants where it has been installed.

A straight line is the shortest distance between two points. This being the case, if you want to maintain an even steam pressure, the most effective means of accomplishing this result is to have the steam pressure directly control the forced draft fan. This is the direct straight line and it is a better arrangement than to have the steam pressure directly control the damper and then let the draft over the fire in turn control the forced draft fan.

In following out this principle of reasoning we arrive at once at the proposition that two or more sources of control may perhaps be better than one. Here we run counter to some exponents of a single source of control. Let us examine the situation as impartially as possible.

Control of Forced Draft

Our forced draft fan is operated by an engine or motor, so that we can govern it through the medium of regulation on the steam lines to the engine, or in the electric circuit of the motor. We have the choice also of letting the governing factor be the amount of fuel supplied, the draft over the fire, or the steam pressure. Now, if you want to raise steam pressure in a hurry there is one reliable and immediate method, and that is to increase the draft. Setting about the matter in any other way simply complicates the situation and increases the length of time it takes to produce the desired results. Falling steam pressure is instantly compensated for by an increased draft.

Granted that this form of control is adopted you have to decide on some modification of it when more than one boiler takes air from a fan. The modification sometimes used is that of arranging to govern the butter-fly gates and the air ducts leading to individual boilers, by the rate of combustion in each boiler. This does not work well in practice, since the greater the amount of combustion in an individual boiler, the greater the air supply, and therefore, still greater the increase in combustion. In other words, a condition is created whereby one boiler tends to pull the load away from another.

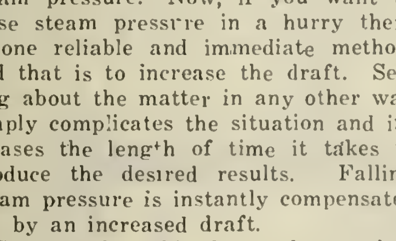


Fig. 2—Draft Gauge.

Therefore, the proper way to handle the butter-fly gates is to determine the best average point at which an equable distribution of the load can be obtained and then to set the butter-fly gates permanently in this position. This method eliminates see-sawing, as each boiler will take its share of the plant load at all times without any tendency toward "hunting."

Draft Over the Fire

The amount of draft over the fire is directly influenced by the damper. Here again, the shortest distance between two points is to have the draft control the damper. The point simply is this: For each given rate of combustion there is a certain draft over the fire which assures the highest economy. An even draft can be maintained most readily by shifting the position of the damper. To let the steam pressure govern the damper is to go considerably out of our way and to have a less satisfactory result than if we regulate the draft over the fire by means of the damper.

To make this still clearer, suppose we open the damper by a change in steam pressure. We then find that the damper must be open an appreciable length of time before the forced draft fan has increased the amount of gases to a volume corresponding to the opening. In the meantime the economy of combustion has been adversely affected. We need to separate very clearly in our mind these two propositions.

Proposition 1.—The maintenance of steady, even steam pressure is of value only in its relation to load conditions. Governing the forced draft fan from the steam pressure is the most direct method of maintaining uniform load requirements. While highly desirable and frequently absolutely necessary it is not primarily a means of effecting economies. The savings may range from 2 to 5 per cent. of fuel.

Proposition 2.—Damper regulation controlled by draft over the fire is one outstanding means of effecting marked economies in combustion. Here the savings in fuel may range from 5 to 15 per cent.

Damper regulation from the draft over the fire is, therefore, recommended for all plants. Where there are a number of boilers in a plant direct control of each damper from the draft over the fire in the boiler to which it is attached is a very much better proposition than to attempt to move all dampers simultaneously without regard to the conditions obtaining in the individual boiler.

With mechanical stokers the feed of fuel to the furnace may be arranged to give constant steam pressure, constant draft over the fire, or it may be made to increase or decrease with the load on the boilers. The latter method is, of course, theoretically the best. If you could vary the amount of coal just as the load varied you would have an ideal condition. Unfortunately combustion equipment manufacturers have not yet, as a class, been able to solve the problem of devising a simple, efficient and dependable control of fuel feed from the steam flow.

For the present we must content ourselves with indirect control of the fuel feed. Here we have our choice of controlling the fuel feed from the draft over the fire or from the steam pressure. Utilizing the draft over the fire for this purpose is not a satisfactory arrangement for a number of reasons. One of them is that the control must be extremely sensitive as to have a variable ranging from 0.05 to 0.15 inches of water to control a stoker, which determines the output of the boiler.

This brings us back then to the control of fuel feed from the steam pressure, or if preferred, from the forced draft fan. Either arrangement is satisfactory and possesses the advantage that increases or decreases in the supply of coal directly corresponding with increases or decreases in the air supply.

Stoker control systems designed along these lines are rendering satisfactory service in literally thousands of plants. There is no reason why they should not be unhesitatingly adopted by any power plant operator.

Points to Remember

Here are points to remember in purchasing boiler room apparatus, particularly controlling devices.

1. The apparatus should be as simple and elementary as possible, telling the boiler room crews exactly what they need to know and no more. All readings should be direct so that calculations are unnecessary.

2. Strength is just as desirable as simplicity. Boiler room apparatus is subject to a good many hazards and unless it can successfully withstand bumps and knocks it is of little value. Moreover, the apparatus must be able to operate accurately when covered with dust and grease.

3. The apparatus should be so designed that it can be installed by the operating engineer in charge of the plant without having to go to the expense of an engineer from the manufacturer's factory.

4. Directions for cleaning and repairing the apparatus should be so clear that the operating engineer can understand them readily and can make the necessary repairs when required.

5. Control apparatus should be sensitive enough to maintain desired combustion conditions without hunting, racing, see-sawing, or lag.

Safety Factors in High Pressure Boiler Design

*By D. S. JACOBUS

In Boilers Built for 1200 lb. Pressures by the Babcock and Wilcox Company, the Superheater is Placed Above a Series of Tubes in a Drop Leg and Below the Main Body of Tubes

JACOB PERKINS was a pioneer in the use of high-pressure steam. In 1822, over one hundred years ago, he made an apparatus in which water was heated under a high pressure in a generator kept full of water by a force pump, and only a very small quantity of the highly heated water was allowed to escape at a time into a tube, where it flashed into steam and passed on to an engine.

His generator of 1824 is described in the following way in a book entitled "History and Progress of the Steam Engine," by Elijah Galloway, published in 1830:—"The boilers, or steam generators as they are called, are in this case very thick cast iron bars, 5 in. square, with circular holes perforated longitudinally through them of 1½ in. diameter, a transverse section of which is exhibited in the figure. They are arranged in three tiers, A, B, D, and are of sufficient length to lie across the furnace, and to pass through the opposite walls, where their extremities are connected together, by a means we shall presently describe, so as to form one continuous vessel.

"By the operation of the forcing pump, water is continually injected into the two upper tiers of generators, so as to keep them always full, and under the pressure of the heavily loaded valve. The lowest tier of generators contain no water, but are kept at a temperature of about 1,000 deg. F. At each stroke of the engine, a certain quantity of water, heated to about 700 deg. or 800 deg. F., is discharged into the valve box C, communicating with the lowest tier, wherein the water flashes into steam. The steam thus formed passes successively through every pipe in the lowermost range, which is exposed to the strongest action of the fire, before it enters, by a short tube, the safety chamber L, for the supply to the engine, to which it is conveyed by the pipe H. At G is a loaded valve to relieve the pressure, should the chamber become overcharged with steam."

A Critical Pressure

Heating the water to 700 deg. or 800 deg. F. would involve operating at the critical pressure of, say, 3,000 lbs. per square inch.

The late Frederick Sargent talked with me on a number of occasions in regard to the form of boilers that might be developed to meet the demand of increasing pressures. This led to the Babcock and Wilcox Company deciding that it would be advantageous to make experiments on a boiler built along entirely different lines from those it was constructing with the idea of determining the possibilities. This resulted in the design and construction of a boiler between seven and eight years ago in which there was a forced circulation and which had no steam and water drum.

The boiler was purposely made of a form in which it was felt there might be certain difficulties in order to search out the principles involved in such boilers.

The arrangement of the boiler in the form in which most of the tests were made is shown in Fig. 1. In the first tests the water was fed into the cross box most remote from the fire, passed in series through the loops from one cross box to the next, and finally left in a superheated state from the last cross box. But few tests were made on this form, and the boiler was changed by placing the separating tank, dotted in Fig. 1, between the economizer and boiler part and the set of loops nearest the fire which formed the superheater. The boiler was fed in the same way as in the first form, and the steam generated, together with some contained water, passed into the separator. The loops were constructed of 2-in. tubes, and the straight portions of the loops were fitted with cores.

Regulate Water Supply

The water was maintained at a given height in the separating tank by regulating the rate of supply of the feed water, and at the same time a small amount of water was continually bled from the separating tank and returned to the feed water. This insured the passage of a certain amount of water at all times through the economizer and boiler element. From the separating tank the steam was passed to the superheater located next to the fire. The name "Series Boiler" was applied to the apparatus.

It was first intended to place boiler surface ahead of the superheater so that the hot gases from the furnace could pass first over the boiler surface, then over the superheater, and thence over the boiler and economizer surface. In order to simplify the apparatus, the boiler surface was not placed ahead of the superheating surface, and doors were provided in the setting for tempering the gases from the oil-fired furnace to a point where they would be at a low enough temperature to avoid burning the superheater.

After the cores had been adjusted to the size finally used, it was found unnecessary to admit air to prevent the superheater from being burned out even though the oil furnace was at a high temperature.

The superheater tubes became coated with black oxide on the outside, but they did not burn out nor was there any trouble through leakage throughout the tests, although the superheater might have failed eventually had the boiler been run for a longer time. The boiler was operated at a maximum capacity of about 425 per cent. of rating, based on the entire amount of heating surface of the economizer, boiler and superheater. The surface was not arranged in a way to give efficient results, the object of the tests being to determine the features of circulation and the prac-

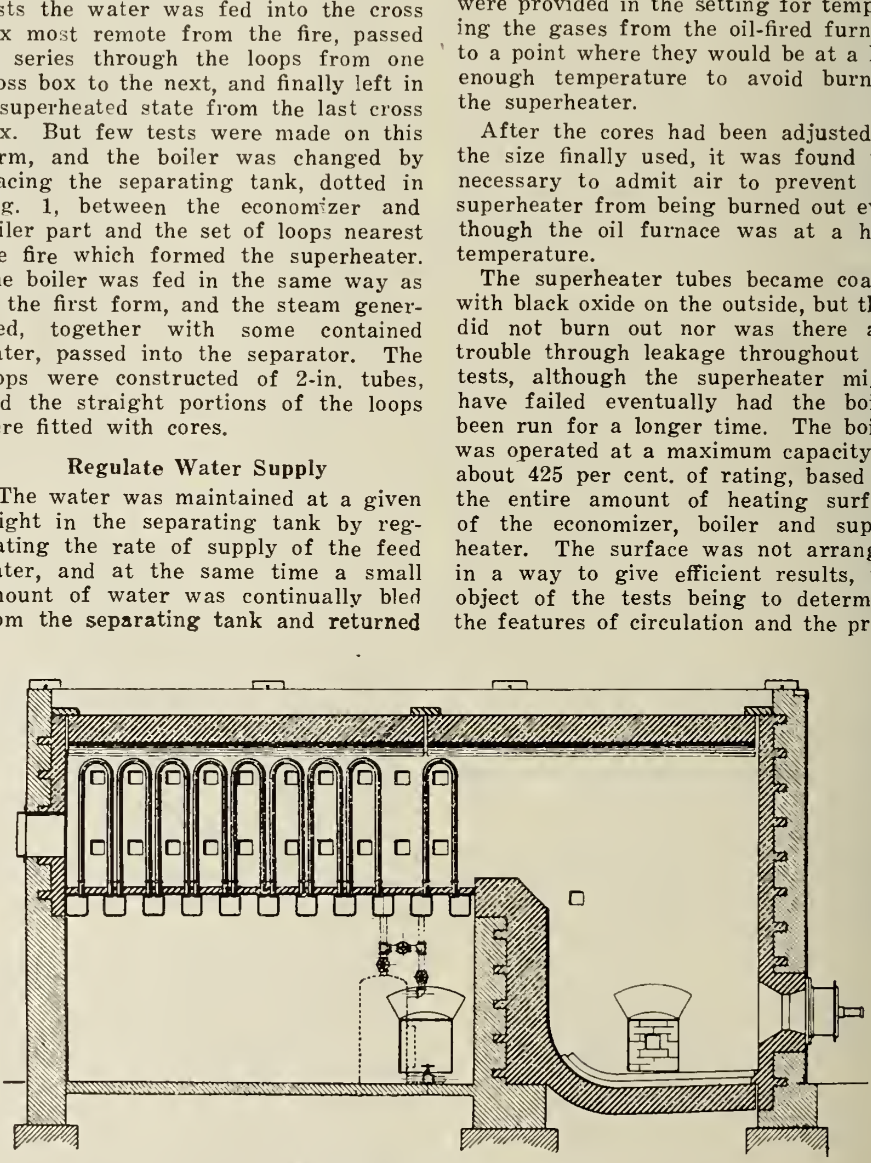


Fig. 1—Experimental Series Boiler.

---

*Advisory Engineer, the Babcock & Wilcox Company.

ticability of operating a boiler of the sort.

In operating a series boiler, care must be taken in starting up to maintain a circulation of water or steam through the boiler. This would necessitate the installation of special arrangements in a power plant, especially if the heat imparted to the boiler in the starting up is returned to the system. Again, it is difficult to operate a boiler of the sort under fluctuating loads, and in any event the feed-water pumping system must have 100 per cent. reliability.

It was therefore decided to build a series boiler to be used in combination with a relatively small boiler, having a steam and water drum. The combined unit shown in Fig. 2 was therefore constructed.

Comparatively Small Unit

This consisted of a boiler with 2 in. tubes having a steam and water drum and a combined boiler and economizer with 1 in. tubes, in which the heating surface was 3.7 times the heating surface of the boiler having the steam and water drum. The unit was a comparatively small one, having 187 square feet of tube surface of the boiler with the steam and water drum exposed to the hot gases, 51 square feet of superheater surface, and 685 square feet of boiler and economizer surface in the section made of 1 in. tubes, or 923 square feet of heating surface in all.

The boiler was fired with oil fuel with a mechanical atomizing burner and operating at 600 lb. gauge pressure. A connection fitted with a valve was run from the steam and water drum to the lowermost part of the series boiler, and this connection was left open in starting up the boiler, so as to provide a local circulation. The unit was run at times at over 500 per cent. of rating, based on the total boiler and economizer surface, and all parts were found to operate in an entirely satisfactory way.

The percentage of rating at which the boiler with 2 in. tubes having the steam and water drum was operated in the high-capacity tests was about 1,500 per cent.

We are building boilers for 1,200 lb. working pressure with wrought steel economizers for power plant surface of the general form shown in Fig. 3, which is illustrative only as certain features of the tube arrangement may be changed. In developing this boiler, we had before us the results secured for the use of 1 in. tubes in a great number of our White-Forster marine boilers for destroyer service and the results of the experiments with the series boiler. A great number of different arrangements were laid out and considered, and the one finally adopted was that shown in Fig. 3, which approaches very closely to a standard Babcock and Wilcox boiler.

Tubes 2 in. in Diameter

In this boiler the steam generating tubes are 2 in. in diameter, which is a convenient size for internal cleaning, whereas it is difficult, if not impossible, to properly clean tubes, say, 1 in. diameter and smaller. The steam and water drum, which is 48 in. internal diameter of forged seamless steel construction, provides a reserve water capacity, making it easy to operate the boiler under all sets of conditions, such as in starting up and under variable loads, and making it unnecessary to provide pumps having 100 per cent. reliability, such as would be necessary for a series boiler.

The tubes are arranged so that they can be thoroughly cleaned on the outside from between the diagonal lanes. The feed water from the economizer passes directly into the boiler, which makes it necessary to build the economizer for a somewhat higher pressure than the boiler. The economizer is made up of 2 in. seamless steel tubes expanded into forged steel boxes.

The boxes are spaced apart to allow the removal and replacement of the economizer tubes from between the boxes with the tubes at an angle which allows the tubes to be removed and replaced with a relatively narrow aisle width. The ends of the horizontal circulating tubes of the boiler are bent so that they enter the drum in circumferential lines which are twice as far apart as the distance between the horizontal circulating tubes where they enter the headers. This greatly increases the efficiency of the ligaments between the tube holes.

There are two circulating tubes runing from the top of each uptake header to the steam and water drum. The boilers are built to meet the requirements of the A.S.M.E. boiler code. Certain features of the forged steel drum are not covered in the A.S.M.E. code, but the general character of the steel in the drum will conform closely to that specified in the A.S.M.E. code for boiler plate and the maximum allowable stress is taken at 11,000 lb. per square inch, thereby corresponding to the figure specified in the code.

Individual Turbines

The boilers built for 1,200 lb. working pressure will be supplied with individual steam turbines. It is the idea to eventually generate all of the steam for a power plant with high-pressure units of the sort, and after passing the steam through several of the high-pressure steam turbines to pass the exhaust steam from these high-pressure steam turbines to a main steam turbine. The steam supplied to the high-pressure steam turbines is superheated to a total temperature of, say 727 deg. Fahr., by primary superheaters.

The exhaust steam from each individual high-pressure steam turbine is returned to a secondary superheater placed with the high-pressure boiler setting at a pressure of, say, 300 lb. above the atmosphere, and is re-superheated to a temperature of, say 725 deg. Fahr., and supplied to the main steam turbine. The individual high-pressure steam turbines therefore serve to reduce the pressure of the steam from the initial pressure of 1,200 lb. to that used at the main steam turbine.

With an economical main steam turbine operated with the exhaust steam from the high-pressure steam turbines, the amount of power generated by the high-pressure steam turbines would be 20 to 25 per cent. of that generated by the main steam turbine. Should the main steam turbine be run at a lower pressure than 300 lb. and at a lower temperature than 725 deg. Fahr., the gain through using the high pressure would be increased and might reach, say, 30 per cent. or more. There is a possibility, therefore, of re-vamping present power stations and considerably increasing their efficiency through using the high-pressure units with individual steam turbines and exhausting the steam into the present steam mains.

In order to warrant the additional investment necessary for installing the high-pressure boilers in an old plant,

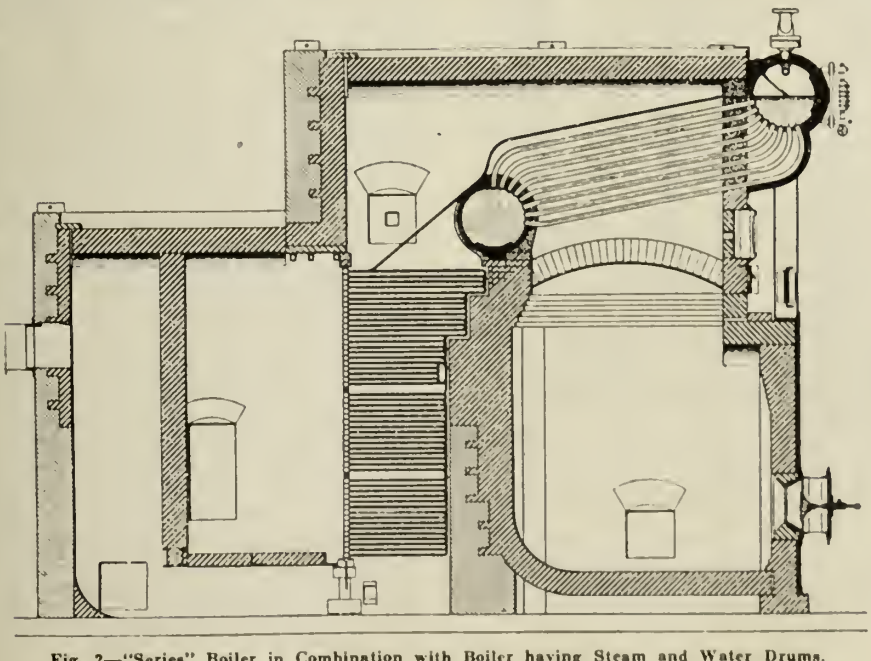


Fig. 2—"Series" Boiler in Combination with Boiler having Steam and Water Drums.

it would be necessary to have a very steady load, or what is known as a "base load condition." The investment would not be warranted under present conditions for a widely fluctuating load.

In place of using individual high-pressure steam turbines for each boiler, the high-pressure steam from a number of boilers could be used for larger high-pressure turbines. Experience alone can demonstrate which system will be best, and no one can say what plan will be adopted in the future in the effort to secure higher and higher efficiencies. There will no doubt be difficulties that cannot be foreseen to be worked out, and those who are pioneers in installing high-pressure units of the sort should be commended for their willingness to spend the time and money that will be necessary in the development.

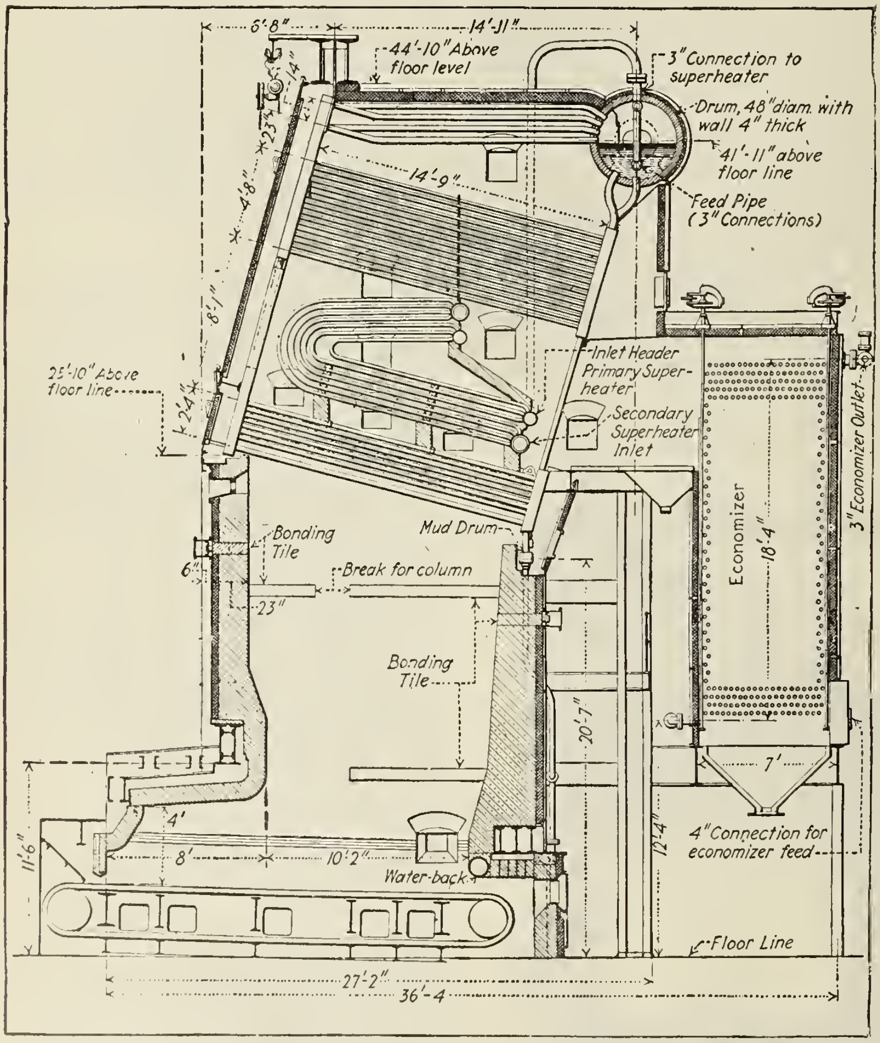
Would Simplify Problem

If it were possible to maintain absolutely tight surface condensers, it would be unnecessary to clean the interior of the boiler tubes, and the problem of designing high-pressure boilers for power plant service would be greatly simplified.

Under present conditions, there is always a chance of leakage at the condensers, either at the tube ends or through the cracking or corrosion of the tubes, and this necessitates arranging the boiler so that it can be cleaned on the inside. Tight condensers and the use of a closed system would also overcome any trouble through corrosion due to oxygen in the feed water on the interior of the economizers and boilers. The fact remains, however, that leakage in condensers has not as yet been overcome, and the problem of both cleaning the interior of the tubes and of removing any excess oxygen from the feed water must be faced in all cases.

The effect of temperature on the lowering of the elastic limit of steel has been referred to by engineers as something that might give trouble in a high-pressure steam boiler. At a temperature of about 750 deg. Fahr. the elastic limit may drop to half that obtained at ordinary room temperatures, and it is important that the effect of this falling off be understood.

The temperature of the saturated steam corresponding to 1,200 lb. pressure is somewhat less than 570 deg. Fahr., and at this temperature the strength of the steel is higher than at ordinary room temperatures and the elastic limit is about the same or only slightly lower, so there need be no apprehension with respect to the boiler proper. The only part that is affected through being brought to a temperature that would cause any material difference in the strength or the elastic limit of the steel is the superheater. Of all parts of a boiler the superheater is the safest as far as its liability to injure anyone or to cause property damage is concerned, as the worst that might happen in case the superheater became overheated would be to burn out or blow out some of the tubes, and this would not ordinarily result in any damage other than to the superheater itself.



SECTION THROUGH BOILER, SHOWING SECONDARY SUPERHEATER AND FOUR-INCH THICK DRUM

Tests Strength of Steel

The effect of a rising temperature is first to increase the tensile strength of steel from, say, 10 to 20 per cent., and afterwards to decrease it, and at 700 deg. Fahr. the tensile strength is about the same as at ordinary room temperatures. At 750 deg. the tensile strength falls off, say, 10 per cent. below what it is at ordinary temperature, and the elastic limit is about one-half what it is at ordinary room temperatures.

In a complicated structure used under pressure at 750 deg. Fahr., the falling off in the elastic limit would result in a liability for leakage, and in such a structure it might be well to use a factor of more than 5 based on the tensile strength. In a structure like a superheater, however, there would seem to be no necessity of providing a factor of safety of more than 5 based on the tensile strength.

We have become so accustomed to the use of relatively high factors of safety in boiler construction to those used in some other lines that we are apt to overdo matters to make sure we are on the safe side. When one considers the relatively low factors used in the design of large guns and for torpedo tubes carrying very high pressures, one feels a great deal safer when it comes to boiler design. Again, in the work we have done in designing and building oil stills and tanks for use at high pressures and at temperatures of 825 deg. Fahr., we made a careful study of the falling off of strength and elastic limit and of the practice in still design that has been found to give safe results, and all this makes us more confident in feeling that the factors of safety we are using in boiler and superheater design are ample.

As superheated steam of higher and higher temperatures is being used in power plants, the time is approaching when it may be necessary to provide some automatic means for preventing the temperature exceeding a certain figure. It has been the general practice to run at a temperature which can be exceeded for a time without giving trouble.

The Babcock and Wilcox Company made experiments over ten years ago to develop an apparatus for attemperating superheated steam and maintaining the temperature at a given figure, provided the initial temperature of the

(Turn to page 47)

Motor Trouble in Power Plants and Its Cure

By R. L. TULLIS

Good Commutation the Keynote to Successful Operation of Direct Current Motors—Neglect, Improper Installation or Continuous Overloading Usually to Blame for A. C. Troubles

IT IS the writer's desire to set forth in as clear, concise, and non-technical manner as possible his practical experiences on the care and maintenance of motors.

A large percentage of all direct-current motor troubles can be directly or indirectly traced to the commutator. Good commutation is the key-note to successful operation of direct-current motors. Therefore a few pointers on the proper care of commutators may be in order.

The commutator should be kept clean, dry, and free from oil, grit, smut, etc. If oil or grease is allowed to collect on the surface of the commutator, it will prove an aid to the collection of grit, copper dust, and smut which will soon destroy the commutator surface and cause the brushes to wear away quickly. Again, more serious trouble may be caused by the accumulation of copper or carbon dust in the grooves between the segments of the commutator; a short-circuit will result, and the armature is liable to burn out.

Cut Grease Loose

The commutator can be cleaned and polished while in motion by holding a pad of clean canvas against the revolving surface. Where the commutator is badly oil-soaked or greasy it is sometimes advisable to use a small amount of gasoline to cut the smut and grease loose.

Formerly it was the practice of many operating engineers to apply a small amount of vaseline or a tallow candle to the surface of a commutator. This was supposed to prevent sparking or chattering of the brushes. At best the effect of such treatment is only temporary, and encourages the collection of destructive substances on the surface of the commutator.

Modern engineering practice does not advise the use of lubrication on a commutator. If the surface is smooth and polished and the proper quality of brushes used, lubrication is unnecessary.

Chattering of Brushes

High mica or mica extending above the surface of the commutator is often the cause of sparking, chattering, or jumping of the brushes. High mica is usually caused by the brushes wearing the copper surface more quickly than that of the mica between the segments.

On the other hand, too deep undercutting of the mica encourages the collection of copper or carbon dust worn from the commutator surface and the brushes. This collects in the grooves between the segments, and a short-circuit is liable to result. The depth of the undercutting should vary between 1-32 in. and 1-16 in., depending upon the size of the commutator. The undercutting grooves should be V-shaped or with bevelled edges to prevent cutting of the brushes against the sharp edges. Also the V-shape facilitates the throwing out of undesirable foreign substances by the centrifugal action of the revolving commutator.

Heating of Commutator

Heating of the commutator may be due to a number of causes. Severe overloading will cause sparking and excessive heating of both the motor and commutator. Many motors are burned out by overloading without the engineer becoming aware of the real cause of the trouble. Every engineer in charge of a number of motors should have a portable ammeter which he can temporarily connect in on the line and ascertain whether the motor is pulling more than its rated capacity.

Excessive heating of the commutator may also be caused by poor contact of the brushes. Again, it may be due to burned or roughened surfaces or the presence of dirt, smut, or oil, which prevents proper transfer of current from the brushes to the commutator.

Commutator trouble is often caused by the mica insulation between the segments becoming oil-soaked, which in turn will cause disintegration and honeycombing of the insulation, eventually leading to a short-circuit between the segments or to the shaft of the machine.

Need of Cleanliness

The bearings may become worn and leak or throw oil, which will be drawn into the machine, due to air currents used in the ventilation of modern machines.

As a result of poor ventilation methods many motors and generators suck in and collect a great amount of dust, grit, smut, or lint from the surrounding atmosphere. Therefore, it is advisable to use some type of enclosed or dustproof machine, where the atmosphere is heavily laden with destructive substances.

Moisture, acid, and oil-laden air is injurious to motor insulation; precautions should be taken to protect the motors as much as possible from such conditions.

Occasionally, it is advisable to cover the motors with some form of thin sheet-iron housing; but an the other hand, if enclosed too tight, lack of proper ventilation is liable to cause serious overheating. All motors should be thoroughly cleaned at least once a week by blowing out with compressed air. If oil, dirt, and smut cannot be removed with compressed air, they should be wiped out with a cloth saturated in gasoline.

Portable Blowing Outfit

Very often in large industrial plants there is no compressed-air line near the motors to which a hose and nozzle can be attached to blow out the motors and electrical equipment. In such cases it is advisable to construct a small portable blowing outfit mounted on a four-wheel truck. Such an outfit consists of a small air-cooled motor-driven air compressor (which can be attached to any lighting circuit), together with a pressure tank and any length of small air hose desired. Such an outfit can be wheeled around with each, making it possible to reach motors in inaccessible positions where there is no compressed-air supply line.

A badly grooved and scored commutator is caused by improper staggering of the brushes—that is, they are allowed to follow in each other's track. The brushes should be adjusted or staggered as to completely cover the commutator surface, leaving no uneven surface or high ridges between.

Care of Brushes

If the commutator is eccentric or out of round, badly grooved, scored, or cut, it should be taken out and turned down. However, before putting it back in operation the surface should be polished with fine sandpaper, as the cutting tool used in turning often leaves minute sharp edges or particles, which will cause unnecessary wear on the brushes.

If the commutator is eccentric or out of round, and is not too badly grooved, scored, or rough, it may be trued up or smoothed by the use of a revolving wheel grinder made especially for truing commutators, or it may be stoned by holding a grindstone or medium-grade scythe stone against the revolving surface. The surface should be ground down evenly by working the stone from one end to the other.

The job should be finished with the finest grade of quartz sandpaper and polished with a pad of clean canvas.

Many engineers apply sandpaper while the brushes are down and the motor in operation. This is undoubtedly the easiest, but at the same time an improper method, as fine particles of sand and copper dust are certain to work under and become embedded in the contact surface of the brush. This will cause undue wear and cutting of the surface of the brush and commutator, together with sparking. In a short time the conditions will be as bad as they were before the treatment.

Do Work Properly

In order to do the work properly it is necessary to revolve the commutator with the brushes raised, by some means other than its own motive power.

At the present time, carbon and graphite, or a combination of the two substances, are the main materials used in brush construction. The brushes are manufactured in various qualities and degrees of hardness to suit individual requirements.

Carbon and graphite brushes have come into universal use because they are comparatively soft, less injurious to commutator surface, are superior conductors of electrical current, and can be radially applied without injury to the commutator, making it possible to reverse the direction of rotation of the motor without changing the position of the brushes and without injury to same.

In operating direct-current motors it is important to keep the brush pressure at the proper value. All brush-holders are equipped with adjustable springs, whereby the brush pressure may be increased as the brushes wear down. Insufficient brush pressure will cause sparking and jumping of the brushes.

Hit and Miss Principle

If the brushes wear to any great extent and the brush pressure is not increased, the brushes will fail to make proper contact with the commutator surface. Arcing will take place, the commutator will become burned, and the motor will operate on the hit-and-miss principle, due to the jumping of the brushes.

If the motor is operated in parallel with the lighting system this will cause fluctuation of the line voltage and may cause flickering of the lights on the circuit. On the other hand, too much brush pressure will cause an undue amount of friction and consequent heating of the commutator, together with rapid wear of the brush surface.

Brushes sticking in their holders will cause sparking and troubles similar to those described above. The brushes should move freely and smoothly in their holders without being loose.

If the brushes are loose in their holders and the commutator is rough it will cause noise and chattering while in operation. A set of brushes under proper conditions should last from two to three years. There are exceptional cases where they have been in operation from ten to twelve years; however, under adverse conditions they may only last for a few weeks.

Burning of Brushes

Glowing or burning of the brushes may be caused by overloading of the machine, improper contact, improper fitting of the brushes, or insufficient brush pressure. All brushes should be carefully fitted to the curvature of the commutator. It is not advisable to use graphite brushes where the motors are exposed to oil vapors. Under such conditions dry carbon brushes should be used.

The brushes must be equally spaced about the circle of the commutator—that is, the distance between each set of brushes must be exactly the same, otherwise unbalancing of the armature circuit will result.

The distance between each brush-holder and the surface of the commutator should be identical. If the brush-holder becomes loose, the spring pressure will force it backward, away from the commutator. The position of the brushes will be changed, the brush pressure lessened, and sparking will result.

Pig Tail Necessary

Many engineers make the mistake of installing brushes on motors without pig-tails. The pig-tail is necessary to conduct the current from the holder to the brush, whence it travels through the brush to the armature circuit. Occasionally the pig-tails become loose or burnt off.

Brushes without pig-tails make a faulty, loose connection. If the brushes become loose in their holders, the current will arc between the two; brushes and holders will be pitted and burnt by the action of the current.

A.C. Motor Trouble

On alternating-current motors the commutator, brushes, and brush-holders are eliminated; due to the elimination of these three parts a great deal of the repair and maintenance troubles peculiar to the direct-current machine is automatically done away with.

Probably 90 per cent. of all direct-current motor trouble can be directly or indirectly traced to some form of commutator or brush trouble. Due to the fact that the alternating-current induction-type of motor is void of these troublesome parts, it is probably the most satisfactory prime mover of the present day.

Most motor troubles can be attributed to lack of proper care or attention, improper installation, or continuous overloading above their rated capacity.

Cleanliness is of the greatest importance around all types of electrical machinery; still many engineers fail to realize this fact.

There are hundreds of small installations where the motors are expected to run from year to year without ever being properly cleaned; still the operators wonder why it is that the machines burn out their windings occasionally.

Ventilation Important

Ventilation methods used in the construction of all modern types of machines cause them to suck in and collect a great amount of dust, grit, lint, and other destructive impurities in the atmosphere. Then if the bearings become loose or worn, they will leak or throw oil, which also will be drawn in by the

---

Demands Revision of Boiler Law

Power House Takes Part in Deliberations at Spadina Crescent on Invitation of Ontario's Minister of Labor

THE wheels of the gods grind slowly—at Spadina Crescent, Toronto. Three pages of the June 5 issue of Power House were devoted to the charge that former Minister of Labor Walter Rollo was "too busy to heed the claim of members of the Canadian Association of Stationary Engineers, of Councils of the Universal Craftsmen, of the International Union of Steam and Operating Engineers, of boiler manufacturers and city officials that "holes" in the Ontario Inspection Act made it the poorest in the Dominion.

And now on the eve of the publication of this issue of Power House, more than four months after the criticism in question had been commented on favorably by daily newspapers throughout the province, a "meeting of representatives interested in the manufacture, repair, sale, purchase, operation and insurance of Steam Boilers and Pressure Vessels has been arranged by the Department of Labor, and approved by the Hon. Dr. Forbes Godfrey, Minister of Public Health and Labor.

In inviting Power House to take part in the deliberations, James H. H. Ballantyne, deputy minister of labor, says: "It is the intention of this department to find out and how far and to what extent the present statutes are effective in meeting and dealing with the most important phases of the Steam Boiler and Pressure Vessel industry, and your co-operation and aid in discussing this important matter will be greatly appreciated."

Let us hope that this investigation will not be farcical—that as a result of the accession of Dr. Godfrey to the portfolio of minister of labor, more will come of it than "the careful consideration of the department." If Dr. Godfrey has any doubt of the absurdity of present conditions, of the absurdity of sixteen inspectors responsible for the proper observance of the Factory Shop and Office Building Act, including four women, being responsible for the inspection of operating boilers, let it be remembered that explosions in Ontario are more numerous than in any other province of the Dominion, despite the fact that the modern steam boiler as manufactured in Ontario, if periodically inspected in a capable manner during operation, is perfectly safe.

suction of the machine. Thus a mixture of oil, dirt, and lint will collect between the adjacent coils and windings; a short-circuit is liable to result, or at least the insulation will be damaged by the accumulation of such impurities.

All motors should be frequently blown out with compressed air. The air pressure generated by a hand bellows is usually not sufficient to thoroughly clean a motor.

All oil, moisture, or acid-laden vapors should be kept out of the winding of the machines. If the bearings throw oil they should be protected by suitably constructed guards. Very often this trouble is caused by worn bearings and can be remedied by the installation of new bearings.

Inspect Bearings Weekly

If the bearings become badly worn they will often throw all the oil out of the reservoir within a few days; while if they are in perfect shape they will retain oil for a long period. To avoid trouble from running dry and burning out, the bearings on all motors should be inspected once per week.

The writer was once employed in a large factory which contained about 200 motors of various sizes ranging from 2 h.p. to 12 h.p. The motors were all of the induction type operating on 220-volt, three-phase, 60-cycle alternating-current system.

In this plant a great deal of trouble was being experienced due to the motors burning out. Nearly every week one or two motors were being sent to the shops for rewinding and repairs; consequently the bills for repairs were large.

A study of the situation soon disclosed the cause of the trouble. Every motor in the building was equipped with the ordinary type of three-pole knife switch for starting and stopping. Nearly every one of the motors was heavily over-fused, and was handled by anyone who had occasion to use them. Many of the motors were heavily overloaded, and when in operation would blow a fuse on one phase of the line.

Due to Bad Bearings

The motor would then continue to run on one phase until it burned out or became badly over-heated. On a number of occasions the motor burn-outs were due partly to bad bearings. If the motor bearings were badly worn and would lose their oil, they would run hot and seize the shaft. Then, when the motor had stopped, the current would continue to flow through the winding until it was burned out.

Ninety per cent. of the motor trouble and consequent expense of repairs in this plant was eliminated by the proper care of motors and in the installation on each motor of a modern type of automatic protective switch, which prevented the continuous overloading and single-phase operation of the polyphase motors.

The air space or clearance between the rotor and fields of an induction motor is very small; consequently, if the bearings wear to any extent, the rotor will rub on the field windings and excessive friction will result. Such a condition should be remedied at once.

Low voltage will cause trouble with the induction type of motors, as the turning power or torque is proportional to the square of the applied voltage; thus half voltage would produce quarter torque, and the motor would become seriously overloaded.

Most motor-bearing troubles can be attributed to excessive belt tension, dirt in the oil, oil-rings not turning, or improper line-up of motor to its load. Unbalanced voltage or a three-phase system will cause motor trouble due to low voltage. If the voltage differs on the two legs of the circuit by 20 per cent., the output of the motor will be reduced 25 per cent., and serious overloading and burning-out of the motors are liable to result.

The writer recently came into contact with a case of an unbalanced circuit in a large plant which contained a great number of small motors.

The current was supplied through step-down transformers. The power and light circuits were taken off the same main line, the motors operating on 220-volt three-phase, 60-cycle current, while the light circuit was stepped down to 110-volt.

Additional motors and lighting circuits were being installed frequently, and the circuit was not equipped with any form of balancer coil; consequently the circuit became badly unbalanced. Both the motors and lights soon began to give a great deal of trouble.

A number of motors were burned out, undoubtedly due to low voltage and consequent overloading, while on the other side of the line the lights would burn out in a short time. The trouble caused

(Turn to page 47)

"Jokers" Weaken Ontario Act

Engineers Feel Examinations Should be Standardized and Not Designed to Offset Variations in Labor Market

WHO is responsible for the present administration of the Ontario Stationary and Hoisting Engineers' Act? As pointed out previously in Power House the manner in which this act is administered at present, tends, in contrast with a province like Quebec, to place Ontario in the position of not knowing exactly what qualifications are required for the issuance of certificates, and raises doubt as to whether the demand for these qualifications is constant and consistent.

The regulations promulgated by order in council with regard to the enforcement of the act would appear to be partly responsible for the inconsistencies and irregularities in the act's administration. On the other hand, they certainly are not responsible for the variation in the standard of the examination set from year to year such as has apparently been the case in past years.

It has been suggested on several occasions that this variation in the standard of examination was designed to offset variations in the labor market, the examinations being more severe in the days of labor plenitude and less of an obstacle to a certificate when the demand for men was pronounced.

Collect $22,000

The government, according to the third annual report of the Department of Labor, collected upwards of $22,000 in fees for engineers' certificates and plant owners' registration certificates. This amount should adequately cover the cost of administration and both the public and the engineers of the province have a right to expect an efficient and fair enforcement of the act for their money.

The examinations for provincial certificates should be wholly for the purpose of ascertaining whether a candidate has sufficient knowledge and experience to properly perform the duties an engineer of his class may be called upon to perform, and as this requirement is primarily for the protection of the public, every man in charge of a plant for which a certified engineer is required under the act should have the necessary certificate, except those continuing in positions they held before the act came into force.

Qualifications Vary

With regard to qualifications required from candidates for second class certificates it is to be noted that an apprenticeship of at least two years as a stationary engineer, erecting engineer, machinist, boiler maker, or blacksmith is required, or the candidate must have completed at least a two year course in Science or Engineering in any university.

What about the two year student of steam engineering in a technical school? Surely the student of a good technical school has as good a foundation in knowledge and experience for this work as has the two year blacksmith apprentice.

What is the standing of the marine engineer under existing regulations, as a ship can hardly be regarded as a building, and the definition of plant given might be used to bar him from a certificate regardless of his knowledge, his experience not having been gained in a "steam plant" within the meaning of the Act.

A comparison of the Ontario and Quebec requirements for the various grades of certificates shows that in the latter province the requirements in the way of operating experience are much larger than in Ontario and it is felt by competent Ontario engineers that this province could well afford to model the requirements upon the lines of the Quebec Act.

How Heat is Produced by Combustion of Coal

This Paper, Written by a Well Known Canadian Engineer, is the First of a Series to be Given as Part of the Educational Program of the Canadian Association of Stationary Engineers

COMBUSTION or burning is defined in "Experimental Engineering" as "any kind of chemical combination evolving heat." It explains further that "the only kind of combustion used to produce heat for engineering purposes is the combustion of various kinds of fuels with oxygen."

There is nothing very enlightening in the definition unless something is known about physics and chemistry, therefore it is necessary to take some time here to explain how these sciences are mixed up in the burning of coal.

There is more or less water in all coal, which begins to come off as vapor, just as soon as the coal is placed in a hot furnace, and, because water boils at 212 deg. Fahr., most of the water in the coal is evaporated as soon as the lump reaches that temperature. A physical change takes place. The heat of the water is raised till it has suffered a "change of state," but it is still water, and if allowed to condense again, it becomes a liquid.

Molecule Smallest Part

The smallest portion of any substance is called a "molecule" which means "a small mass." The molecules of water may exist as ice, water or steam. The change of state does not change them, except to increase their activity if they become gas or to slow up their motion if they become solid matter.

The chemist examines every substance to see how it is made up. His idea is to know matter in its simplest forms and learn how to combine these simple forms to make up various substances. He can prove for instance, that the molecule of water is made up of hydrogen and oxygen, both of which are gases under ordinary conditions.

Also that in all of the substances in daily use there are only some eighty elements from which it is impossible to get any other substance.

For the practical chemist, the smallest unit is called an atom, which means "can't be cut, indivisible." If no more than one kind of atom can be gotten from a substance, that substance is called an element. Atoms or elements do not usually exist alone, but form partnership with others of their kind to form a molecule.

Two quite different substances may unite to form a third entirely different from either. If they do, the process is carried on atom by atom, and the results are exact in every case.

Forms Carbon Monoxide

If a molecule (two atoms) of the carbon in coal is placed where a molecule (two atoms) of the oxygen of the air can get at it, and the temperature is high enough, each of the atoms of the carbon partnership immediately leaves his brother for one of those of the oxygen partnership because they have greater liking or "affinity" for the atom of the other than for their own. They enter into "chemical combination" to form carbon monoxide (CO), a substance which is entirely different from either.

Just why the atoms of one element should have such a decided preference for the atoms of certain other elements, but want a mere acquaintance with those of a second element, and have no liking at all for those of a third element, has never been explained.

It is a fact just the same, and follows along such strict lines that laws are based upon them, and it is possible to tell what will happen when one element is brought into contact with another at the right temperature.

For example, it is known that immediately one atom of carbon is reached by two atoms of oxygen at a temperature of from 755 deg. Fahr. to 925 deg. Fahr., two molecules of CO_2 ($2C+2O_2=2CO_2$) are formed.

When water is changed to steam, many heat units are necessary to effect the change, and this heat will be given out when the water is condensed again. Likewise, heat is "evolved" or produced when water is turned to ice. In the same way heat is a factor in every chemical combination which takes place. The plants and trees which were growing several million years ago were taking CO_2 from the air to make our coal. This CO_2 was decomposed by the heat of the sun, the carbon being retained by the plants, while the oxygen was returned to the air. When that carbon in the form of coal is placed on grates and air brought into contact with it, just as many heat units are given back as were used up in the leaves of the ancient trees.

What has just been stated will explain the fact frequently made in engineering books, to the effect that all the heat of our fuel came from the sun. It did, indirectly, for as has been said, the sun supplied the heat for the chemical action which could not have taken place unless there had been a supply of heat available.

Some idea of the quantity of heat supplied by the sun may be obtained by estimating what heat the combustion of the coal will produce, for the amount produced is equal to the amount absorbed in the years long gone by.

It may be explained here also that although in our every day work it is customary to speak of the number of B.t.u. per pound of coal, the heat units are not actually in the coal. What is meant is that if the coal is brought into contact with oxygen at the right temperature, a chemical reaction will take place in which just so many B.t.u. per pound of coal fired will be produced.

Heat cannot be explained. All that is known is that when energy in this form is applied to a substance, the molecules move more rapidly, and when heat is removed, they slow down. If we apply heat until the substance reaches a certain temperature, solid material will change to a liquid or gas and atoms are likely to hook up with oxygen to form new substances.

Action takes place between the constituents of coal at any temperature. Only a small amount of heat is developed at ordinary temperatures, but coal that is allowed to lie exposed to the weather for several years will lose enough heat to make an appreciable difference in its heat content.

If a fire starts in the coal pile, it is because the heat is confined and the temperature builds up to the point where the heat evolved in the chemical reaction is greater than that lost by conduction through the surrounding coal.

At a Temperature of	Substance	Symbol	Equation
	Carbon	C	$2C+O_2=2CO$
766	Fixed Bit. Coal		$2C+2O_2=2CO_2$
870	Fixed-Semi-Bit. Coal		
925	Fixed-Anthracite Coal		
1210	Carbon Monoxide	CO	$2CO_2+O_2=2CO_2$
1130	Hydrogen	H	$2H_2+O_2=2H_2O$
470	Sulphur	S	$S+O_2=SO_2$
			$S+3O_2=2SO_3$
1202	Methane	CH_4	$CH_4+2O_2=CO_2+2H_2O$
900	Acetylene	C_2H_2	$2C_2H_2+5O_2=4CO_2+2H_2O$
1022	Ethylene	C_2H_4	$C_2H_4+3O_2=2CO_2+2H_2O$
1000	Ethane	C_2H_6	$2C_2H_6+7O_2=4CO_2+6H_2O$
	Hydrogen Sulphide	H_2S	$2H_2S+3O_2=2SO_2+2H_2O$

This phenomenon occurs in lighting a fire, heat is applied to a portion of the fuel until chemical action begins and the heat released is sufficient to raise the temperature of the surrounding fuel till the process goes on of its own accord.

Moisture Driven Off

If heat is added to a single lump of soft coal the moisture begins to vaporize at once, and the water is for practical purposes completely driven out by the time the temperature of the coal has reached 212 deg. Fahr.

Molecules in the coal are caused to move much more quickly than before, and the hydrocarbons begin to come away in the form of gas. This continues till a piece of coal is at a red heat through and through.

The gases are not all driven off at the same temperature, nor do they ignite till they are raised to a very much higher temperature.

As all the combustibles in our lump of coal should produce heat, it is necessary to arrange the furnace so the temperature is high enough to ignite every different compound coming from the coal. Also, the right quantity of air has to be supplied when the ignition point is reached.

This is not as easy as it sounds, for a lump of soft coal weighing one pound is only about four inches square. Even if the arrangements are so good that it will take only 12 pounds of air for its perfect combustion, this air will occupy approximately 163 cubic feet of space.

Suppose this 163 cu. ft. of air (more or less) is passed over the small lump of coal during the time it takes to heat it through and through. The great difficulty will be to do it, without supplying too much or too little oxygen for proper chemical combination.

The lump is lying on the grate with spurts of gas coming from it here and there. These gases mix with the air arising through the grate and combustion may or may not take place in the space above the lump, all depending on the temperature.

Like a Sponge

Suppose that half its actual volume is driven off the lump of coal in the form of gas. How does the rest burn? It is probable, though I have never seen any explanation of the process, that the molecules of the fixed carbon are in such violent agitation due to their heated state, that the lump of coal is like a sponge and the oxygen gets right through it.

The heat from the combustion of the fixed carbon keeps the gases moving straight up unless the draft pulls them in other directions.

Consider first the case where they do mount straight up. If conditions are exactly right, the body of burning gas should take the same shaped form as the flame of a candle, although the edges will be somewhat jagged. The molecules in this body of gas are highly heated and according to their nature they rush along in straight lines, so that each molecule comes to the outside eventually and is mixed with the necessary air for combustion.

It might be assumed, without being so very far wrong, that they travel straight upwards. That would insure that each molecule got enough air to burn just where it reached the surface of the body of flame. If the distance is great enough and the temperature high enough, any quantity of gas would be burned eventually.

What happens if some object below the ignition temperature interferes? Suppose the sheath of burning gas is broken by boiler tubes or bits of the shell of a boiler. What is to prevent all the gas inside the cone from escaping up the stack unburned? Not a thing, if there is no heat to raise its temperature to the ignition point again.

It might be advisable to note that owing to the metal being a good conductor of heat, the tubes or shell of a boiler are very little hotter than the contents, which is at a temperature corresponding to its pressure, and therefore cool compared to the gases which should be somewhere above 2,000 deg. Fahr.

So far only a single lump of coal has been considered. If a number of lumps are placed in a row, the conditions remain much the same, for the air flow between the lumps would probably be sufficient to supply oxygen enough for proper combustion.

Suppose one extra lump is placed on top of the row where it is exposed to the heat on all but one side. It is likely that that particular lump will give up its gas faster than any of the others, while the lump below will give up very little less than those along side it which are not covered.

Keep Fire Level

Together the two lumps will produce about as much gas as any other two lumps, therefore double the air will be required just over that spot on the grate than above any other. That spot can only get air through the grate as fast as the others, so it will be dull and send up a smoky flame. This is one reason why the fuel on the grate should be kept level.

GOLDIE & McCULLOCH AND BABCOCK-WILCOX EXPANSION

A complete chain of offices across the Dominion, with a strengthened sales force, and the utmost in plant and service efficiency, will be developed by the amalgamated firms of Babcock-Wilcox & Goldie-McCulloch. The head office will be located in Galt, and the present Babcock-Wilcox office at Montreal will be retained.

This much has been intimated by officers of the new firm, who are busily engaged with organization and expansion plans.

R. O. McCulloch is president of the new company, A. G. Pratt of New York is chairman of the Board of Directors and A. R. Goldie, vice-president. The other directors are Sir James Kemnal, managing director of Babcock-Wilcox, London, England; W. D. Hoxie, of New York, president of Babcock-Wilcox Company of New York; E. H. Wells, of New York, chairman of the board of Babcock-Wilcox Company of New York, and A. W. Atwater, K.C., of Montreal.

Power House Service in Quebec

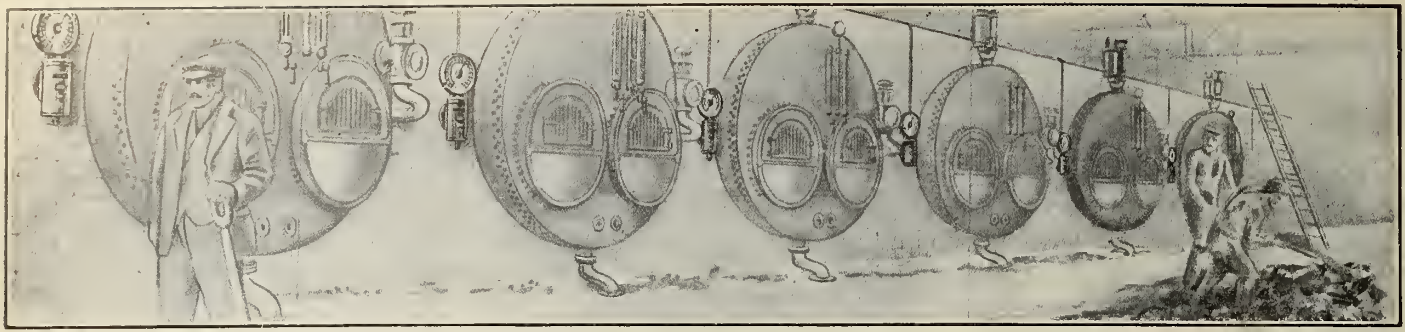
Field Engineer Walter J. Hudson in Montreal to Aid Engineers in Solving Power Plant Problems

RETURNING from a unique service trip to Winnipeg on behalf of Power House, Walter J. Hudson, field engineer, is now in Montreal. That his western trip was such a success Mr. Hudson attributes to the co-operation and assistance of the northern and western engineers, and he wishes to express his appreciation through the columns of Power House. Mr. Hudson feels particularly indebted, among others, to Robert A. Stewart, chief inspector, Bureau of Labor, Winnipeg; W. J. Restall, worthy chief of Winnipeg council, U.C.C. of E.; J. Mills, supt. Grain Exchange Building Winnipeg; William Usher, Engineers' Supply Company, Winnipeg; A. Rusk, chief engineer, Fort William Pulp and Paper Mill Co.; G. W. Exell, chief engineer, General Hospital, Fort William; S. Smith, engineer, Canadian National coal docks, Port Arthur; F. H. Redmile, chief engineer, Central School, Port Arthur; W. J. Ferguson, chief engineer, Thunder Bay Elevator, Port Arthur; W. A. Dedman, chief engineer, Spanish River Pulp and Paper Mill Co., Sault Ste. Marie.

As on his western trip, Mr. Hudson is giving the benefit of his many years' experience in power house problems to all operators who may have perplexing problems to solve or difficulties to overcome in power plant operation.

Few men in Canada in engineering circles have had greater experience than Mr. Hudson, who qualified as a stationary engineer in 1881, and who since that date has filled executive positions with a number of prominent firms in the United States and Canada. His Canadian experience since 1913 has been with such well-known plants as the Moffat Stove Company, Weston, the Standard Sanitary Manufacturing Company and the Coca-Cola Company, of Toronto.

Mr. Hudson is a past master of the A. F. & A.M., and past district deputy of the I.O.O.F. He is a past chief of the Universal Craftsmen Council of Engineers, from which he resigned his position as secretary of Toronto No. 27 on Aug. 27 last.



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.
Director of Engineering, Central Technical School, Toronto.

IN DISCUSSING the generation, transmission or application of power, many people use mechanical terms in the wrong sense or designate mechanical quantities in the wrong units. This is noticeable even among engineers. Of course we must assume that in the case of engineers, such wrong usages are just the result of carelessness or thoughtlessness.

On the other hand most of us do not wish to be considered careless or thoughtless, and it is therefore well for us to check ourselves up from time to time on such questions.

One trouble seems to be that many engineers are too lazy to use compound units of measurement when there is no simple unit of the quantity we are talking about. One of the simplest examples of such laziness or carelessness is in the case of areas. Often we hear such expressions as—so many yards of sheet packing—when "square yards" is meant; or a pressure of so many pounds, or so many pounds per inch when "pounds per square inch" is intended.

Of course everybody knows better than to use such expressions and it is a mere detail, and everybody knows what we mean anyway; but it is the man who is careful about all details who gets along, for if he forms the habit of care in details in his work, he will be careful about details in all his dealings, including his conversation.

An employee's attention to details is often the only characteristic by which an employer is able to judge of his engineer's interest in his work, etc., and it is by the engineer's conversation and written reports that the employer can notice such details.

Clear Up Doubts

There are other quantities, less simple than areas, about which even some engineers seem a little hazy, and it is the purpose of this lesson to try to clear up these knotty problems. The more important quantities of this type in the engineer's work are—force, pressure, work, power, energy, etc.

There is no need of a definition of the word "force." It is merely necessary to mention that a force is measured in pounds, the pound being the force exerted on a unit mass by gravity at sea level. Pressure on the other hand is the amount of force acting on a unit of area, and can be found by dividing the total force acting on the body by the area on which it acts.

Thus the unit of pressure will be the unit of force divided by the unit of area such as "pounds per square inch." The word pressure is often used to designate the total force acting on a body instead of that acting on a unit area. This is not technically correct, but should be designated as "total pressure" to distinguish between it and unit pressure. In this case total pressure really means a force and will be measured in the units of force, or the pound.

Work is defined as "a force acting throughout a distance." Thus if a force is acting on a stationary body there is no work being done, as there can not be work without movement through a distance. The unit in which "work" is measured is the unit of force multiplied by the unit of distance, or the "foot-pound."

Rate of Work

Power may be defined as "the rate of doing work." This brings into consideration the unit of time as well as those of force and distance, making our unit of measurement more complicated still. In expressing speed, or the rate of moving through a distance, we use a unit such as miles per hour, or feet per second, which is the unit of distance divided by the unit of time, or the distance moved by the time taken to move through that distance.

Likewise in determining the rate of doing work, we divide the work done by the time consumed in doing it, thus we may have a unit of power which is the unit of work divided by the unit of time, such as the foot-pound per minute.

The "foot-pound per minute" is a comparatively small unit and if we try to measure very large powers such as are used at the present day by this unit we will find that we should have enormous figures to handle, and one is always more likely to make mistakes in handling large numbers than small ones.

In order to be able to do more of our work in small figures we use a larger unit of power called a "horse-power."

This unit is thirty-three thousand times as big as the foot-pound-per-minute, or one horse-power equals 33,000 foot-pounds per minute. This larger unit is also convenient in that we all can form a better mental conception of a horse-power than we can of the foot-pound-per-minute for the reason that we know what a horse can do, thus in speaking of power in this unit, we get somewhat more of an idea of just what that amount of power is, than when we use the abstract units.

Energy and Power

Energy is "the ability to do work," and since a certain amount of energy is only able to do a definite amount of work, it can be measured by the amount of work it is capable of doing, or in "foot-pounds." Thus it is seen that power and energy, which are so often confused with one another, even by many engineers, are entirely different things and are measured in different units. Power may be defined as the rate of transfer or production of energy.

There are various forms of energy, prominent among which are heat, electrical energy, mechanical energy. These various forms of energy are measured in various units. In the case of heat, the quantity of energy is measured in British Thermal Units, or B.t.u's. This unit is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

It has been found by a long series of scientific experiments that one B.t.u. is equal to 778 foot-pounds, and if we could change heat into mechanical energy without any loss during the change, each B.t.u. would do 778 foot pounds of work. Unfortunately, it is as yet impossible to change heat into mechanical energy without loss.

Introduces Time Element

The rate at which heat energy is being transferred or produced may be considered as a measure of power. This requires the introduction of the time element into the unit of measurement, and power in the form of heat may be expressed as so many B.t.u.'s. per minute or per hour. The term "boiler horse-power" which has been used quite extensively was intended as a unit of heat power, or of rate of heat transfer. This unit has had various definitions, some of which were quite exact in value, while others were anything but definite as a measure of power or capacity to produce power.

Kent in his handbook says "No definite value can be given to this measure, which varies largely with local custom or individual opinion of makers and users of machinery." The most commonly accepted value of the B.h.p. is the equivalent of 33,479 B.t.u.'s. per hour. Converting this to mechanical units it becomes about 435,000 foot pounds per minute, or just over 13 horse-power.

Literally speaking there is no such thing as boiler power, because power is a rate of doing work, and a boiler does not do work, but merely transfers heat units. One should therefore not speak of the power of a boiler, but of the capacity of the boiler.

In electrical work the relation between the units of power and energy is just the reverse of that in mechanical work. In the latter case the unit of power is a compound of the units of energy and time, or is the unit of energy divided by the unit of time, while in electricity the unit of energy is the unit of power multiplied by the unit of time.

The watt or the kilowatt (equals 1,000 watts) is the accepted unit of electrical power, or rate of flow of electrical energy. Therefore the amount of energy transferred in a given time will be the product of the rate of flow and the time, or will be measured in watt-hours, or kilowatt-hours.

The commonly known relation between the electrical and mechanical units of power is, 746 watts equals 1 horse-power. Therefore, one watt equals 33,000 ÷ 746 equals 44.3 foot pounds per minute. One watt-minute will equal 44.3 foot pounds, and one watt-hour will equal 44.3 x 60 equals 2,658 foot pounds.

A mistake which is frequently made is in expressing the capacity of any piece of apparatus in the wrong units. This is especially the case in electrical generators and motors, which are often indiscriminately spoken of in horse-power or kilowatts. The capacity of any piece of apparatus should be expressed in the units in which its product is measured.

The product of a generator is electrical energy, and should therefore be measured in watts or kilowatts, and the machine should be rated in these units. The product of a motor on the other hand is mechanical energy, and therefore the motor is rated in horse-power. It will be noticed that the manufacturers always rate their machines in this way.

To be consistent with this, the capacity of boilers should not be expressed in mechanical units of power, but in heat units, as its output is heat, not power. The Power Test Code Committee of the American Society of Mechanical Engineers recommend that the unit of capacity of steam boilers be "one pound of water evaporated into dry steam from and at 212 degrees F. per hour."

Convention Notes

The 14th annual convention of the National Association of Practical Refrigerating Engineers is to be held in Memphis, Tenn., Dec. 12, 13, 14 and 15, 1923.

Registration headquarters will be at the Chisca Hotel, and S. M. Jackson, P. O. Box 212, Memphis, is chairman of the hotel accommodation committee.

The convention sessions and exhibits will be held in the Scottish Rite Temple on Union Avenue.

Shaw Course Awaits Engineers

Thos. H. Fenner Ready to Give Candidates for Certificates the Knowledge Necessary to Satisfy Examiners

EDUCATION for engineers was one of the strong passions of the late A. M. Wickens and it received a great deal of valuable help from him during his long life. It is perhaps fitting that an act of his shortly before his death was indirectly responsible for the inauguration of a special series of courses for stationary engineers.

The courses referred to are those of the Shaw Schools, prepared by Thos. H. Fenner, and the link that connects Dad Wickens with them arose in this way. An old acquaintance of "Dad's," who had returned to Ontario after an absence of some years, was desirous of obtaining a first-class certificate.

Feeling the need of some instruction before taking the examination, he approached Mr. Wickens with a view to obtaining some advice. Mr. Wickens recommended his friend to Mr. Fenner, and the latter consented to take on "the job." The result was satisfactory, and it was not long before others were applying to Mr. Fenner for instruction.

These enquiries eventually became so numerous that it was impossible for Mr. Fenner to handle them individually, so he decided to place the matter before the Shaw Schools, feeling that their organization was well fitted to handle such a proposition.

Saw Need for Course

W. H. Shaw, the president, and Mr. Chant, the general manager of the school, were quick to recognize the need for such instruction, and decided to place their organization in the field. After careful preparation, the courses are now ready for the engineering public.

The courses have been prepared for the express purpose of enabling candidates for certificates to obtain the knowledge necessary to satisfy the examiners. No claim is made that the course will fit milkmen or any one not already in the power plant engineering field for the responsibilities of power plant operation. The lessons have been prepared for the man who has the amount of practical experience necessary to qualify but who requires aid in expressing his knowledge clearly, and to supplement that knowledge where necessary.

The third-class course consists of ten lectures or lessons, and at the end of each lesson a series of questions for the student to answer are given. These answers will be corrected, and further explanation given where necessary, and any question that may occur to the student will be answered in the same way.

To readers of Power House for the past few years, Mr. Fenner needs little introduction. To new readers it will suffice to say that he has had many years' experience in both marine and stationary engineering, is a member of the Engineering Institute of Canada, a member of the Educational Committee of the C.A. S.E., was for three sessions instructor in power plant engineering at the Central Technical School, Toronto, holds an extra first-class board of trade certificate, first-class province of Quebec certificate, boiler inspector's certificate for the same province, and is at present holding a responsible engineering position in Toronto.

Power Notes

Shortage of common labor has driven manufacturers to an intensive study of the possible economies of material handling equipment in industry. The addition of material handling equipment to the National Exposition of Power and Mechanical Engineering is, therefore, a very timely move, as it furnishes a remarkable opportunity for executives and engineers in industry to study the latest developments in this art. The exposition is to be held in the Grand Central Palace, New York, from Dec. 3 to 8, 1923.

The equipment to be exhibited will include conveyors of all kinds, fireless steam locomotives, industrial trucks, elevators, hoists and large scales. Many novelties are on the list and engineers will have an excellent opportunity to study each type, select the one most suitable for their particular problem and secure the cost data necessary for the decision.

Steel belting for conveyors is a novelty in this country and one exhibitor is to instal a working model of a complete system of steel belting conveyors. The model will be one-tenth actual size. This type of conveyor is well suited for handling sticky materials, sharp-edge materials or materials at high temperature.

The handling of coal at the steam power plant is a severe problem and one exhibitor will show a working model of complete coal-handling equipment in a miniature power house. The model will show a skip-hoist, bunker, coal weigh larry and cable drag scraper.

A program of interesting motion picture films, showing the application of material handling equipment in various industries, will also be displayed.

The power exposition, held annually, features the development of apparatus for the economical combustion of fuel and the production and utilization of power. The managers of the exposition are Fred W. Payne and Charles F. Roth, with offices in the Grand Central Palace.

Electricity in the Power House

By J. A. BURNETT, M.E.I.C., Consulting Engineer, 205 St. James St., Montreal

EXPERIENCES ON THE ROAD

TO BE a successful trouble man, it is necessary to have some knowledge of the design and characteristics of the apparatus causing complaint.

Troubles with apparatus can be divided into two classes—real troubles and imaginary troubles. The latter need not worry the service engineer farther than presenting proof that they do not actually exist. Sometimes the operating engineer has imagined difficulties, but before the discovery of his position he has committed himself, and in order to "make good" he must adhere to his statement that something is wrong. In many cases it is well for the service engineer to act in a diplomatic manner and give the operating engineer an opportunity to withdraw gracefully without injuring his standing with his company.

When the trouble is a real one, then it is wise for the engineer to use caution.

In Unfriendly Mood

Most troubles, before they reach the point where an engineer is sent out, have put the customer in an unfriendly mood, and when the manufacturers' engineer arrives upon the ground, he finds himself received, in many cases, in an abrupt and cold manner. The manager may ask you for an opinion before you have looked over the case, and may show displeasure if you cannot give him an immediate answer. It is best for the service engineer to maintain silence, listen to all that is said, but make no judgment in his own mind until he has made a careful investigation for himself.

The operation of a standard type of alternator, sold with a glowing description to the customer, was far from satisfactory. The alternator was of the well-known compound type, belted to a high-speed engine equipped with a flywheel governor.

Characteristics Known

The characteristics of the alternator were well known. The load was lighting, therefore nominally noninductive, and the exciter was of ample capacity.

The report on this installation stated that at times great difficulty was experienced in keeping up the voltage, that the exciter was heavily overloaded and that two exciter armatures had been damaged.

Several electrical engineers had experimented with the machine and had secured no satisfactory results, therefore it was not a very welcome job for the service engineer. However the plant was visited and as usual the same cold reception given.

The plant was started and everything ran well. The alternator held voltage with a large margin on the rheostats and the exciter was quite cool to the hand. The alternations were approximately correct with the engine running about 250 r.p m.

In a half hour, however, the condition had changed. The alternator could barely hold voltage, with all the rheostats out, and the exciter, laboring under a heavy overload, was quite hot.

A different hum from that at the start of the machinery was heard, so the speed of the unit was taken. The engine was found to be running not at 250 r.p.m. but at 217 r.p.m.

This explained everything. There was a defect in the engine governor which caused the speed to drop at a certain load and to remain there. After this defect was remedied, the engine held speed and the electrical apparatus proved to be in every way satisfactory.

Source of Trouble

The centrifugal pump driven by an electric motor is sometimes a source of annoyance, and the motor receives the blame. The purchaser will tell you that anyone can calculate the power required to drive a pump, but the electric motor is an incomprehensible piece of apparatus and therefore must be the part at fault.

One installation, driven by a 20-h.p. direct connected motor, should have required about 12 h.p., but the motor ran so hot that frequent shutdowns were necessary to permit the motor to cool down.

Actual tests showed that the pump took approximately 33 h.p. and that two-thirds of the required power was expended in churning water.

This pump was adapted for a much higher head than that under which it was operating, resulting in a very low efficiency and its attendant evil, high power for a given load.

Four large alternators in a certain plant would not maintain voltage beyond a load of two-thirds of the capacity of the units. Upon meeting the manager, he desired a clear explanation of the difficulty before an investigation could be made. Of course, an intelligent reply to his questions was im-

R. O. McCULLOCH.

R. O. McCulloch, who heads the new firm of Babcock-Wilcox & Goldie-McCulloch, held the post of president and treasurer of the Goldie & McCulloch Co. He is also a director of the Canada Machinery Corporation and president of the Galt Art Metal Co. A graduate of Toronto University, Mr. McCulloch was called to the Ontario bar in 1888. He is at present a member of the executive of the Canadian Manufacturers' Association.

Mr. McCulloch assumes the presidency of the new firm with a wealth of practical experience in the business fields of Canada, and an executive ability of unquestioned worth.

possible and he would not accept a statement that the cause was not known yet, but took the view that something was being hidden from him.

Preventing Flux Passage

Proceeding quietly with the work, taking a saturation and regulation curve, according to the methods in vogue at that time, it was soon discovered that something was preventing the passage of the magnetic flux through the armature coils.

This, of course, directed attention to the air gap and pole tips. It was noted that the field bobbins were at a distance back from the tips and that the tips were unusually close together.

Acting upon the theory that the lines of force must be held in and driven through the armature iron, the coils were dropped close to the armature.

The immediate effect was that 25 per cent. more load could be carried than before with maintained voltage. The generator still was not up to the guarantee, so to strengthen the pole tips still more, the back fourth of the field bobbins was cut out and the field current increased 25 per cent.

This accomplished the result desired, and the puzzle was solved; but troubles were not yet over.

Going to the manager, we explained that the trouble lay in the field bobbins and that we wished to return them, one set at a time, to the factory to be changed, but he, thinking he had not been treated right, denied the favor, at the same time acknowledging that the machine was not satisfactory nor accepted by him.

A survey of the situation brought our erecting engineer to the conclusion that this was all a case of bluff and trying to get even with the company; therefore, it was resolved to stop one machine that night.

A complete set of bobbins was out of the plant and in a box car before daylight the next morning.

Operation Satisfactory

Of course "blue smoke" rolled about our heads next day, but after the return of the bobbins from the factory and the machine was put into service again it was so satisfactory to the operators that the manager gracefully acknowledged that he had been beaten.

In a selling office, much "charity" and "missionary work" is necessary. For example, a customer reports that his motor is burnt out; an investigation shows that perhaps a fuse is blown or the power off the circuit. Another reports that his motor is grounded, which means that he had a static discharge coming from the belt.

Recently a customer thought something was wrong because the voltage on a compound direct-current generator increased when the load came on instead of decreasing. He had always been used to the voltage decreasing with the increase of load, and any other condition he reasoned to be wrong.

Induction Motor Troubles

Many remarks could be made as to induction motor troubles, the principal one being worn bearings, permitting the rotor to drop and resulting in "firing" at bottom and damage to stator coils.

A rough-and-ready test is to set a wood block under the motor pulley and to use a wooden pry to work the pulley up and down. Any slight movement being visible, it can be determined at once if the bearing is worn or not. The remedy is to repair the bearings or replace with new.

A. R. Goldie, who assumes the office of vice-president of the Babcock-Wilcox & Goldie-McCulloch Co., has been manager of the Goldie & McCulloch Co. since 1897, succeeding his father, John Goldie. Mr. Goldie is a graduate of Toronto University, School of Practical Science. He joined the Goldie & McCulloch Co. in 1895 as assistant manager and in 1917 assumed the position of vice-president of the firm.

Mr. Goldie is not only a practical mechanical engineer but a business man of unusual ability, who adds infinitely to the strength of the new firm.

A. R. GOLDIE.

PIPE LINES

UNCOVERED IN ANY OLD SPOT

The ostrich whimpers in distress,
And takes it rather ill
That he, indeed, is killed to dress
The girl that's dressed to kill.

* * *

Exhaust pipes should always be water-jacketed. A number of fires have occurred by oil leaking out of the fuel lines and striking a red-hot exhaust pipe. It is never advisable to use a water jet inside the exhaust pipe. If sulphur is present it will eat the iron pipe.

* * *

A cat has nine lives;
But isn't it right
That a frog's just as good,
For it croaks every night?

* * *

In starting a Diesel the cylinders should not be oveprimed; if the starting cylinders get much fuel, there may occur a pre-ignition resulting in a bent connecting-rod or fractured cylinder head.

* * *

Women's faults are many;
Men have only two—
Everything they say, and
Everything they do!

* * *

The crankshaft-bearing housings on all modern engines are bored true to within 0.001 inch. The bearing shells are bored to size so that the crankshaft must be level if the base is level.

* * *

Two engineers were talking. The first said: "That fireman you're had working for you asked me for a job this morning. Was he a steady chap?"

The second engineer answered: "He was. If he'da been any steadier he'da been motionless."

* * *

A Diesel driven flour mill will produce a barrel of flour at an expenditure of 0.55 gal. of fuel oil, 0.006 gal. of lubricating oil, and with 1 cent of repairs. The total power cost including fuel, repairs, wages, etc., is 9 cents per barrel.

* * *

An optimist is an engineer who wears a white vest and carries a fountain pen that is so constructed that it won't leak.

Practical Ideas From Practical Men

CONTROLLING FIVE PUMPS

IT MAY be of more than passing interest to readers of "Power House" to know how, with a little effort and perseverance, we succeeded in practically cutting in two, in our plant, the work of tending the pumps shown in the diagram. Nos. 1 and 2 are boiler feed pumps, pumping from the heater to the boilers; No. 3 is a standby, to pump either boilers, heater or storage tank; No. 4 supplies an overhead storage tank for both mills and four furnaces; and No. 5 supplies water to the heater.

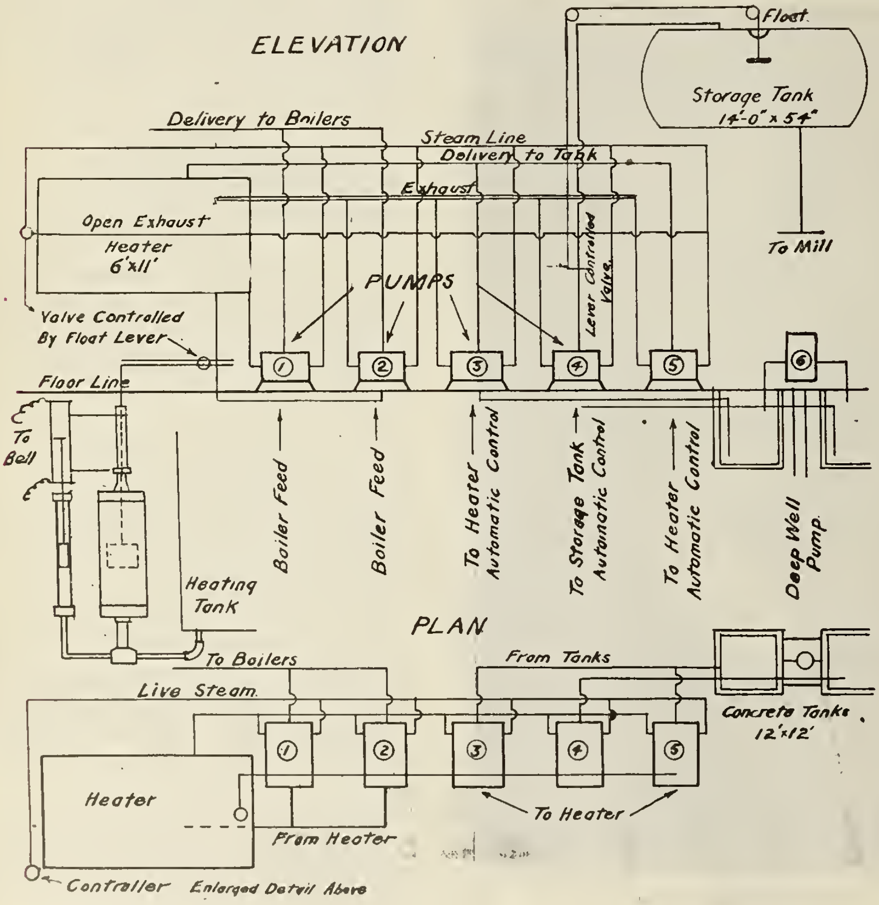
These pumps were not supplied with governors, but had to be controlled by hand with considerable guesswork, as most of the time the watertenders would be out around the boilers, which are pretty well scattered over the mill and some distance from the pump room. The overhead storage tank is rather small, the delivery being 4 ins. and the main outlet 5 ins., feeding close to 50 branch lines of ½, ¾ in., and 1 in. pipes, all of which or any number, may be running at the same time.

The watertender has no control over these outlets except to keep water in the tank.

It often happened that the tank would become empty, causing a delay in both mills as they cannot run without water. The same thing happened to the feed water heater occasionally. Sometimes the heater was fed too fast, the tank filling up, resulting in a loss of heat, as it was supplied with exhaust steam. When the heater was empty, the pumps would run away through lack of water, and when the water rushed into the heater again, there was a tendency to wash up mud, which would go into the pumps and thence to the boilers. The storage tank overhead had a wooden float in it to indicate the amount of water.

One day I ran across an old 1 in. globe valve with a sliding stem, and decided to fix it up. Our blacksmith forged a steel yoke for it, a lever being attached to the yoke and stem.

The valve was then installed in the steam line and by means of necessary pulleys and about 40 ft. of small chain, the pump was made to run automatically from the storage tank. This was about 15 months ago, and it has not failed once since. As a check on its performance, another float was put in the tank for a gauge.



I then wanted to run the heater automatically, but the tank was so full of large trays that a float could not very well be put in it, so I conceived the idea of tapping the bottom of the tank and attaching a chamber to work the float.

The chamber was made from 8 in. pipe nipple with couplings at each end and bushed to 1 in. about 20 ins. overall. A round tin float was made about 7 ins. in diameter and 9 ins. long, a small pipe attached and levers to operate a valve similar to the other.

The steam line was taken around the heater and back again to Nos. 3 and 5 pumps, and after making necessary adjustments, we were able to maintain a half a glass of water steadily in the heater.

I was not altogether satisfied with this, so a 2 in. pipe of the same length as the other, was attached to the bottom of the chamber and another smaller float about 1¾ ins. diameter and 10 ins. long, made. Two ¼ in. nuts were soldered on top and a ¼ in. wooden stem screwed on it. A copper blade was fastened to the top of the stem, the blade travelling between two more fixed contacts, one for high water and one for low. The float was then wired up for an electric gong.

Now, instead of the heater getting too full or empty, it maintains a constant level, and when the water reaches a predetermined point from its normal level, through failure of its float arrangement to work, the smaller float operates the gong, there is still 6 ins. of water in the bottom of heater giving us time to attend to it before it is empty.

An old buzzer which was lying around and doing no useful work, was taken and a blade carrying ink soldered to the arm. It was then fastened inside the box of a recording voltmeter and wired to the gong circuit.

The buzzer draws a circle on the chart, and when the gong rings puts a line at right angles to the circular line, plainly indicating any movement of the buzzer and recording the time.

These two tanks in the past, required careful attention, and were the cause of much worry. All troubles have been eliminated. ARTHUR H. LACEY, Manitoba Rolling Mill Co., W. Selkirk.

REPAIRING A BEDPLATE

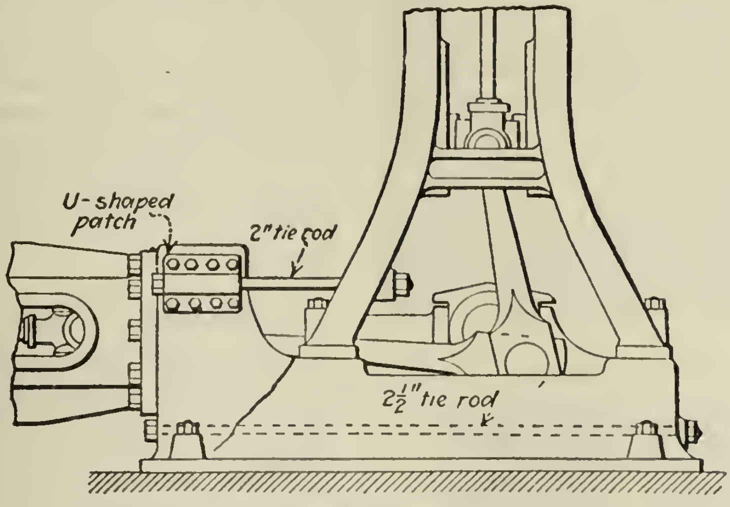
Owing to a slug of water passing into the cylinder along with the steam, the bedplate of a horizontal engine driving a vertical ammonia compressor was cracked as shown in the illustration. The damage was repaired by drilling two 2⅝-in. holes in each end of the bedplate and clamping it together with 2½-in. tie-rods.

The rods were heated to a dull red for about 18 in. in the middle of their lengths before they were inserted. Washers, one of which was beveled on one face to conform to the taper at the outer end of the frame, were slipped over the rods, and the nuts were pulled up tight. As the rods cooled, the ends of the bedplate were drawn together until the fracture was almost invisible.

The machine was then put in service, but after it had been run for a day or two, it became apparent that the staying afforded by the through-rods was not sufficient. It was then decided to tie the engine-bed to the A-frame supporting the compressor cylinder. Accordingly, two 2 1/16-in. holes were drilled in the A-frame and a U-shaped patch was fastened with 1½-in. capscrews to each side of the bed forming the guide yoke. The U-patches were then clamped to the A-frame with 2-in. tie rods. These bolts were also heated in the middle to a dull red before putting them in place.

This job of patching was at first intended to be only temporary, as it was planned to replace the broken bedplate with a new one at the first opportunity. But the repair job proved to be so substantial that all thought of replacing the bedplate was finally abandoned.

—WALTER J. HUDSON.



Broken Bedplate.

ENGINE LINER TROUBLES

Herewith is a rough sketch of the H.P. cylinder of a triple-expansion engine of 500 h.p., which I had charge of some time back. The engine gave very little trouble but began to develop a "hault" in its movement, which appeared to be in the H.P. engine.

I shut the engine down and lifted the H.P. valve over, feeling certain that the root of the trouble was there, but alas, on drawing the piston valve, everything was "O.K.," so I closed up the valve chest and opened the cylinder, but as the H.P. piston appeared all right I closed up the cylinder and started up again "to have another look at her."

I had no indicator, or the first thing I should have done would have been to take a set of cards which would have immediately shown up the defect, but a brilliant idea struck me while watching the engine struggling around. I opened the indicator cocks; the top cock discharged steam full bore, and the bottom cock made no response. This, along with the gradual dropping of I.P. and L.P. receiver pressures, caused me to form the opinion that there was something radically wrong with the H.P. engine.

The cylinder liner was steam-jacketed, the heating steam passing through the jacket before entering the coils of a H.P. "feed heater."

The liner was a fixture in the bottom fitting strip of cylinder, but was free to expand lengthways in the top fitting strip. The top end was fitted with a copper expansion ring A, which allowed for expansion and at the same time maintained a steam-tight joint between jacket and cylinder.

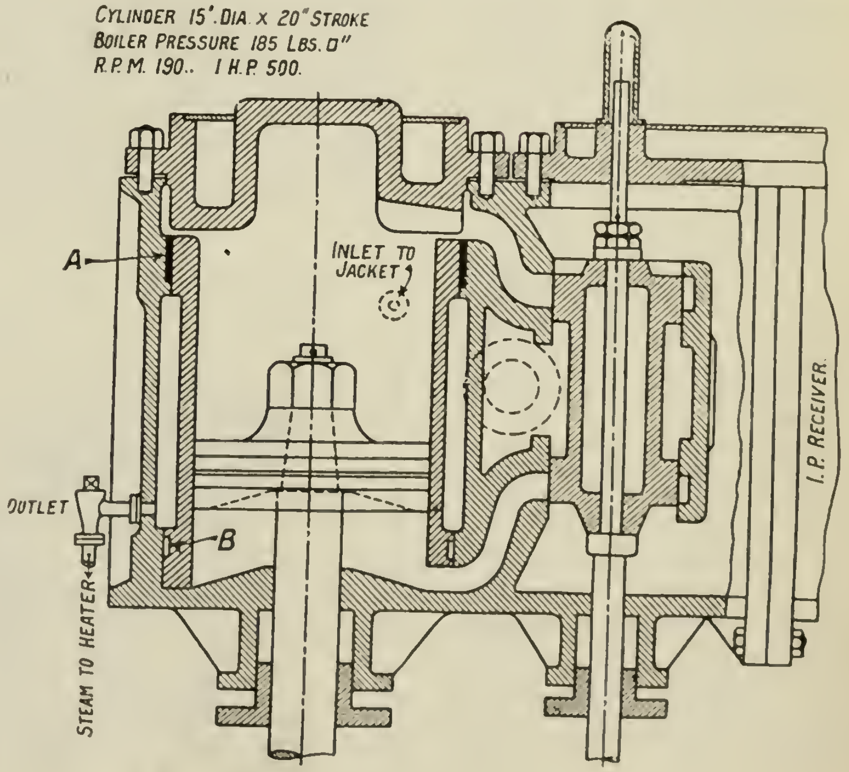
On the cylinder being again opened, the inlet valve to heating jacket was accidentally left open, thus allowing steam to escape round expansion ring, showing liner to be slack, but as there were no marks on lifting bolt holes, I couldn't see how much the liner had moved. Two ⅝-in. eye bolt holes were drilled in liner end, and on the weight being taken up on a set of blocks, the liner lifted clean out of the cylinder.

It was then discovered that the lower end of liner had been a poor fit in bottom fitting strip, also there was about 1/16 in. clearance between liner end and cylinder cover and evidently the liner had moved up and down with the piston, and at the same time turned round sufficiently to nearly close the bottom port.

The defect was remedied by turning a groove 2 in. at B and deep enough to take 1-16 in. copper wire, leaving a good projection. This was wound firmly on and sweated with hard solder, and after being filed up to allow for a good fit, was shrunk into cylinder body; the copper ring, which remained in top fitting strip, was then caulked up, and on being tested everything was found "O.K."

Incidents such as described above tend to show the amount of trouble that may be averted by the frequent use of an indicator, the defect in itself being of quite a simple nature, but the average engineer would just have soon thought of looking for a bag in the steam pipe as a liner turning as stated.

A. TREAVES



Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

LOST PUMP MOTION

How is the pause obtained at the end of the stroke of a direct duplex steam pump?

—OTTAWA ENGINEER.

Ans: The pause is obtained by valve-rod clearance, commonly called "lost motion," which is obtained in various ways.

Fig. 1 shows how the clearance usually is provided on small pumps. A valve rod nut (a) is placed on the rod (b) inside of the steam chest, the nut being thinner than the space (c) between projections on the top of the valve. Either the diameter of the nut is made large enough to prevent its turning on the rod and adjustment is made by turning the valve rod, or jamb nuts are used. In this design the total lost motion is fixed and the lost motion (J) at either end, cannot be changed except by use of a nut or jamb nuts of different thickness.

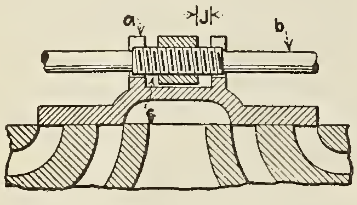


Fig. 1, Inside Fixed Lost Motion

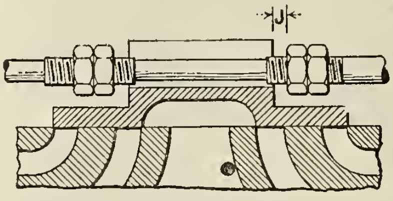


Fig. 2, Inside Adjustable Lost Motion

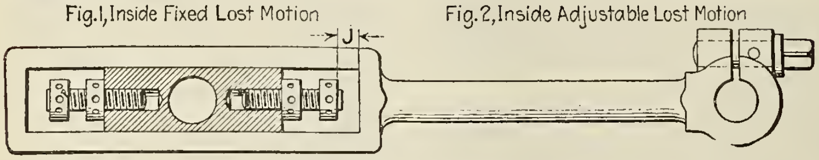


Fig. 3, Outside Adjustable Lost Motion

In Fig. 2 the lost motion is adjustable both in amount and distance (J) at either side by changing the position of the jamb nuts on the rod on either side of the valve, although the pump must first be stopped and the steam-chest cover removed.

On large pumping engines that are operated by skilled attendants, the clearance is provided in an outside adjustable lost-motion link, Fig. 3, in the train of connections between the valve and its rocker. One end of the link is slotted for carrying a sliding block, shown in cross-section, and the lost motion (J) at either end of the block is readily adjusted by tappets secured by check nuts, by means of which the lost motion for either end of the valve can be modified while the pumping engine is running.

BOILER TUBE LEAKAGE

During periods of shortage of anthracite, we have burned bituminous coal for our return-tubular boilers, and whenever it is used we are troubled with leakage of the tube ends in the rear tube sheets of the boiler. How can this be remedied?

R. WYLIE.

Answer:—The trouble undoubtedly results from incompletion of combustion in the furnace combined with carrying of coal dust to the back connections where the combustion is completed, resulting in exposure of the tube ends to extraordinary heat. This may result from stoking too much coal at a time and undertaking to force the boilers with insufficient air supply. If there is a strong draft, particles of coal may be carried into the back connection and burned there in place of burning on the grates. This may be largely prevented by wetting down the coal before it is fired.

CORLISS ENGINE PIN

For starting a Corliss engine, why is it necessary to have the governor raised with the collar supported on the starting pin, and why will the engine run away if the belt breaks with the starting pin left in place?

A. READER.

Ans.:—When the governor pin is out, the engine cannot be started from rest because the governor is down so low that the safety cams prevent the steam valves from being picked up. When the governor is raised to a position in which it is supported on the starting pin, the safety cams become moved around to a position that permits the valves to be picked up.

Then with the throttle valve open and enough steam pressure for moving the piston, the engine can be started fast enough to carry the crank over the centre, and the engine will continue to move faster until cut-off comes into action.

Should the governor belt break with the starting pin left in, the governor could not fall to a low enough position to bring the safety cams into a position that would prevent the valves from being picked up, as when starting up, and, unless the load chanced to be very much in excess of normal, the engine would run away.

SEMI-DIESEL CAPACITY

Why will a semi-Diesel engine cylinder of a given stroke develop more power with than without water injection?

—A. R. HUGHSON.

Ans.:—The introduction of water into the cylinder during the scavenging part of the stroke serves to lower the temperature of the hot piston head and cylinder walls. The air, on entering the cylinder, does not heat up so much. A greater weight of air will then be trapped in the cylinder and, since the power output depends upon the weight of air present to be combined with the fuel, the water enables the engine to burn more fuel and develop more power.

TRAP DISCHARGE

When a tilting trap dumps from the weight of water in the trap, what would be the reason for failure of the water to be discharged from the trap?

Ans.:—The trap would fail to discharge either from stoppage of the discharge connections or from more back pressure on the discharge than the pressure maintained within the trap. The latter condition would exist if the trap received the condensate from a vacuum system with the discharge open to the atmosphere; or if the pressure of returns received from a heating system were insufficient to overcome the pressure required for overcoming friction of flow plus the pressure against which final discharge must take place.

OPERATING MOTORS

Will you kindly advise if overmotoring a load when using direct current causes a waste of power? We need a 7½-h.p. motor and have for disposal a 30-h.p. motor. The size of this motor does not cause us inconvenience as far as floor space is concerned, but would the large motor be less economical, first cost not considered, than the smaller motor?

—WINNIPEG BOY.

Ans.:—The full-load efficiency of a 7½-h.p. motor is about 85 per cent. A 30-h.p. motor carrying this load would be operating under 25 per cent. load and its efficiency under this condition would be about 77 per cent., leaving a difference of 8 per cent. in favor of the 7½-h.p. motor. Of course, this will vary with the type and speed of the motor, but the figure is a fair average value.

Using the foregoing figures and assuming that the 7½-h.p. motor operates under full load, then its power consumption is 7.5 × 746 ÷ 0.85 = 6,582 watts. To carry this same load on the 30-h.p. motor would require 7.5 × 746 ÷ 0.77 = 7,266 watts, or a difference of 7.266 — 6,582 = 684 watts in favor of the small motor. Assuming that the motor operates eight hours a day for 300 days a year gives 684 × 300 × 8 = 1,641,600 watt-hours, or 1,642 kilowatt-hours.

If power costs, say, 4c. per kilowatt-hour, then the saving for the year by installing a 7½-h,p, motor would amount to 1,642 × 0.04 = $65.68. Of course, this saving will vary with the cost of power and the load on the motor.

It ought to be possible to dispose of the 30-h.p. motor for a price equivalent to that for a new 7½-h.p. machine. If this can be done, then the saving in power will be a net gain.

STEAM PUMP PORTS

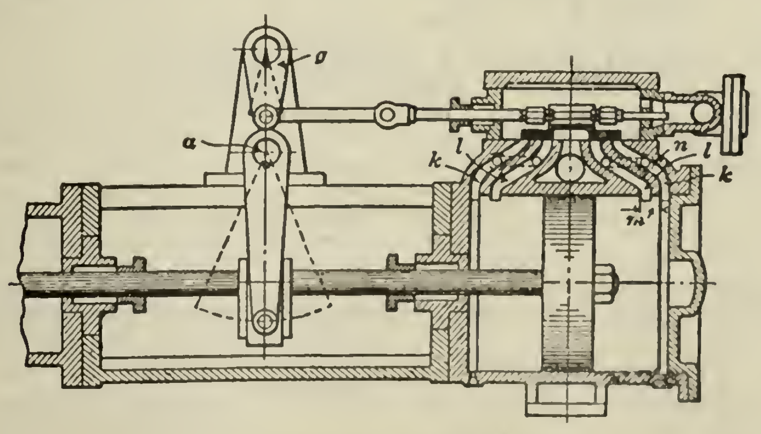
Why is each steam cylinder of a duplex steam pump provided with five ports? —HAMILTON B.

Answer:—The outer port at each end acts as a steam admission port and terminates at the end of the cylinder so as to guide the incoming steam into the clearance space behind the piston, while the ports nearer the middle or central exhaust passage act only as exhaust ports. When the piston is near the end of the stroke, it covers the exhaust port.

Any steam then remaining in the end of the cylinder and the connected steam passages, is entrapped and, becoming compressed by the piston, acts like a cushion in overcoming the momentum of the piston and thus brings it quietly to a stop without striking the head of the cylinder.

The arrangement of the ports is illustrated in the figure, showing a vertical section through the steam end of the left-hand side of a duplex pump, with the piston, valve rockers a and g, and the D slide valve in heavy shading, all shown at mid-travel. The outer ports k are the steam ports and the other passages are for the exhaust. The distance m from the outer edge of the exhaust port to the head forms the cushion.

On pumps having more than 10 in. stroke, a passage is usually provided between the ports k and l and a valve n is inserted, which can be opened for the escape of part of the exhaust from the port k to the exhaust port l, should the piston cushion too heavily.



Section Through Steam End.

UTILIZING WASTE HEAT

Will you kindly work out the approximate saving which would be effected in a boiler plant by the utilization of 257,100 lb. of water at 190 deg. F. per week at present running to waste?—REGULAR READER.

Answer.—Very few particulars are given by "Regular Reader," but assuming certain factors, he will be able to work out the correct coal saving as follows: Boiler assumed working at 100 lb. gauge pressure, with steam temperature 337 deg., the sensible heat = 308 B.T.U. and latent heat 877 B.T.U., and total heat required to raise 1 lb. of water from 32 deg. F. to the above pressure therefore = 308 + 877 = 1,185 B.T.U.

If the present feed-water supply to the boiler be taken at 50 deg. F., 1,167 B.T.U. are required to raise each pound of water from 50 deg. to steam at 100 lb. gauge pressure. We can further assume the calorific value of the coal used at an average figure of 12,000 B.T.U. per pound, and 6½ lb. of water evaporated per pound of coal from 50 deg. to steam 100 lb. gauge. The total heat available in the weekly supply of hot water = 257,100 lb. at 190 deg.; therefore, 190 — feed-water temperature of 50 deg. = 140 deg. 257,100 × 140 deg., approximately 36 million B.T.U. Correcting these figures—

$$\frac{35,994,000 \text{ B.T.U.}}{1,167 \times 6\frac{1}{2}} = 4,879 \text{ lb. coal per}$$

week; or weekly saving in coal of two tons three and a half hundredweight. A small amount of steam will be required to deliver the hot water to the boilers, reducing this figure to approximately two tons per week.

Colonel H. D. Savage, of New York, director, Pulverized Fuel Division, Combustion Engineering Corporation, will deliver a lecture before a meeting held under the auspices of the Ontario section, American Society of Mechanical Engineers in the Mining Building, Room 22, University of Toronto, on Nov. 27. Colonel Savage has been intimately connected with the development of pulverized fuel from its infancy and is a frequent contributor to the technical press on this subject. The more efficient utilization of our fuel resources is a matter of national concern and this comparatively new development promises to be of value in the burning of many coals not readily amenable to ordinary methods.

Can YOU Qualify for that Good Job?

HAVE you got a First-Class Certificate? You cannot get very far, cannot make the most money, until you have passed **every** examination. To-day it is easy to prepare yourself for any Certificate Examination. T. H. Fenner, former editor of "Power House," will train you by mail in your spare time through Shaw's Course in Stationary Engineering. There's a big demand for qualified men. Decide to-day to get full facts and details.

Write for syllabus to

SHAW SCHOOLS Ltd.
DEPT. 101
46 Bloor St. West
TORONTO

Comments in the Power Plant Field

UNVARNISHED TRUTH

The Editor,
Power House.

Regarding the letter in a recent issue of Power House, "Some New Theories" by Robert McLaren, I quite agree with that engineer's remarks that the design of the furnace has much to do with completed combustion of coal.

Many engineers know that there is a greater waste of coal going on from some chimneys that do not show black smoke, than from those that do. Carbon monoxide gas is invisible, therefore it is impossible for any man to know when it is escaping out of the stack unless he is provided with the necessary flue gas recording instruments and draft gauges. Such instruments are as necessary these times of dear and scarce coal, as steam gauges for indicating the pressure inside the boilers.

This is not theory; it is plain, unvarnished truth, but how difficult it is to cause some owners of boiler plants to realize it! The day may dawn when to conserve our coal the powers that be will make all large users instal devices for saving coal, and also require that the recording charts be forwarded to a department provided by the provincial government, with penalties for infraction of laws provided.

Cut Fuel Costs

By such means the consumption of coal would fall greatly. As demand creates price, it should be a money saver for the consumer.

When acting as inspector of boilers, I have come across sights that would bring tears to one's eyes. The following are a few instances: 50-100 H.P. multitubular boilers set with only sixteen inches between top of grate and the underside of boiler. The top of fire bridge wall six inches from boiler, and encrusted with clinker, fused into the brick, leaving only 2-3 inches of opening. The space between the floor line and underside of boiler at rear of bridge wall filled in to a depth of 7 inches for gas travel, thereby not only not providing any combustion chamber or gas pocket, but actually causing the products of combustion to impinge on the water wall of boiler.

In some cases, the temperature of the induction water is 160 degrees lower than boiling point. We are aware what the temperature of the flue gases must be in in order to unite with the incoming oxygen and burst into flame. Under such conditions, how is it possible for those products of combustion to retain anything like the temperature at which they left the bed of fire?

Throttling the Gases

I have also seen cases where only seven inches of space was allowed between the end of a multitubular boiler and the rear wall, thereby further throttling the gases and carrying them to be retarded and held up to the cold shell of the boiler for a longer time than necessary. 24-28 inches would be better for this chamber.

A higher efficiency with less fuel is obtained when boilers have been raised forty-eight inches off the line of grate. If we place our finger momentarily in the flame of a lighted match we do not feel as intense a heat as when the finger is held one or two inches above the flame. The same remarks apply to the burner of a gas cooking stove. Better results with less gas will be obtained by having a space of four to five inches between flame and under side of kettle.

When it is stated that Canada uses up $100,000,000 worth of fuel per year, and that there are thousands of cases where from twenty-five to thirty per cent. of fuel is unnecessarily burned, it is obvious that the money value of such waste could be applied to more useful purposes. Some may ridicule my estimate of the waste. Cases have been recorded when taking a steam evaporation test showing that fifty per cent. of the coal was being burned to waste.

When Pipe is Hot

Not long ago, I asked the caretaker of a building heated by hot water how he knew when the water was hot enough to suit the outside temperature. He took me into another part of the building and placing his hands on the overflow pipe from an expansion tank, said "When that pipe is hot I check the fire."

Every engineer is aware that before an expansion tank will overflow and cause boiling water to come down that pipe, the radiators are too hot, especially if the outside air is only twenty degrees lower than the inside air, which was the case on that day. Apart from the waste of fuel, such management is apt to cause very considerable air or vacuum after cooling down, which means more fuel unnecessarily burned in order to have the radiators circulating efficiently.

A thermometer connected into the waterway of the heater or header at a cost of a few dollars would have saved considerable money each day in fuel.

—J. S. KINGSTON, A.M.A.S.M.E.,
Ottawa.

VALVE INSTALLATIONS

During years of experience in power plant work, including pipe-fitting, I have profited by the mistakes of others. Some of the mistakes in question have been fully described in the pages of Power House, but the following instances have to do mainly with valve work, many valves on new work being made worthless by careless workmen at the time of installation.

Even the experienced man sometimes applies a wrench to the hexagon farthest from the pipe when screwing on the valve, a proceeding which is liable to distort the valve body. If it is a globe or gate valve refacing it may prove a cure if the "twist" is not too great. Irrespective of the style of valve, however, it should be closed when being screwed on the pipe and its rigidity will be slightly increased.

To look at some pipe-fitting jobs, a person gets the impression that the erector had taken particular pains to so place the hangers that the valves would be compelled to assume a great deal of the strain due to weight, expansion and contraction. All such harmful strains can be prevented, as far as the valves are concerned, with reasonable care.

Even at this date some pipefitters will persist in painting the threads inside of valves and fittings instead of applying the paint or grease to the pipe threads. Since paint or grease is sticky, if it is allowed to lodge in valves, (disk, gate or other design) it will catch grit, such as pipe scale, etc., and the first time the valve is operated the grit may cut the valve enough to make it leak.

Steam should be blown through a new line of pipe for a longer or shorter period, depending upon the length of the line, its size, and the pressure of the liquid or steam. The longer this blowing can be maintained the better, even though it extends to half an hour. Of course, reason and common sense must be used; a six-inch steam main with a high pressure could be left open for only a short period. All valves on the line should be opened wide before the blowing is started.

In pipe-fitting it is safer to use a short thread on the pipe than a long one when connecting brass valves. In the latter case, the pipe end may shoulder against the valve seat and injure the valve beyond repair. I have seen men place a long wrench upon the bonnet of a valve, a six-foot length of pipe on the handle of the wrench, and then a couple of men at the other end of the pipe—a long pull, a strong pull, and a loosened bonnet and a permanently distorted valve. Probably the wrench alone with one man and no pipe could have loosened the bonnet if a jerking jarring pull had been used instead of a steady pull.

Very often a tight bonnet can be loosened by tapping it with a hammer and applying the flame of a blow torch around it for a minute or two. The slight expansion is enough to crack the fried, hardened paint, or other dope. I have seen valves permanently injured by the workman attempting to screw in the bonnet with the stem and disc in the closed position, with the result that the disc reached the seat before the bonnet was down, thus causing a bent spindle and a sprung seat.

—JAMES E. NOBLE.
173 Macdonell Ave., Toronto.

POWER PLANT EQUIPMENT

INCLUDING

WATER TUBE BOILERS
SUPERHEATERS
MECHANICAL STOKERS
OIL BURNING EQUIPMENT
ELECTRIC CRANES
COAL AND ASH CONVEYORS
STEAM AND WATER PIPING
WATER MEASURING APPARATUS
WATER SOFTENERS
ACCESSORIES
TOOLS, ETC.

Sole Canadian Agents for :

LAGONDA
TUBE CLEANERS
TUBE CUTTERS
VALVES, ETC.

BABCOCK-WILCOX & GOLDIE-McCULLOCH CO., LIMITED

Toronto Office
Bank of Hamilton Building

Head Office
GALT, ONT.

Montreal Office
St. Henry Street

Miscellaneous

The Wellman-Seaver-Morgan Co., Cleveland and Akron, O., have arranged for the Newport News Shipbuilding & Dry Dock Co. to take over the hydraulic turbine business of the Wellman Co. This includes patterns, drawings, data, patents, inventions, records, etc.

The Wellman-Seaver-Morgan Co. have built numerous large turbines for Canada, including some for the Chippawa development project.

The John Inglis Co., of Toronto, built turbines to the designs of the Wellman Co. Recently three units of about 2,500 h.p. each were shipped to the Nova Power Co., and Mr. Inglis to-day stated that the change would not affect his manufacturing rights as he would now build turbines to the designs of the Newport Co.

The Ottawa Electric Railway contemplates the construction of a $20,000 garage and power house on Albert St., Ottawa.

Thomas A. Marsh, chief electrical engineer of the Combustion Engineering Corporation, Chicago, was the speaker at the meeting of the Manitoba branch of the Engineering Institute of Canada, Nov. 1, in the Engineering Building, University of Manitoba. Mr. Marsh gave a non-technical discussion on "The Combustion of Canadian Coals."

The Hamilton Branch of the Engineering Institute of Canada opened the winter season with a dinner at the Royal Connaught Hotel, Hamilton, Nov. 1. Walter J. Francis, M.E.I.C., consulting engineer, of Montreal, and president of the Institute, in an interesting address, stressed the gravity of the fuel problem facing Canada to-day. The chair was occupied by R. K. Palmer, chief engineer of the Hamilton Bridge Works. Other speakers were: Fraser S. Keith, Montreal; Major Alan Mair Jackson, Brantford; Wm D. Black, of the Otis-Fensom Elevator Co.; Col. N. R. Robertson and J. A. MacFarlane, of the Hamilton Bridge Works.

R. J. Durley, M.B.E., M.E.I.C., secretary of the Canadian Engineering Standards Association, addressed the Ottawa branch of the Engineering Institute of Canada at a luncheon in the Chateau Laurier, Oct. 31. Mr. Durley was professor of mechanical engineering at McGill University for eleven years, and during the war was in charge of gauges and standards of the Imperial Munitions Board. His subject was the standardization of engineering products and the resulting benefits that would accrue to industry from the simplification and unification of manufactured pieces. Mr. Durley said that standardization was not altogether the best word to use and that simplification or unification would better express the objects the association had in view.

The town council, Forest, Ont., is having plans prepared for the installation of a waterworks system, including 3 stage centrifugal pumps, mains, valves, hydrants, tower, etc. Chipman and Power, Mail Bldg., Toronto, engineers. Estimated cost, $100,000.

John T. Farmer, chief engineer of the Combustion Engineering Co. of Canada, was the speaker at a meeting of the Canadian Association of Stationary Engineers, Nov. 6, in the Mechanics' Institute, Atwater Ave., Montreal. His subject was "Flue Gas Analysis and Its Bearing on Economy in the Power House."

The name of the Central Quebec Power Co. is being changed by supplementary letters patent to the Algonquin Power Co. The capital of the company has been increased from $1,000,000 to $2 000 000. These changes are regarded as preliminary to the formation of plans for the development of a power site in Quebec controlled by the company.

In This Issue

Editorial Point of View 21

Cutting Draft Losses 22
By Robert June, A.S.M.E.

High Pressure Boiler Design 24
By D. S. Jacobus.

Curing Motor Troubles 27
By R. L. Tullis.

Revision of Boiler Law 28

Jokers in Ontario Act 29

Heat In Coal Combustion 30
C A.S.E. Educational Paper.

Power House Service 31

Easy Engineering Lessons 32
By M. Barry Watson, B.A., Sc.

Shaw Engineering Course 33
Power Notes.

Electrical Experiences 34
By J. A. Burnett, M.E.I.C.
Illustration R. O. McCulloch.

Pipe Lines 35
Illustration A. R. Goldie.

Practical Ideas 36
Controlling Five Pumps
Repairing a Bedplate
Engine Liner Troubles

Problems With Answers 38
Lost Pump Motion
Boiler Tube Leakage
Semi-Diesel Capacity
Corliss Engine Pin
Trap Discharge
Operating Motors
Steam Pump Ports
Utilizing Waste Heat
Diesel Operation

Comments in the Field 40
By J. S. Kingston, A.S.M.E. and James E. Noble

U.C.C. of E. Notes 42
Miscellaneous News

New Power Equipment 44
A Vacuum Pump Line
A Controller Valve
Novel Data Sheets
A Superheat Packing

Book Reviews 47

The town council, Hespeler, Ont., contemplates improvements to the town waterworks system, to cost $13,000.

The Village Council, Wheatley, Ont., contemplate the construction of a $13,000 hydro power plant and a $22,000 power line.

Price Bros. & Co., Quebec, contemplate the construction of a dam and a hydro-electric power house on the Chicoutimi river.

The Engineering Institute of Canada will hold the annual general meeting at Montreal, Jan. 22, and Ottawa, Jan. 23-24, 1924.

The township of Teck contemplate the installation of an electric lighting plant at Swastika, Ont. M. Campbell, Kirkland Lake, clerk.

The town council, Arnprior, Ont., are in the market for machinery for a pump-house. M. Campbell, Waterworks Commission, purchasing agent.

Sharp and Thompson, 708 London Bldg., Vancouver, are preparing plans for a $250,000 central heating plant on University Campus, Point Grey, B. C.

North Shore Power Co., Three Rivers, Que., contemplate the construction of a hydro-electric house and mills to develop 5,000 horse power at Batiscan, Que.

The Ford Motor Company of Canada, Ford, Ont., have been receiving tenders for the heating of a power and screen house being erected in connection with their plant.

Dominion Hotels, Ltd., 66 King St., Hamilton, contemplate the erection of a three or four story hotel at Sault Ste. Marie. Estimated cost $300,000. Architect, V. K. Gibson, 624 South Michigan Ave., Chicago.

Toronto East General Hospital Assn., City Hall, Toronto, contemplate the construction of a 3-story, 400-bed hospital, including vacuum steam heating system with electrically driven ventilation. Estimated cost, $250,000. Engineer, C. Harris, City Hall.

The British Thompson-Houston Co., have been awarded the contract for the generators for the new hydro-electric system of the Newfoundland Power and Paper Co. The Canadian General Electric Co. are supplying 31 transformers with a total capacity of 170,000 k.v.a. General contractors, W. G. Armstrong-Whitworth Co.

U.C.C. of E. Notes

Queen City Council and Canada Council No. 27 U. C. C. of E. will hold a "Get Together Night" on Nov. 26 in the Oddfellows Temple on College Street, Toronto. Visitors are expected from Hamilton Council No. 60.

The DUNHAM

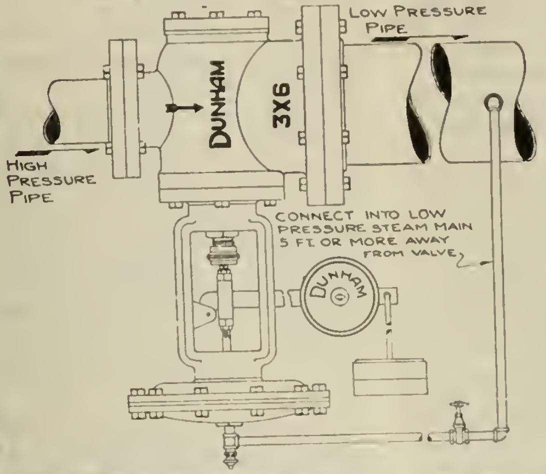
REG. TRADE-MARK

HEATING SERVICE

[Made in Canada]

Reducing Pressure Valves

The Dunham Expanded Outlet Reducing Valve shown installed in horizontal steam main is especially designed for steam heating systems which require very low pressure. The expanded outlet permits quick steam expansion and facilitates reduction from high initial pressure to as low as atmospheric pressure.


LOW PRESSURE PIPE
DUNHAM
3X6
HIGH PRESSURE PIPE
CONNECT INTO LOW PRESSURE STEAM MAIN 5 FT. OR MORE AWAY FROM VALVE
DUNHAM

Varying High Pressures Automatically Reduced to Constant Low Pressure

Dunham Reducing Pressure Valves insure an unvarying pressure on the low pressure side of the valves despite a considerable variation in pressures on the high pressure side. Steam, water or air is reduced to the desired pressure (atmosphere minimum) in one step without chattering.

Dunham Reducing Pressure Valves are applicable to a wide range of pressure service. An interchangeability of diaphragms which is permitted by standardized construction takes care of almost any pressure requirement.

Made in Straight and Expanded Outlet patterns. Finest materials and workmanship. Complete data on request.

C. A. DUNHAM CO., Limited
TORONTO, ONT.

HALIFAX VANCOUVER WINNIPEG OTTAWA MONTREAL CALGARY
LONDON, ENG., 18 ST. THOMAS ST., S.E. 1.

Also manufacturers of a popular line of heating specialties.

If the big steel concerns put their faith in a product—

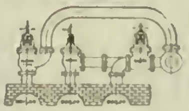
they have sound reasons for their choice, whether this represents a safety device or any other important mill equipment.

The leaders of the steel industry are now using

4300

Golden-Anderson

Patent Automatic Double-Cushioned Triple-Acting and Non-Return Valves



Double Extra Heavy Valves

Elbow, Angle, Globe

for the complete protection of life and property against abnormal steam flow into a damaged boiler or a break in a steam main—you are safe in making the identical selection for your plant. Consider the following features:

1. Automatically cut out the boiler the instant that a tube ruptures or other internal break occurs.
2. Automatically cut off the steam flow from every boiler the instant that a steam pipe breaks.
3. Automatically equalizes the pressure beween all boilers.
4. Automatically cut in a boiler making accidents due to inaccurate steam gauge impossible.
5. Positively prevent backflow of steam into a cold boiler.
6. Can be closed by hand, like ordinary stop valve, and arranged with "combination feature" to open valve like regular gate and globe valve.
7. Can be tested in service from boiler room floor.
8. Double Corliss Dash Pot that cushions in opening and closing.
9. Cannot pound, spin, stick or chatter.

Made by Golden-Anderson Valve Specialty Co.

THE ARTHUR S. LEITCH CO., Limited, Toronto

High Grade Power Plant Equipment

Progress in New Power Equipment

A NEW PUMP LINE

A NEW line of steam and belt-driven dry vacuum pumps has recently been placed on the market by the Canadian Ingersoll-Rand Co., 260 St. James St., Montreal.

The belt-driven units are known as the Class ER-1, and the steam-driven machines as the Class FR-1 type. They are similar to this company's ER and FR air and gas compressors and, like the latter, are of the single stage, straight-line, centre crank, dust and dirt-proof type with automatic lubrication of both running parts and vacuum ends.

They embody every refinement of modern vacuum pump design, including a number of features which make them as nearly automatic in action as any machine of this type can be expected to be. This is an important consideration in any vacuum pump, but is even more essential in the case of small and medium-sized units which are often operated in isolated locations where but little attention can be given them.

Large machines, on the other hand, are generally located in a central power house under the supervision of an expert engineer. These machines are recommended for use in canning factories, smelting plants, packing houses and paper mills.

Ensures Steam Economy

The class FR-1 vacuum pump consists of a plate-valved vacuum cylinder direct-connected to a steam engine with balanced piston valve, a design which makes it possible to operate with high pressures and superheated steam as well as the moderate pressures more common in the past. This feature ensures steam economy at all pressures.

The main frame of both types, as previously mentioned, is of the enclosed design, the bottom part forming a reservoir for the combined splash and flood lubricating system. It is fitted with removable side and crank and covers which are not bolted on but are retained by lips on the frame casting. Removal of these covers permits inspection or adjustment of all running parts.

The crosshead guides are of the bored type and the design of the frame provides for an oil stuffing box near the cylinder end of the frame, which prevents any chance of crank case oil entering the vacuum cylinder. Openings in the cylinder end of the main frame and in the trunk piece interposed between the steam and air cylinders on the class FR-1 type provide for adjustment of stuffing boxes when running.

The main frame and trunk piece of the steam-driven units are mounted on a substantial cast-iron sub-base which lends rigidity to the entire structure, makes the machine a complete, self-contained, accurately-aligned unit, and also forms a support for the single rocker arm which guides the valve rod. There are no guide blocks or other sliding surfaces in the piston valve gear.

Little Appreciable Wear

The main bearings are of very heavy construction and provided with removable die-cast shells or liners of genuine babbitt metal which can be removed and renewed in a few seconds, at small cost. Due to the area of the bearings and the complete circulation of oil through them at all times, however, the shells last for very long periods without appreciable wear.

The crank-shaft and connecting rods are solid one-piece drop forgings, accurately machined and heat-treated. The connecting rod is of the solid end type with renewable and adjustable boxes in both crosshead and crank pin ends. The crosshead is of the cylindrical type, of box construction with adjustable bored and turned shoes.

Pistons are of the box type with broad faces and are securely fastened to a turned and ground steel rod.

Oil is distributed to all of the running parts by throwers on the crank webs which lift or throw the oil against baffles from which it runs to all wearing surfaces. This system, now widely used, was originated by this company more than twenty years ago and is probably the simplest, most effective and economical ever devised.

Lubrication of steam and vacuum cylinders is provided for by a double compartment, adjustable sight feed, mechanically operated lubricator.

The piston steam valve is provided with two piston rings at each end and operates in a renewable bushing. With this type of valve there is no rapid wearing or cutting and the valve chest stuffing box is only subjected to exhaust pressure. as steam is admitted to the centre of the valve and exhausted from the ends.

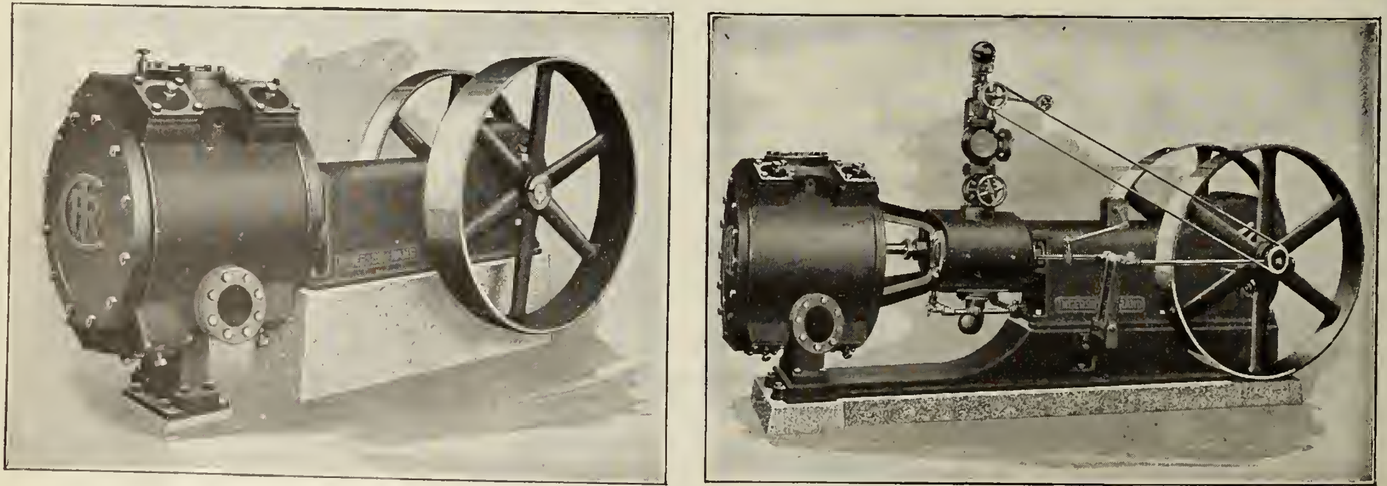
Regulation of the class FR-1 vacuum pump is regularly provided for by an adjustable speed throttling governor, although a "Wide-Range" automatic cut-off flywheel governor is sometimes used.

Saves Floor Space

The class ER-1 belt-driven units are furnished for either long or short belt drive. The latter arrangement is generally preferred as it not only saves floor space but also increases the arc of belt contact and reduces belt wear and bearing load.

Both classes of these machines are built in four sizes with piston displacements of about 500 to 2,300 cu. ft. per minute. They are well adapted for filter pans, evaporator effects and similar classes of service where high and steady vacuum is required.

With closed intakes they will pull up to 1.0 inch absolute, or 29 inches when referred to a 30-inch barometer—this



Ingersoll-Rand Class "ER" Belt Driven Dry Vacuum Pump and Class "FR" Steam Driven Dry Vacuum Pump.

vacuum differing, of course, with the size and stroke of the pump.

High speeds of operation, coupled with the high volumetric efficiency provide greater capacity for a given size of cylinder, resulting in a marked economy of floor space.

The Canadian Ingersoll-Rand Company also announce their bulletin K-315, describing these machines, which are produced at their Sherbrooke plant. This catalogue contains numerous illustrations covering these machines, and should be of value to anyone interested in either belt or steam driven vacuum pumps.

NEW CONTROLLER VALVE

A CONSIDERABLE advance has been made by the Bristol Company, of Waterbury, Conn., in the production of temperature controlling apparatus by the development of the Bristol-Fuller Controller Valves.

This apparatus is intended for use with oil and gas heated furnaces or ovens and is designed to maintain an indicated temperature by controlling automatically the flow of the air, gas or oil to the furnace.

Motor Operation

Both the fuel and air valves are operated by one electric motor. When using the valves for controlling a temperature, both the valves are first adjusted to a low setting, giving a flame of perfect combustion, but too low to bring furnace up to desired temperature.

If an automatic controlling instrument is used in connection with valves to measure temperature of furnace, when set to temperature wanted, a contact will be made which will start the motor. When the valve is opened the motor stops.

With both valves in this position, they may be adjusted to give a high flame of perfect combustion, which will bring temperature of furnace slightly above the temperature wanted, then as soon as the furnace has reached the temperature higher than desired, the instrument will make contact, thus operating the motor and close the valve to the low flame.

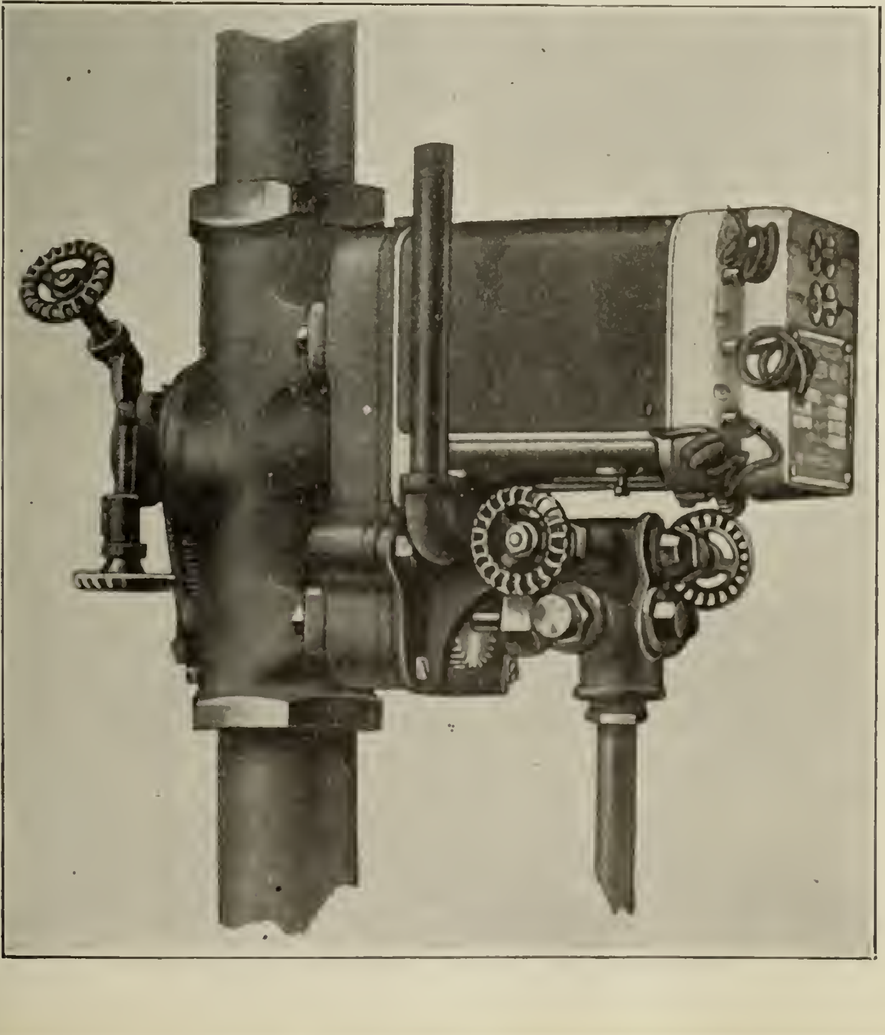
Independent Adjustments

All adjustments of the valves are made independently, and thus, in no way can one adjustment upset any other.

When a sensitive controlling instrument is used, and the high and low flames are correct, it has been found that the furnace assumes the temperature desired.

The equipment consists of the gear box, motor and switch so arranged that any one is readily replaceable. A standard make of motor is used and the speed is reduced in the gear box to operate the crank for the valves.

The valves are opened and closed by crank motions thus the motor is not reversed, but is stopped at the end of



CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—with house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

POWER PLANT FOR VILLAGE OF TIGNISH About 18 kil. hour capacity 110 to 220 volting alternating current. Apply to John A. Hackett, Box 67, Tignish, P. E. I.

EQUIPMENT FOR SALE

FOR SALE—ONE CANADIAN GENERAL belt driven, direct current generator, 115 to 125 volts, capacity 360 amperes, speed 975 R.P.M's.; also a quantity of used shafting and pulleys. Apply to Box 114, Power House.

SAW MILL MACHINERY FOR PORTABLE medium and heavy mills, band or circular; we build everything for the saw mill from haul-up to sorting table. The Waterous Engine Works, Ltd., Brantford.

TAYLOR SAFE FOR SALE—INSIDE DIMENsions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110, Power House

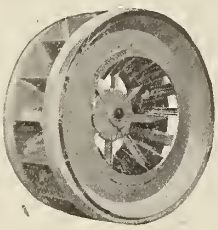
For Quick Sale

Self-oiling high speed engine, single cylinder 17 in. bore x 16 in. stroke. Engine develops 200 H.P. when running at 235 R.P.M. with 100 lbs. steam pressure. There are two heavy leather belts 18 in. wide. The engine has two fly-wheels, each 78 in. diameter x 18 in. face. Apply **Box 112, Power House.**

PISTON RINGS

EVER-TYTE and ZELCO Piston Rings with Patented Zelco Process Save Gasoline, Oil, Increase Capacity, Prevent Cylinder from Wearing Out of Round, Lessen Carbon; after using, make arrangement with us to sell them; made up to 80-inch; used in Locomotives, Boats, Engines, Compressors, Ice Machines, Autos, Trucks, Tractors, etc.; are looking for distributors with mechanical knowledge; all or part time; real opportunity. Ever-Tyte, St. Louis, Mo.

J. A. BURNETT,
M.E.I.C., P.E.Q.
CONSULTING
& APPRAISAL
ENGINEER
Room 301—205 St. James St.
Telephone Main 6737. Montreal.



Here's a Positive Remedy

that efficiently and economically puts a stop to your cinder troubles. The Sturtevant Cindervane Fan collects even the finest particles before they are blown up the stack; at the same time affording an excellent induced draft.

Write for Folder 609.

B. F. STURTEVANT CO.
of Canada, Ltd.
Montreal Galt Winnipeg Toronto

POWER HOUSE

Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

TWO ISSUES PER MONTH
TWENTY-FOUR PER YEAR
TWO DOLLARS

the stroke of the crank. In order to stop the motor at the high and low valve adjustments, a control switch operated by a cam turned by the motor, is opened.

This switch has two sets of contacts, one in the circuit of high contact of control system, and the other in circuit of the low contact. When the cam breaks one circuit, it makes the other. This cam and switch are housed in an aluminum case.

The case also contains push-button switches, which may be used to operate the valve electrically, without the controlling instrument.

A different type of controller valve is supplied for the different mixtures whether of air and gas or air and oil and varying also with the pressures used. For low air pressures not exceeding two pounds per square inch a butterfly type of valve is used to control the air supply while a globe valve is used with higher pressures.

A SUPERHEAT PACKING

The Steel Mill Packing Company, of Detroit, have placed on the market a sheet packing called Safety Superheat Sheet Packing, and it is claimed that this packing will stand a high temperature, cannot be forced out by high pressure, and will resist the disintegrating influences of heat, oil, acid or alkali.

The packing is a combination of asbestos and rubber with color and mineral fillers giving a compound that, according to the makers, will resist heat to the utmost degree, and which cannot soften, burn, blow or ooze out of the joint. The compound as a whole is said to be water, acid and alkali proof and will successfully resist the action of these agents in the finished product.

The ingredients are thoroughly mixed into a plastic mineral mass and then felted under immense pressure into a compact yet elastic sheet which has been so rolled and compressed that further compression by the flange is impossible. A gasket, once inserted, requires no following up.

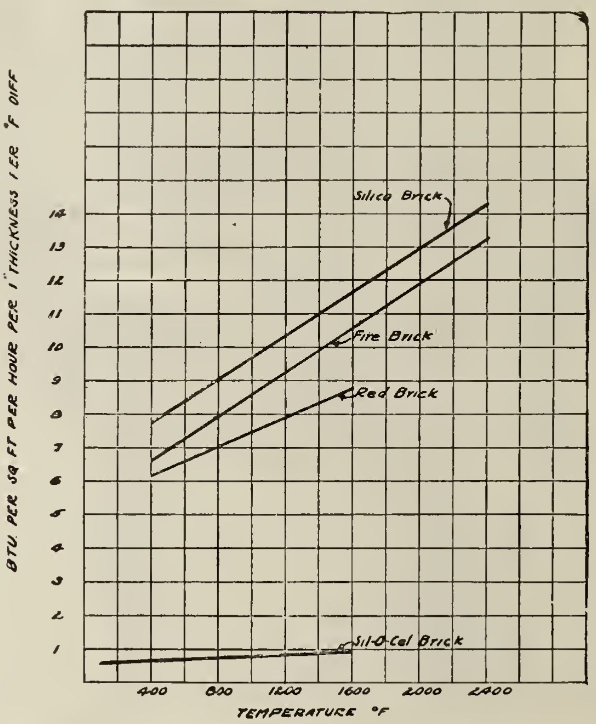
This company also manufacture the Safety Elastic Metallic Packing for use with steam, water, gas and hydraulic machines and valves. This packing is made of an alloy of the best anti-friction metals, combined with the finest lubricating materials, and is practically self-lubricating and frictionless, and, according to the makers, will stand steam pressure up to 550 deg. Fahr., and hydraulic pressure up to 5,000 lbs. per square inch.

NOVEL DATA SHEETS

The Celite Products Company have recently instituted a novel method of distributing engineering data on their heat insulation products. For the convenience of engineers who may use that form of engineering data, they have reproduced many of their blueprints and charts in sheets, punched and ready for insertion in standard looseleaf binders.

These include charts showing comparative conductivities of Sil-O-Cel brick, red brick and refractories, as well as heat losses through wall constructions, insulated and uninsulated, and drawings showing methods of insulating such equipment as boilers, furnaces, ovens, brick, lime and cement kilns, gas equipment, glass equipment, oil stills, etc.

The sheets are not intended to replace the regular literature and standard size blueprints, but the number of requests received indicates their popularity for ready reference purposes. Copies will be gladly sent Canadian engineers on request.



Conductivity of Sil-O-Cel Brick, Red Brick and Refractories.

SAFETY FACTORS IN HIGH-PRESSURE BOILER DESIGN

(Continued from page 26)

steam entering the attemperator was at a somewhat higher temperature than the steam discharged. It was found entirely practicable to hold the temperature within a range of, say, 5 deg. or 6 deg. Fah. between the highest and lowest points by spraying a regulated amount of water into the superheated steam. The apparatus consisted of a vessel containing water placed in the exit pipe conducting the superheated steam away from the attemperator.

Generate Definite Pressure

There was a definite pressure generated in the vessel for each particular temperature through boiling the contained water, and this pressure acted on a diaphragm and actuated an apparatus for admitting more or less water to the superheated steam. The temperature of superheated steam that could be handled in this way was limited to, say, 650 deg. Fah. For higher temperature than this it was proposed to use mercury in place of water in the vessel.

Shortly after experimenting with the attemperating device, the idea was applied to an independently fired superheater as a superheat limiting device, where, on the temperature rising to a given point, doors were opened in the setting for admitting cold air. This arrangement proved to be entirely reliable through trials made every twenty-four hours, where the temperature was purposely raised to the point for which the apparatus was set.

An interesting feature developed, as it was found possible to operate the independently fired superheaters much more closely through observing the pressure in the vessel containing the water than by reading a thermometer. The vessel consisted of a coil having a considerable surface in contact with the superheated steam in proportion to its volume, and an attached pressure gauge indicated changes in temperature much more effectively than a thermometer, as the change in pressure due to the boiling of the water was greater than the corresponding change in the temperature.

For example, raising the temperature from 490 deg. to 500 deg. Fah. resulted in raising the pressure 62 lb. per square inch, so that there was a change indicated by the pressure gauge of about 6 lb. for each 1 deg. Fah. It was found that the superheater could be operated at such a constant exit temperature through observing the pressure gauge that a recording thermometer placed on the outlet gave practically constant readings.

An apparatus of the sort could be used either for attemperating the steam and holding it at a given temperature, or it could be used as a limiting device to reduce the superheat in an emergency without attempting to maintain the temperature of the steam at a given figure.

In the latest boilers for high-pressure and high-temperature superheated steam built by the Babcock and Wilcox Company, the superheater is placed above a series of tubes in a drop leg and below the main body of tubes of the boiler.

A superheater properly arranged in this position in a properly designed boiler gives a more constant degree of superheat at different ratings than if placed in the ordinary position above the boiler tubes and permits a higher degree of superheat to be obtained with a given amount of superheating surface, and for the temperature of superheated steam now employed the superheat obtained with a superheater of the sort is near enough constant for use without an attemperating device.

There is but little gain in the economy in increasing the steam pressure to a higher point than 350 lb. per square inch without interstage heating of the steam; that is, the steam from one stage of the turbine must be withdrawn from the turbine, re-superheated and returned to the following stage of the steam turbine.

MOTOR TROUBLE IN POWER PLANTS

(Continued from page 29)

large expense for lamp renewals, as a new lamp would burn out within a few hours. The engineer was undecided as to what was the cause of the trouble, not being very well versed in electrical work.

Finally, an electrician connected with the company which supplied the plant with current was called in. He soon located the trouble with a portable voltmeter, for the voltage on one leg of the circuit was 138, while the other leg was around 90. The trouble was eliminated by the installation of a suitable balancer coil.

Book Reviews

Kent's Mechanical Engineer's Handbook. By the late William Kent, Tenth Edition. Rewritten by Robert Thurston Kent, editor in chief, and a staff of 35 specialists. Published by John Wiley & Sons, New York City, 1923. Limp binding with gold edges; 4¼ x 7 in.; 2,247 pages with tables, curves and diagrams. Price: Genuine leather, $7; Atholeather, $6.

This handbook is not merely the tenth edition of the late William Kent's work. It is truly a new "Kent," rewritten to bring it into line with recent engineering practice With slightly larger type pages and with 700 more of them, the new Kent contains over fifty per cent. more material than the ninth edition.

A casual inspection reveals at once a great wealth of new material. Useful tables, in particular, are supplied in greater profusion than ever. The book is divided into 27 main sections, each with its own table of contents.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES

4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines —the Indicator—Lubrication—PRACTICAL MANAGEMENT. GAS, GAS ENGINES—*Aeroplanes* and *Aviation*—HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers.—Mechanical Stockers—Oil Burners—Setting—Chimneys—Mechanical Draught —HOW TO SELECT A BOILER—BOILER DESIGN based on A.S.M.E. BOILER CODE—OPERATION FIRING. Pipes, Fittings—Heating and Ventilation—Refrigeration—Cooling Towers —Condensers—Distilling Apparatus—Elevators—Cranes—Ropes and Cables—Splicing—*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license—ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now—today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you , 1 monthly until $12 is paid.

Signature ____________

Occupation ____________

Employed by ____________

Residence ____________

Reference ____________

M. BARRY WATSON

B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer

Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W

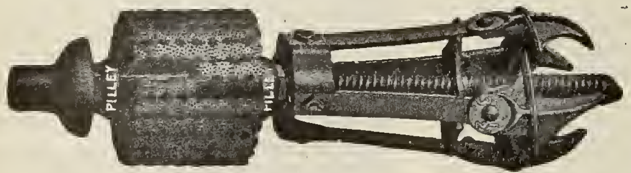
THE BUYERS' GUIDE

will be found on

Pages 50, 52, 54

HINTS TO BUYERS

The Simplest and best cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO.
623 South Third Street - - - St. Louis, Mo
Eastern Office: 71 Fulton St., New York

AMERICAN
STEAM ASH CONVEYORS

Labor-saving ash-handling equipment of proven economy. Information on request.

Canadian Representatives:
CLEATON CO. (Canada) Ltd., Montreal.
GORMANS, LIMITED, Edmonton, Calgary,
WM. A. GOOLD, Winnipeg.
T. M. GRINDLEY CO., Vancouver.

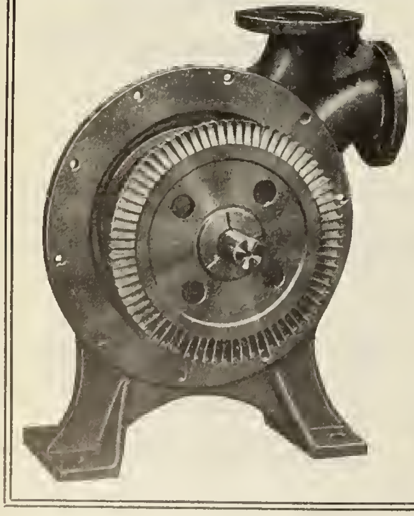
CONVEYORS CORPORATION OF AMERICA
326 W. MADISON STREET CHICAGO

Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

Make Good With
Your Product
and Then
Advertising Can
Make Good for You



Westco Pumps

Specially adapted for :

- Water Supply Systems,
- Fire Protection,
- Oil Burner Installations,
- Boiler Feed, Transfer and Booster Service.

A Marvel of Simplicity.

WESTCO MFG. CO.
LIMITED
220 King St., W.
Toronto

McDaniel Improved
STEAM TRAP

FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One on Trial?

Reducing Valves, Pump Governors
Relief Valves, Exhaust Pipe Head
Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street-MONTREAL, CAN.

WATSON & McDANIEL CO.
No.146 N. 7th St., PHILADELPHIA, Pa.

MONCRIEFF'S "UNIFIC" WATER GAUGE **GLASSES**

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

I HAVE been treating **FEEDWATER** for steam boilers for 24 years and am in a position to investigate your feedwater problems.

I WILL give you a formula for your special plant and thus save you 10% to 20% of your fuel.

Send in Your S.O.S. to:—
H. P. STEPHENS
Feedwater Specialist.
June. 5642 2004 Dundas St. W. Toronto

YORK Ice Making & Refrigerating **MACHINERY**

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO, LIMITED
Villiers and Munition Sts., Toronto
324 Craig St. West, Montreal
1415 Whyte Ave., Winnipeg
1158 Homer St., Vancouver

WHEN YOU REQUIRE
Industrial Electric Control Apparatus
Consult "Sundh"
Dominion Engineering Agency Limited
TORONTO:-D. M. Fraser, 24 Adelaide East
MONTREAL:-E. W. Playford, 358 Beaver Hall Square

WATER TUBE TILES
Special Firebrick Shapes, Slabs, Furnace Arch Brick, Stoker Bricks, Etc.
Made to withstand Highest Temperatures
BELL FIREBRICK CO.
1347-51 DUFFERIN ST.
KENWOOD 4335 TORONTO

THE BROWN INSTRUMENT CO., PHILADELPHIA, PA., U.S.A.
Largest Pyrometer Manufacturers in the World.

Brown Thermometers

For Province of Quebec: LaChapelle Eng. Co., 137 Mcgill Street, Montreal, Que. For Ontario: Brown Instrument Co 1421 Ford Building, Detroit Mich., U. S. A.

Send for Catalog No. 63

BOILER SETTINGS
SPECIALISTS IN
FIREBRICK AND ARCHWORK
FOR EVERY TYPE OF STEAM BOILER
A. E. RULE COY.
122 Garden Av. TORONTO Lakeside 1274

Morehead Back to Boiler SYSTEM

Stops Waste of Condensation

Saves Fuel--Raises Efficiency In the Plant

Write us for information

J. E. FARRELL
Director of Sales
304 Manning Chambers, Toronto, Ont.

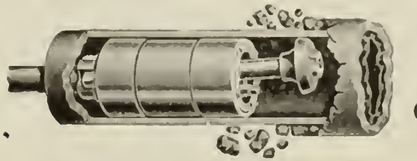
ENGINEERS' CERTIFICATES

THERE are about 85 engineers in Ontario holding 1st class certificates, all of them using mechanical means for removing the scale from their Boiler Tubes. 60 per cent. using the Dean Boiler Tube Cleaner. If it is such a good thing to have in large Boiler Rooms, **WHY NOT** let us show you what we can save you in your own plant.

We will give you a free demonstration or

CLEAN YOUR BOILERS OF SCALE, BY CONTRACT, ANYWHERE AND ANY TIME

We guarantee to save you from 15 to 50 per cent on your fuel bill and 75 on your compound.



The "Dean" removing scale from Return Tubular Boilers.

Over 100 Testimonials.
Write or phone us for full particulars.
Phone:
ADELAIDE 1135.
Geo. Farrow & Son
17-19 Victoria Boulevard
Mount Dennis,
TORONTO.

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

---

SUPERHEATERS ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE, BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA THE SUPERHEATER CO., LIMITED, WORKS AT SHERBROOKE, QUE.
Transportation Bldg., Montreal

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
H. Mueller Mfg. Co., Ltd., Sarnia, Ont.

AIR COMPRESSORS
Laurier & Lamb Co., Montreal.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Teronto.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Michigan.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto.

AIR FILTERS
Midwest Canada, Ltd., Montreal.

ALARMS (LOW WATER)
Bristol Co., Waterbury, Conn.
James Morrison Brass Mfg. Co., Ltd., Toronto.

AMMETERS
Bristol Co., Waterbury, Conn.

AMMONIA COMPRESSORS
The Vitter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

ASH CONVEYORS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal, Que.
Heat Automatic Damper Control.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BEARINGS
Can. Fairbanks-Morse Co., Ltd., Montreal
Beveridge Supply Co., Montreal, Que.

BELT LACING
Bristol Co., Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
D. K. McLaren Ltd., Montreal.
Dominion Belting Co., Hamilton.
L. F. Smidth & Co., New York.

BELTING LINK
Can. Fairbanks-Morse Co., Ltd., Montreal.
Link-Belt Ltd., Toronto, Ont.

BELTING, ROLLER
Hans Renold of Canada, Ltd., Montreal and Toronto.

BELTING, RUBBER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Dunlop Tire & Rubber Co., Ltd., Toronto.
Gutta Percha & Rubber Co., Ltd., Toronto.

BLOWERS, TURBINE
Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton. New Jersey.
Turbine Equipment Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BLOWERS, FAN
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
De Laval Steam Turbine Co., Trenton, New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
Canadian Blower & Forge Co., Kitchener, Ont.
De Laval Steam Turbine Co., Trenton New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BOILER TUBE CLEANERS
Pilley Packing & Flue Brush Co., St. Louis, Mo.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd. Toronto.

BOILER COMPOUNDS
G. F. Sterne & Sons, Ltd., Brantford.
H. P. Stephens, Toronto.
Shell Bar Boico Co., Toronto.
Refinite Co. of Can., Ltd., Toronto.
Kirby & Co., Toronto.

BOILER TUBES
Babcock & Wilcox, Ltd., Montreal.

BOILER SETTINGS
A. E. Rule Co., Toronto.
Beveridge Supply Co., Montreal, Que.
Gates Engineering Co., Ltd., Montreal.
Celite Prodcuts, Ltd., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto, Ont.
Shell Bar Boico Co., Ltd., Toronto.
Sterne & Sons, G. F., Brantford, Ont.
W. R. Sexton Boiler Setting Co., Toronto.

BOILERS, HEATING
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Waterous Engine Works, Brantford.

BOILERS, RETURN TUBULAR
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOILERS, VERTICAL WATER TUBE
Geo. T. Ladd Co., Pittsburgh, Pa.

BOILERS, WATER TUBE
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOXES, STEEL, FOR ELECTRIC SERVICE
Canadian Drill & Electric Box Co., Ltd., Toronto.

BREECHINGS
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Engineering & Machine Works of Canada, St. Catharines, Ont.

BRICK, FIRE
Goldie & McCulloch Co., Ltd., Galt, Ont.
Elk Firebrick Co., Ltd., Hamilton, Ont.
Sexton Boiler Setting Co., W. R., Toronto. Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.

BRICK, INSULATING
Celite Products, Ltd., Chicago, Ill.

CABINETS, LIGHTING
Canadian Drill & Electric Box Co., Ltd., Toronto.

CALORIMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

CASTINGS, BRASS & IRON
Canadian Steam Boiler & Equipment Co., Ltd., Toronto.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Kerr Engine Co., Ltd., Walkerville, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CASTINGS, GREY IRON
Velter Mfg. Co., Milwaukee. Wis.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CEMENT, ASBESTOS
Sterne & Sons, G. F., Brantford, Ont.

CEMENT, IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

CEMENT, FIRE BRICK
Sterne & Sons, G. F., Brantford, Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.

CHAINS (See sprockets and chains)
Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, DRIVING
Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, ROLLER
Hans Renold of Canada, Ltd., Montreal and Toronto.

CIRCUIT BREAKERS
Dominion Engineering Agency, Ltd., Toronto.

COAL AND ASH HANDLING MACHINERY
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COAL CRUSHERS
Babcock & Wilcox, Ltd., Montreal.
Canada Stoker Company, Ltd., Toronto and Galt.
The Canadian-Fairbanks Morse Co., Ltd., Montreal.

COAL PULVERIZING EQUIPMENT
Combustion Engineering Corp., Ltd., Toronto.

COCKS, BRASS & IRON
Homestead Valve Mfg. Co., Homestead, Pa.
James Morrison Brass Mfg. Co., Ltd., Toronto.

COCKS, GAGE
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COCKS, STEAM
James Morrison Brass Mfg. Co., Ltd., Toronto.

CO2 RECORDERS AND FLUE GAS ANALYSIS INSTRUMENTS
Sarco Co., Inc., N. Y.
Foxboro Co., Inc., Foxboro, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal.

CONDENSERS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine, Toronto.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

CONDENSERS (JET)
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Galt, Ont.

CONDENSERS (SURFACE)
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CONVEYORS (SEE COAL AND ASH HANDLING MACHINERY)
Babcock & Wilcox, Ltd., Montreal.

COUPLINGS, FLEXIBLE SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

COUPLINGS, SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

CRANES
Babcock & Wilcox, Ltd., Montreal.
John T. Hepburn, Ltd., Toronto.

DEALERS (MACHINERY)
Can. Fairbanks-Morse Co., Ltd., Montreal.

DISTILLING APPARATUS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.

DISTRIBUTING BOARDS
Can. Drill and Electric Box Co., Ldt,. Toronto.

DRILLS
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

EJECTORS
Laurie & Lamb Co., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ELECTRIC GENERATING SETS (STEAM ENGINE)
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton, Ont.
Laurie & Lamb Co., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC GEN. SETS—(Steam Turbine)
Can. General Elec. Co., Ltd., Toronto.
Can. Westinghouse Co., Ltd., Hamilton.
Laurie & Lamb Co., Montreal.
F. Laurie & Co., Montreal.
De Laval Steam Turbine Co., Trenton.
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC MOTORS
Can. General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

ENGINES, DIESEL
Laurie & Lamb Co., Montreal.

ENGINES, CORLISS
Laurie & Lamb Co., Montreal.
Frick Co., Wanesboro, Pa.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, GAS & OIL
Laurie & Lamb Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, PUMPING
Laurie & Lamb Co., Montreal.

ENGINES, STEAM
Can. Sirocco Co., Ltd., Windsor, Ont.
Laurie & Lamb Co., Montreal.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ENGINES, UNA-FLOW
Vilter Mfg. Co., Milwaukee, Wis.
Frick Co., Wanesboro, Pa.

ENGINE REPAIRS
Goldie & McCulloch Co., Ltd., Galt, Ont.

EXPANSION JOINTS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FANS (SEE BLOWERS, FAN)
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

FEED WATER HEATERS
Arthur S. Leitch, Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont
Sims Company, Erie, Pa.

FEED WATER PURIFIERS
Sterne & Sons, G. F., Brantford, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

FILTERS, FEED WATER
Babcock & Wilcox, Ltd., Montreal.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

FILTERS, OIL
Babcock & Wilcox, Ltd., Montreal.
Turbine Equipment Co., Ltd., Toronto.

FILTERS, WATER
Laurie & Lamb Co., Montreal.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

FIRE BRICK ARCHES
Combustion Engineering Corp., Ltd., Toronto.

FITTINGS, AMMONIA
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

FITTINGS, PIPE
International Malleable Co., Guelph, Ont.

FITTINGS, STEEL
Reading Steel Casting Co., Bridgeport, **Conn.**

FITTINGS, CAST IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

FLOATS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FUEL OIL SYSTEMS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
T. J. Cunerty Co., Toronto.

FURNACES
Can. Sirocco Co., Ltd., Windsor, Ont.

FURNACE ARCHES, FLAT SUSPENDED
Canada Stoker Co., Ltd., Toronto and Galt.
Bell Fire Brick Co., Toronto.
Shell Bar Boico Co., Ltd., Toronto.
Gates Engineering Co., Ltd., Montreal.

FURNACE LININGS
Shell Bar Boico Supply Ltd., Toronto, Ont.
G. F. Sterne & Sons, Ltd., Brantford, Ont.

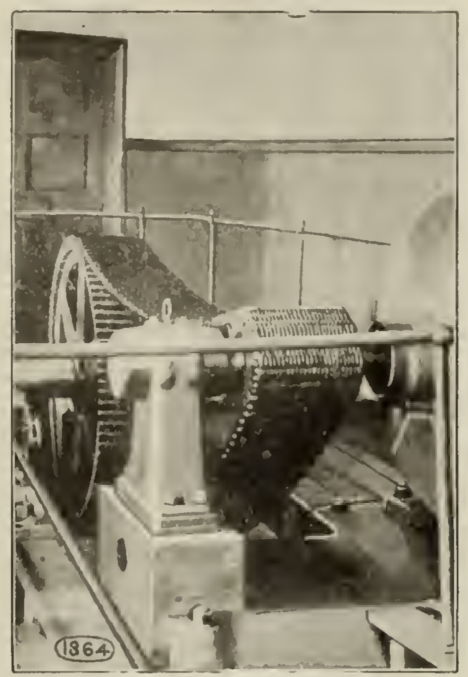
GAGE COCKS (SEE COCKS GAGE)
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASS GUARDS
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASSES
Durabla Mfg. Co., New York City.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, DIFFERENTIAL
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

GAGES, DRAFT
Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd Toronto.


RENOLD
DRIVING CHAINS

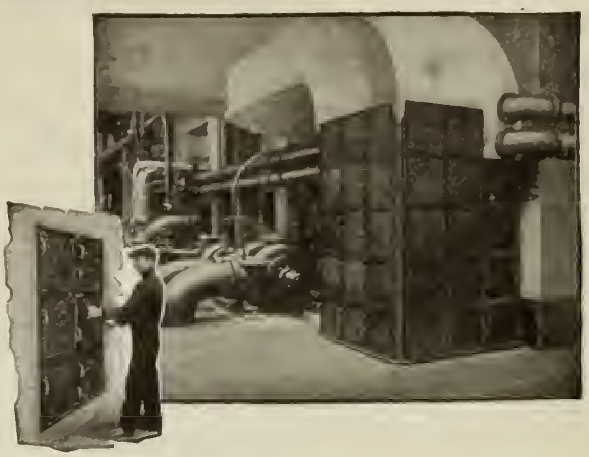
Noiseless in Operation Unaffected by Heat, Cold or Moisture.

RELIABLE
EFFICIENT
DURABLE
COMPACT

Write for Booklet No. 00022. Notes on Selection Chain Gear.

175 H.P. MAIN SHAFT DRIVE.

HANS RENOLD OF CANADA Limited
11 St. Sacrament Street
Toronto MONTREAL New York

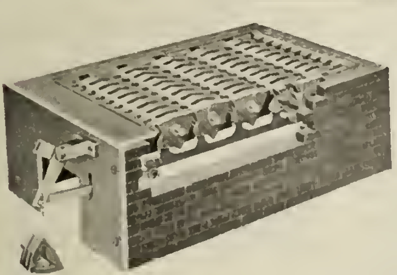

Generator Insurance
Premium:- Part of ONE Man's Time!

Dusty, dirty cooling air for electrical equipment is a real hazard, making easy short circuits, fires, and serious damage.

Insure yourself by using CLEAN AIR from Midwest Air Filters. They have no moving parts, sprays, pumps, nor anything to get out of order. The first cost is practically the last, because the only operating costs are a few minutes by one man for cleaning and a small amount of fluid for charging.

Have you sent for data book, F-15?

MIDWEST AIR FILTERS
MIDWEST CANADA, LIMITED
83 Craig St. W. Montreal, Que.


Anti-Clinker
SHELL-BAR GRATE BARS

Designed and built by men with practical experience, the Shell-Bar Anti-Clinker Grate Bars are built to

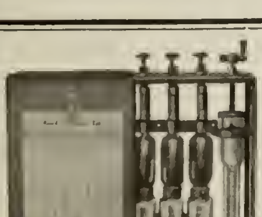
Get the last bit of heat out of the last bit of fuel

Maximum air space permits perfect combustion even of low-grade fuel. Nothing is burnt to waste—nothing is wasted in clinkers. Wherever they are used they are giving more heat with less fuel.

Write for full particulars

SHELL-BAR BOICO SUPPLY, Limited 1-15 Saunders Ave. TORONTO

SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd. Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.


Hays Improved Gas Analyzer.

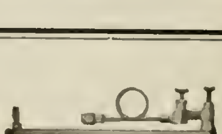
Are You Wasting Fuel?

Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO_2, O_2 and CO; 1-chamber Analyzer for CO_2 only. Stocked by Canadian Agents listed below.

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
Michigan City, Indiana

P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.


HAYS DRAFT GAGES, "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts and Draft Regulation."

GAGES, PRESSURE
Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, RECORDING
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

GAGES, STEAM
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
Babcock & Wilcox, Limited, Montreal, Que.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, VACUUM
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, WATER
The Bristol Co., Waterbury, Conn.
The James Morrisson Brass Mfg. Co., Limited, Toronto, Ont.

GAS EXHAUSTERS
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

GASKETS
Jenkins Bros., Limited, Montreal, Que.
Shell Bar Boico Supply Ltd., Toronto, Ont.

GEARS
E. Laurie & Co., Montreal, Que.
Turbine Equipment Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Limited, Montreal, Que.

GEARS, CUT
Hans Renold, of Canada, Ltd., Montreal and Toronto.

GEARS, ROLLER CHAIN
Hans Renold of Canada, Ltd., Montreal and Toronto.

GEARS, SILENT CHAIN
Hans Renold of Canada, Ltd., Montreal and Toronto.

GENERATORS, ELECTRIC
Laurie & Lamb Co., Montreal, Que.

GENERATORS, HOT WATER
The Sims Co., Erie, Pa.
Arthur S. Leitcb Co., Toronto.

GOVERNORS, PUMP
Canada Stoker Co., Ltd., Toronto and Galt.
Northern Equipment Co., Erie, Pa.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

GRATES
Beveridge Supply Co., Montreal, Que.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Can. Steam Boiler Equipment Co., Ltd., Toronto, Ont.

GRATE BARS
Canadian Steam Boiler Equipment Co., Toronto, Ont.
Engineering & Machine Works of Canada, Limited, St. Catharine, Ont.
Babcock & Wilcox, Limited, Montreal, Que.
John T. Hepburn Ltd., Toronto, Ont.
Goldie McCulloch Co., Ltd., Galt, Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.

GREASE EXTRACTORS
Babcock & Wilcox, Limited, Montreal, Que.

HEATERS, FEED WATER
Goldie & McCulloch Co., Ltd., Galt, Ont.

HEATING SYSTEMS
Can. Sirocco Co., Ltd., Windsor, Ont.

HOISTS, ELECTRIC
Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

HOPPERS, COAL & ASH
Combustion Engineering Corp., Ltd., Toronto, Ont.

HOSE, AIR
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

HOSE, RUBBER
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Bahcock & Wilcox, Limited, Montreal, Que.

HOSE, STEAM
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

HOSE, WATER
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

ICE AND REFRIGERATING MACHINERY (SEE REFRIGERATING MACHINERY)
Jamieson Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
Can. Ice Machine Co., Toronto, Ont.
York Mfg. Co., York, Pa.
Frick Co., Waynesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.

INDICATORS, SPEED
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INDICATORS, STEAM ENGINE
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INJECTORS
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

LUBRICATORS, CYLINDER
The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, FORCE FEED
The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, SIGHT FLOW
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

MACHINE WORK, SPECIAL
Engineering & Machine Works of Canada, Limited, St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

METERS, BOILER
Laurie & Lamb Co., Montreal, Que.

METERS, FLOW
Canada Stoker Co., Ltd., Galt and Toronto.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

OILING DEVICES
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PACKING, ASBESTOS
Durabla Mfg. Co., New York City.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Laurie & Lamb Co., Montreal, Que.

PACKING, SHEET
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Durabla Mfg. Co., New York City.
The James Morrison Brass Mfg. Co., Ltd., Toronto Ont.

PACKING, VALVE STEM PIPE
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

PIPE, BRASS & COPPER
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE BENDING
Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE COILS
Can. Ice Machine Co., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE CUTTERS
The James Morrisou Brass Mfg. Co., Ltd., Toronto, Ont.

PUMPS, BOILER FEED
Albany Pump Co., Toronto.
American Steam Pump Co., Battle Creek, Mich.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CENTRIFUGAL
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
E. Laurie & Co., Montreal, Que.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Co., Toronto, Ont.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CONDENSER
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Micb.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

PUMPS, FORCE FEED
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamh, Montreal, Que.

PUMPS, OIL
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Euipment Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Westco Mfg. Co., Toronto.

PUMPS, POWER
American Steam Pump Co., Battle Creek, Mich.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, ROTARY
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont. Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Westco Mfg. Co., Toronto.

PUMPS, STEAM
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
John T. Hepburn, Ltd., Toronto, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
F. L. Smidth & Co., New York.
Turbine Euqipment Co., Ltd., Toronto, Ont.

"PUMPS-SUMP"
Albany Pump Co., Toronto.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.

PUMPS, TURBINE
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto, Ont.

PUMPS, VACUUM
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Young Pump Company, of Canada, Hamilton, Ont.
John T. Hephurn Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairhanks-Morse Co., Ltd., Montreal, Que.
Arthur S. Leitch Co., Toronto.
Nash Engineering Co., (Hytor) South Norwalk, Conn.

PYROMETERS
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

REFRACTORY MATERIAL
G. F Sterne & Sons, Ltd., Brantford.

REFRIGERATING MACHINERY
Jamison Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.
Frick Co., Wanesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

REGULATORS DAMPER, DRAFT & FAN
Laurie & Lamb, Montreal, Que.
Julian D'Este Company, Boston, Mass.

REGULATORS, FEED WATER
Canada Stoker Co., Ltd., Galt and Toronto.
Northern Equipment Co., Erie, Pa.

REGULATORS, TEMPERATURE
Sarco Co., Inc., New York.
The Bristol Co., Waterbury, Conn.
Julian D'Este Company, Boston, Mass.
The Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

REGULATORS, PRESSURE
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, AIR
Can. Sirocco Co., Ltd., Windsor, Ont.

SEPARATORS, AMMONIA
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.

SEPARATORS, OIL
Anderson Co., V. D., Cleveland, Ohio.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Tbe James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, STEAM
Anderson Co., V. D., Cleveland, Ohio.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SMELTING LININGS
G. F. Sterne & Sons, Ltd., Brantford.

SODA ASH
G. F. Sterne & Sons, Ltd., Brantford, Ont.

SODA SILICATE
Diamond Specialty Mfg. Co., Windsor.

SOOT BLOWERS
Diamond Specialty Mfg. Co., Windsor.
Pilley Packing & Flue Brush Co., St. Louis, Mo.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SPRAY NOZZLES
Can. Sirocco Co., Ltd., Windsor, Ont.

SPROCKETS AND CHAINS
Hans Renold of Canada, Ltd., Montreal and Toronto.

STACKS, METAL
Engineering & Machine Works of Canada, Ltd., St. Catbarines, Ont.
Goldie & McCullocb Co., Galt, Ont.

STACKS, RADIAL BRICK
Combustion Engineering Corp., Ltd., Toronto, Ont.

STEEL PLATE WORK
Engineering & Machine Works of Canada, Ltd., St. Catbarines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STOKERS, CHAIN & TRAVELING GRATE
Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que. Que.

STOKERS, OVERFEED
Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.
Detroit Stoker Co., Detroit, Michigan.

STOKERS, UNDERFEED
Detroit Stoker Co., Detroit, Mich.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.

STOKERS, HAND OPERATED
Combustion Engineering Corp., Toronto, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

STRAINERS, WATER
Sarco Co., Inc., New York.

SUPERHEATERS
Babcock & Wilcox Ltd., Montreal, Que.
Goldie & McCulloch Co., Ltd., Galt, Ont.

SWITCHES, ELECTRIC
Canadian Drill & Electric Box Co., Ltd., Toronto.
Canadian General Electric Co., Ltd., Toronto.

TACHOMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Laurie & Lamb, Montreal, Que.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TANKS
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catbarines, Ont.

THERMOMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

THERMOMETERS, FLUE GAS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

THERMOMETERS, RECORDING
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.

TRANSFORMERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

TRAPS, NON-RETURN
Anderson Co., Inc., V. D., Cleveland, Ohio
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd. Toronto, Ont.
Sarco Co., Inc., New York.

TRAPS, RADIATOR
Sarco Co., Inc., New York.

Made in Canada since 1896

LINDE

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Making Plants Large and Small

Vertical Enclosed Type Machines made for capacities from one to fifty tons.

Horizontal Frame Heavy Duty Type Machines made for plants up to 300 tons capacity.

LINDE Machines embody every improvement that adds efficiency and durability, and are the ultimate development of specialized engineering and manufacturing experience during fifty years.

All present-day Linde Machines are fitted with our patent silent valves, giving increased efficiency and guaranteed to be mechanically silent in operation.

Linde Machines will do the most work for the least money.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

"Yes, Madam, Your Husband was a Careful Investor"

Will your banker be able to give your widow this assurance?

YOU do not save money for the mere joy of having it. You have a definite purpose in view. It may be to protect your own later years; to educate your children and start them out in life or to sustain your widow and dependents should you yourself pass on.

For these purposes you save —and invest what you save. It is a sacred trust. To fulfill it you must put that which you save where it will be safe, first, and produce a good income, second. You do this by investing.

Only carefully made investments will achieve your ends. Careful investing requires reliable information.

You can get this necessary sound information and advice weekly in The Financial Post.

Nine thousand other Canadian business men subscribe to it and look to it for news and advice concerning stocks, bonds, mortgages, insurance and business policies in general.

Do the same yourself. Subscribe to-day. Lay the foundation of your fortune on the solid rock of knowledge.

When you have filled in this coupon and attached your cheque for $5 you have assured yourself of 52 issues full of meaty, intelligible, readable business and investment news. Better do it now.

THE FINANCIAL POST,
143 University Avenue, Toronto.

Send me The Post for one year (52 issues).
I enclose $5 (or you may draw on me).

NAME ....

ADDRESS ....

....

FLEXCO
TRADE MARK
Lamp Guards

You'll Soon Need Guards

Guard every lamp that is in danger of breakage or unauthorized removal. Protect yourself from losses and accidents. Flexco and Flexco-Lok (patent locking) guards cost less than new lamps. Last for years.

Expanded metal re-enforced construction. Attractive in appearance. Very rigid and strong. Made with key locking or plain round head screws. A style for every lamp.

Free sample 50 watt guard and complete information sent on letterhead request, mentioning socket size.

FLEXIBLE STEEL LACING COMPANY
469 Lexington St., Chicago, Ill.

GARLOCK
Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS
THE GARLOCK PACKING COMPANY

TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and draft in last pass.

It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

Write for Bulletin CF-131.
THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

FOXBORO
REG U S PAT OFF
THE COMPASS OF INDUSTRY
5323

TRAPS, STEAM

Can. Sirocco Co., Ltd., Windsor, Ont.
Farrfhern Steam Services, Ltd., Toronto.
Laurie & Lamb, Montreal, Que.
Sarco Co., Inc., New York.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TRAPS, VACUUM

Anderson Co., Inc., V. D., Cleveland, Ohio.

TUBE CLEANERS, BOILER

Pilley Packing & Flue Brush Co., St. Louis, Mo.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal, Que.

TURBINE BLADING

De Laval Steam Turbine Co., Trenton, New Jersey.

TURBINES, STEAM

Coppus Engineering Corp., Worcester, Mass.
Laurie & Lamb Co., Montreal, Que.
E. Laurie & Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Arthur S. Leitch Co., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt. Ont.

TURBINES, WATER

De Laval Steam Turbine Co., Trenton, New Jersey.

UNIONS & UNION FITTINGS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVE DISK

Kerr Engine Co., Ltd., Walkerville, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, AIR

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BACK PRESSURE

The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jenkins Bros. Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BALANCED

Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto.

VALVES, BLOW-OFF

Arthur S. Leitch Co., Toronto.
Babcock & Wilcox, Ltd., Montreal, Que.
Homestead Valve Co., Homestead, Pa.
Jenkins Bros., Ltd., Montreal, Que.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BRASS & IRON BODY

Reading Steel Casting Co., Bridgeport, Conn.
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BYPASS

Kerr Engine Co., Ltl., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, CHECK

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, EXHAUST RELIEF

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES FLOAT

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, GATE

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, GLOBE

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, HYDRAULIC

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, NON-RETURN STOP

Babcock & Wilcox, Ltd., Montreal, Que.

VALVES, SAFETY POP

American Schaeffer & Budeuburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, PUMP

Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, RADIATOR

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.

VALVES, REDUCING

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, REGRINDING

Jenkins Bros., Ltd., Montreal, Que.

VALVES, REGULATING

Northern Equipment Co., Erie, Pa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, RELIEF

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, SAFETY

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, STOP

Babcock & Wilcox, Limited, Montreal, Que.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, SUPER-HEATED STEAM

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Reading Steel Casting Co., Bridgeport, Conn.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, THROTTLE

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, VACUUM

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VENTILATION

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor. Ont.

WASHERS, AIR

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

WATER COLUMNS

The James Morrison Brass Mfg. Co., Toronto, Ont.

WATER SOFTENING APPARATUS

Laurie & Lamb Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Babcock & Wilcox, Ltd., Montreal, Que.
W. J. Westaway Co., Ltd., Hamilton, Ont.

WHISTLES

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

WRENCHES

The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

A Reasonable Saving of 5 to 10%

Should You Expect More?

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, or screenings of same, can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee St. PHONE G. 3660 Toronto, Ont.

Bid Good-bye to Boiler Furnace Lining Troubles

Properly flared, front door arches, complete furnace lining including side wall, bridge wall, baffles, back and front arches are easily built without special forms or tools in one solid piece by the use of

BETSON'S PLASTIC FIRE BRICK
REG. U.S. TRADE MARK PAT. OFF.

This pioneer and original plastic fire brick has stood the severest test and proved its worth over a period of twenty years.

Keep a barrel or two on hand for emergency repairs. It will cut your repair costs in half and prevent long shut-downs and delays while waiting for special forms or shapes.

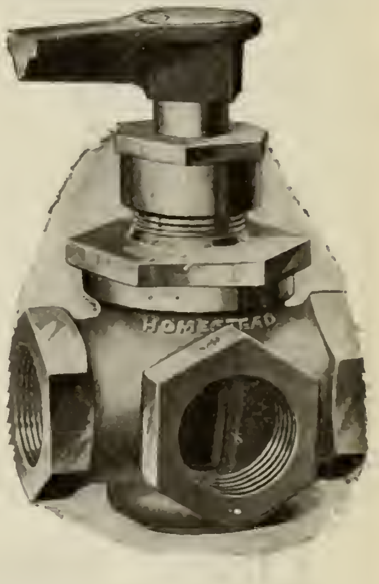
Write for instructive booklet on furnace linings, baffles and Hi-Heat Cement.

Betson Plastic Fire Brick Co., Inc.
Post Office Box 386-6, Rome, N.Y.
Canadian Distributors:
INTERNATIONAL CHEMICAL CO.
26-6 Adelaide St., Toronto, Ont., Canada.

HOMESTEAD Quarter-Turn Valves

Built in
Straight-way
Three-way and
Four-way
Patterns

for the most severe classes of service. Absence of seats eliminates scoring and cutting and insures longevity. Built of brass, semi-steel, bronze and special bodies. Patented cam adjustment maintains absolute accuracy. And best of all they operate by a time-saving quarter turn. Ask for the details.



Homestead Valve Mfg. Company
HOMESTEAD, PA.

EXTRAORDINARY BARGAINS
STEAM ENGINES

1 Goldie & McCulloch heavy duty, cross compound, latest type Corliss condensing engine with rope drive, line shaft pulley and idlers complete, equipped with Dean condenser. Cylinders are 20"x40"x42" stroke. Water heater included.
1 Robb-Armstrong, 18"x18" high speed automatic engine.
1 Robb-Armstrong 11"x14" high speed automatic engine, direct connected to a Westinghouse 70 k.w., 3 phase, 60 cycle, 220 volt generator, complete with exciter and marble control panel.
Also several smaller automatic engines and some air hoists from 4" to 10½".

CHAIN BLOCKS—
2 15-ton Herbert Morris chain blocks with trolleys.
1 10-ton Herbert Morris chain block with trolley.

WATER TUBE BOILERS--
2 250 h.p., 175 lbs. working pressure, government certificate. Everything complete and in first-class condition.

GET FULL PARTICULARS AND REMARKABLY LOW PRICES FROM
WILLIAM COATES
MAIL BUILDING PHONE GLAD. 1947 TORONTO, ONT.

Established 1907

POWER HOUSE

Member A.B.C.

B. G. NEWTON, Manager

S. S. MOORE, Advertising Manager

CANADA—**Toronto** (head office): 153 University Ave., Tel. Ad. 5740. **Montreal:** A. E. Guidal, 128 Bleury St., Tel. Plateau 946. **Winnipeg:** 810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—**New York:** J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. **Chicago:** A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. **Boston:** C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—**London:** The MacLean Company of Great Britain Limited. 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada, $2.00; United States $2.50; Great Britain and other countries in Postal Union, 14s. per year. Australia and other countries not in Postal Union, 19s. per year.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

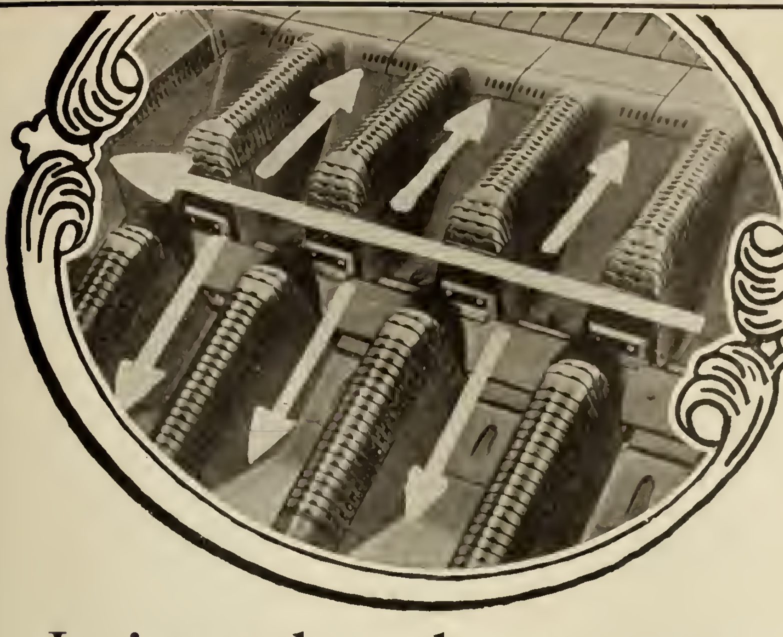
A
Audel, Theo. 47
Allen Feed Water Purifier Co... 8
B
Babcock-Wilcox & Goldie-McCulloch Co., Ltd.......... 20 and 41
Betson Plastic Fire Brick Co., Inc. 55
Brown Instrument Co.......... 49
Bristol Co. 15
Buyers' Directory....... 50, 52. 54
Bird Archer Co. 6
Burnett, J. A. 46
Bell Fire Brick Co. 49
C
Canadian Fairbanks-Morse Co., Ltd. 5
Conveyors Corp. of America.... 48
Combustion Engineering Co..... 9
Can. Allis Chalmers Co....... 3
Can. Steam Boiler & Equipment Co. 55
Celite Products 17
Canadian Ingersoll-Rand Co..... 7
Canadian Blower & Forge Co... 19
Coates, Wm. 55
D
Dart Union Co. 10
D'Este Co., Julian............ 14
De Laval Steam Turbine Co.... 16
Detroit Stoker Co............. 13
Dominion Belting Co........... 14
Dominion Engineering Agency.. 49
Dunham Co., C. A............. 43
Durabla Mfg. Co. 5
E
Engineering and Mach. Works of Canada 6
Edward Valve & Mfg. Co....... 8
Ever-Tyte Co. 45
Elk Fire Brick Co.............. 18
F
Fisher Governor Co............ 19
Foxboro Co., Inc. 54
Flexible Steel Lacing Co........ 54
Flexible Metallic Packing Co... 14
Farrfhern Steam Service...... 49
Farrow & Son, Geo............. 49
G
Garlock Packing Co............ 54
Garth Co., The 48
Gutta Percha & Rubber Co..... 4
Gates Engineering Co.......... 18
H
Hays Corp., Jos. W............ 51
Hans Renold of Canada, Ltd.... 51
Homestead Valve Mfg. Co...... 55
I
Irving Iron Works 16
Imperial Oil Co. 12
J
Jeffrey Mfg. Co. 2
Jamieson Cold Storage Door Co., Inside Front Cover
Jenkins Bros. ....Front Cover
Jointless Fire Brick Co......... 16
L
Leitch, Arthur S. 43
Linde Canadian Refrigeration Co. 53
M
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Moncrieff, Ltd. 49
Midwest Canada, Ltd........... 51
N
National Exposition of Power & Mechanical Engineering 11
P
Pilley Packing & Flue Brush Mfg. Co. 48
R
Rule, A. E..................... 49
S
Superheater Co., Ltd. 49
Sterne & Sons, G. F............ 14
Sarco Co., Inc. 11
Sanford Riley Stoker Co.....Inside Back Cover
Shell Bar Boico Supply Co...... 51
Sterling Engine Co. 15
Sturtevant Co. 46
Stephens Chemical & Mfg. Co. Limited 49
Stephens, H. P. 49
Smart-Turner Machine Co., Ltd. 18
Sexton Boiler Setting Co., W. R. 8
T
Thomson-Gordon, Ltd. 48
U
Underfeed Stoker Co. of Canada .... Inside Back Cover
W
Wall, W. J. 49
Waterous Engine Works Co..... 1
Watson & McDaniel Co......... 48
Watson, M. Barry, M. E........ 47
Westco Mfg. Co................ 48
Y
York Mfg. Co. 49
Young Pump Co. of Canada.... 10

Does your equipment provide Efficiency ?????????

"POWER HOUSE," edited by Canadians for Canadians conversant with Canadian conditions, is the one logical medium for you to use in order to influence Canadian trade your way. Twice a month Power House will carry your message to power plant owners and operators, fresh every issue; and at a time when THEY ARE OPEN for guidance on matters relating to Power Plant Efficiency in Management, Equipment, and Operation.

ADVERTISE YOUR PRODUCT TO CANADIANS

Our experience proves to us that "Power House," the Power Plant Journal of Canada, is a dominating factor in establishing and maintaining a favorable interest and attitude on the part of the Canada buyer towards efficient power plant equipment.



RILEY JONES

The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.

MURPHY

It introduced a new era in underfeed stoker firing—

THE coming of the **"Lateral Retort"** Stoker brought a new epoch in stoker building—and a welcome one. It made available for every plant the high efficiency and high capacity of the multiple retort stoker at the installation and operating cost of the single retort stoker.

Although the **"Lateral Retort"** is multiple retort in effect, in construction it is a simple, single retort stoker. Coal, following the path of the arrows, is first underfed to the main retort and then, actuated by lateral pusher blocks, is underfed into the **"lateral retorts."** Finally, the ash is deposited upon easily operated side dump plates and is dropped into ash pits only 6 to 18 inches below the floor line—so shallow that no expensive ash pit construction is needed.

Ask for the **"Lateral Retort"** Bulletin that shows how this stoker is multiple retort in everything but price—how perfect coal distribution is obtained because of the control of the fuel bed afforded by the main ram and the auxiliary ram—how high efficiency is obtained because of the application of the underfeed principle—how heavy overload capacity is secured by great reserve capacity—how automatic control of fuel and air is given by the use of the Cole Automatic Valve—how features of construction give long life and freedom from excessive maintenance costs.

Your Copy of the Booklet awaits your postcard

The Under-Feed Stoker Co. of Canada Ltd.
146 King Street, West - Toronto

Sales agents for "Jones" Stokers, "Riley" Stokers and "Murphy" Automatic Furnaces

Alta. & West. Sask.: Mr. J. Twomey, Camrose Alberta.

Man. & East. Sask.: W. W. Hicks & Co., Winnipeg.

British Columbia: E. A. Earle, Ltd., Vancouver, B C

Quebec: The Cleaton Co., (Can. Ltd.,) Montreal, Que.

Advantages of the *"Lateral Retort"* Principle

Coal is underfed throughout not overfed on to side grates. This is the only truly *underfed* side-cleaning stoker.

One simple moving unit for five or more retorts—The feeding mechanism of the *"lateral retorts"* is controlled independently of main feed, permitting ideal fuel distribution under all conditions.

Simplest cleaning mechanism—a perfectly balanced dump plate easily operated by hand.

No need for basement ash pits—a trench 6 to 18 inches below the floor line is sufficient excavation for ash pits. This greatly reduces installation cost and makes the stoker adaptable to boilers already in service.

Plate tuyeres—reduce siftings and lower replacement cost.

High air cooled front and rear tuyere blocks keep fire and clinkers away from front wall and bridge wall, reducing furnace maintenance.

The "Lateral Retort" Stoker

TRADE MARK

MORRISON

Pressure Reducing Valves

Efficient — Reliable

J.M.T. Flanged Reducing Valve.

J.M.T. Reducing Valve—Iron Body Bronze Mounted.

To allow for the unequal expansion of the metals, the bronze body lining is suspended from the centre leaving a space between the lining and the body.

Non-Equalizing

Extremely Sensitive.

Nothing could be more positive than the action of the J.M.T. Pressure Reducing Valve in which the low pressure is controlled by the low pressure steam. When the desired low pressure has been obtained the low pressure steam closes the valve. Its simple, automatic effectiveness is the result of years of experiment.

J.M.T. Reducing Valves are made to suit every requirement and are sold with the well-known Morrison guarantee.

"Every Installation is a Demonstration of Merit"

J.M.T. Reducing Valve, differential type, iron body.

J.M.T. Reducing Valve—Low Pressure.

For reduced pressures under 5 lbs. per sq. in. The large diaphragm provides ample power to operate the valve on very low pressures and make the valve sensitive to the slightest change in the reduced pressure.

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Fostering Economy in Steam, Oil and Hydro-Electric Power Development

Vol. XVI—No. 23

Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.

December 5, 1923

MECHANICAL STOKERS

MADE IN CANADA

THE ROYAL BANK BUILDING, TORONTO, ONTARIO, TALLEST OFFICE BUILDING IN THE BRITISH EMPIRE IS EQUIPPED WITH

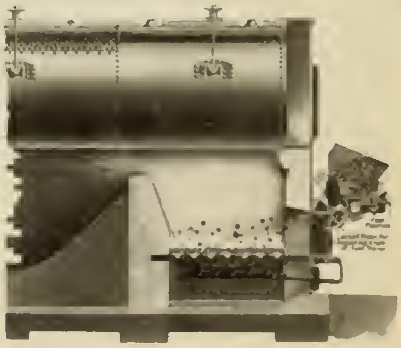
CANADA STOKERS

WHICH ARE GIVING THE BEST OF SATISFACTION.

AS CONTINUOUS SERVICE COUPLED WITH EFFICIENCY AND LOW COST OF UPKEEP IS DEMANDED OF THE POWER PLANT IN SUCH A BUILDING, IT WAS DECIDED TO INSTALL

CANADA STOKERS

AND THEY HAVE FULFILLED ALL THAT WAS EXPECTED OF THEM.



THERE ARE UPWARD OF 500

CANADA STOKERS

IN SUCCESSFUL OPERATION. THE FOLLOWING ARE A FEW OF OUR CUSTOMERS:

LEVER BROS., LTD., Toronto.
WESTERN CANADA FLOUR MILLS, LTD., Goderich, Ont.
CANADIAN INDUSTRIAL ALCOHOL CO., LTD., Corbyville, Ont.
COWAN COCOA CO., LTD., Toronto.
THOS. C. WATKINS LIMITED, Hamilton.
PRINCE GEORGE HOTEL, Toronto.
J. H. DUNLOP CO., Richmond Hill, Ont.
TOWN OF HUMBOLT, Humbolt, Saskatchewan.
PARISIAN LAUNDRY CO., Hamilton.
PENMANS, LTD., Paris, Ont.
STRATHCONA PAPER CO., LTD., Strathcona, Ont.

THE **CANADA STOKER** AND THE **UNIVERSAL CHAIN GRATE** WITH THEIR MANY NEW AND VALUABLE FEATURES WILL BE FOUND EMINENTLY SUITABLE FOR EVERY CLASS OF FUEL, FOR EVERY TYPE OF BOILER, AND FOR EVERY SIZE OF PLANT.

ASK FOR CATALOGUES ON:—
STOKERS, PUMPING MACHINERY, RADIAL BRICK CHIMNEYS, SUSPENDED FLAT ARCHES, HIGH GRADE FIRE BRICK, FLOW METERS AND OTHER LINES APPLICABLE TO POWER PLANT WORK.

THE CANADA STOKER COMPANY LIMITED

GALT, ONTARIO

GENERAL SALES AND INQUIRY OFFICE — 2 GOULD STREET, TORONTO — MAIN 3531

Are You Getting Service?

— If not —

This

Trade Mark

REG. U.S. PAT. OFFICE

Stands for

Service

And Service Means

Dependability — Durability
Efficiency — Economy
Quality — Satisfaction

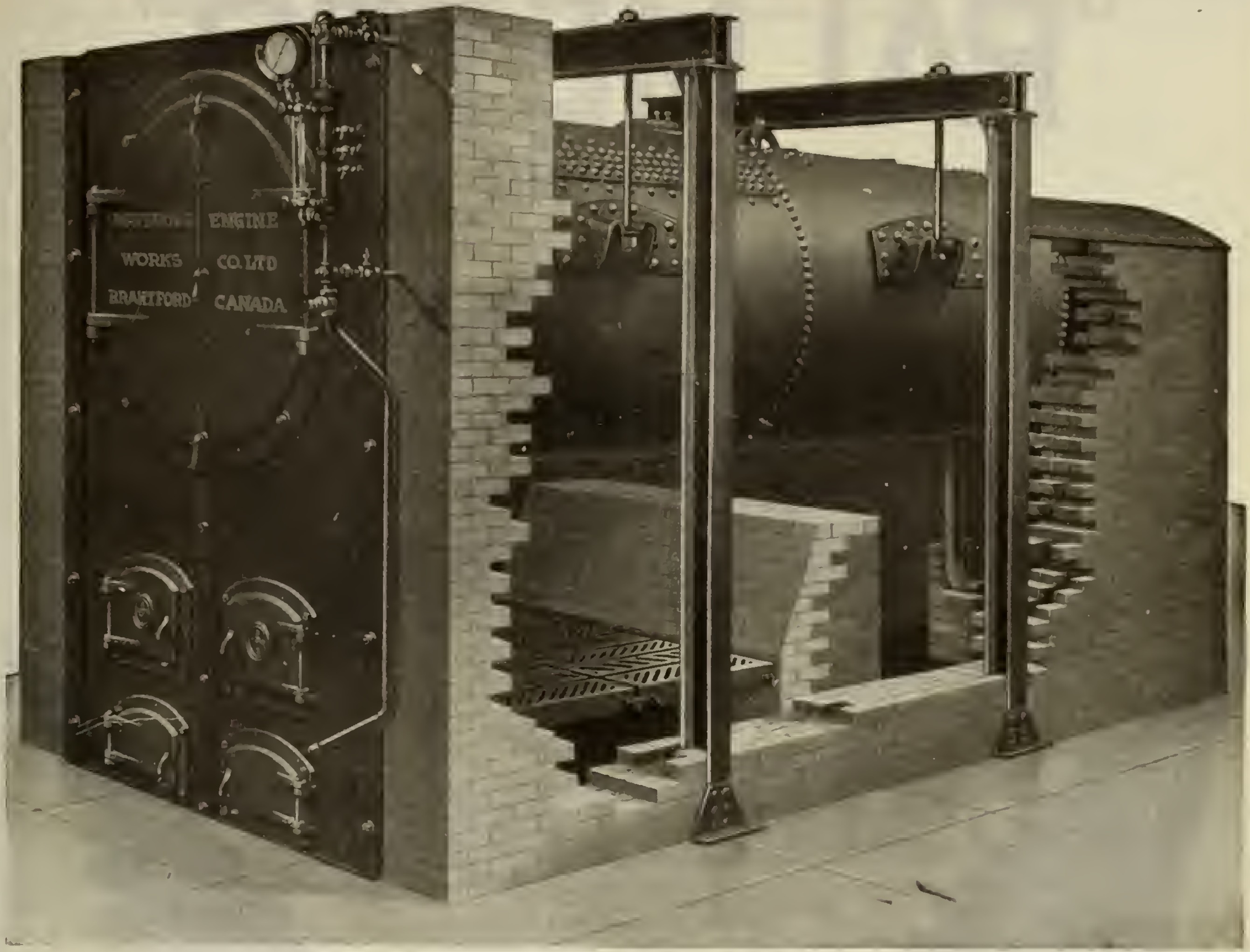
THE GARLOCK PACKING COMPANY, HAMILTON, ONTARIO

Branches:

Montreal, Que.
Calgary, Alta.

Toronto, Ont.
St. John, N.B.

Winnipeg, Man.
Vancouver, B.C.



BOILERS

All Types - All Sizes

We Also Manufacture

Pressure Tanks
Storage Tanks
(Rivetted or Welded)
Bins
Stacks
Steel Plate Work of all Kinds

High Speed Automatic Engines
Heavy Duty Mill Engines
Portable Engines
Stationary Engines
Power Transmission Machinery
Gray Iron Castings up to 15 tons

Waterous
BRANTFORD, ONTARIO, CANADA

"PALMETTO"

REG. TRADE MARK

PACKING

PALMETTO
FOR SMALL VALVES
AND A VARIETY OF USES IN THE ENGINE AND BOILER ROOMS
PACKING
LARGER THAN 5/8 INCH BRAIDED ROUND AND SQUARE
BRAIDED
ROUND AND SQUARE FOR STEAM (ANY PRESSURE) AIR AMMONIA
SQUARE
3/4 PALMETTO 6 LBS
SELF-LUBRICATING PACKING
Size
Weight 1 Pound

Made from a grade of asbestos considered too expensive for packing, but experience has shown that this high grade of asbestos is necessary to secure the perfect heat resistance that gives the long service of true economy.

We ask you to test "Palmetto" for yourself. Working samples will be sent you without charge.

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane Street, New York

CANADIAN AGENTS:
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast

KERR

"Guaranteed" Satisfaction

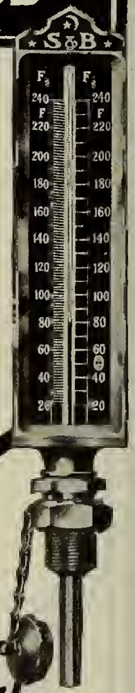
FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

MADE IN CANADA

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
Walkerville - Ontario

Accurate Measuring of Temperatures-

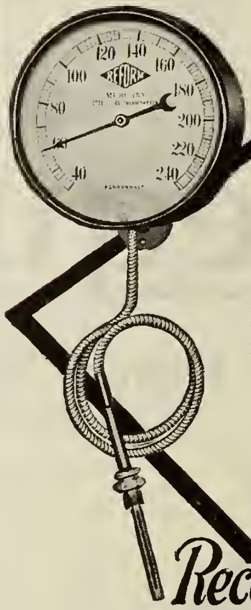


Thermometers of questionable accuracy are a source of real danger.

Schaeffer & Budenberg Thermometers are *guaranteed* accurate. And over seventy years of thermometer-making experience is at your service, gratis, in the solving of your temperature measuring problems.

Crescent Thermometers

For every industrial need. Made in any range up to 1000° F.



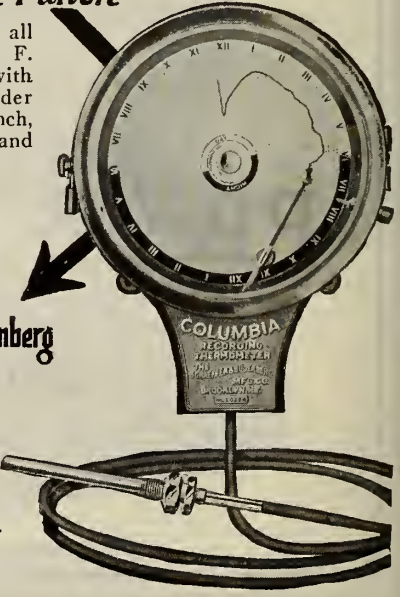
Reform Mercury Dial Thermometers

have the accuracy of the glass thermometer and the reading convenience of the dial face. Indicating dial may be mounted at any point convenient for reading. For temperature ranges up to 1000° F. With 4-in., 6-in. and 12-in. dial.

Columbia Recording Thermometers

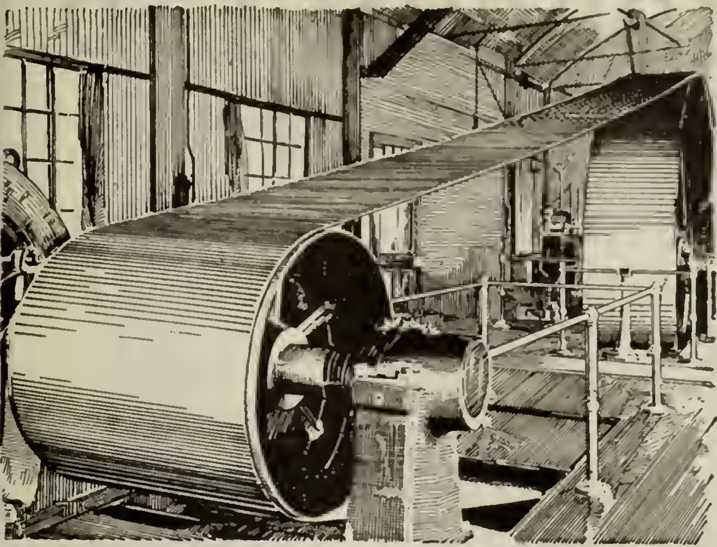
with the Time Punch

For accurately recording all temperatures up to 1000° F. Mercury actuated. Fitted with that wonderful new recorder improvement, the Time Punch, which tells how often and when the chart is read.



Let us prescribe and quote on your Thermometer needs. You will find our Catalog N 33 instructive. A copy is yours for the asking.

American Schaeffer & Budenberg Corporation
SUCCESSORS TO
Schaeffer & Budenberg Mfg. Co.
AND
American Steam Gauge & Valve
MFG. CO. DIVISION
Brooklyn, N. Y.
Canadian Agency
The Canadian Fairbanks-Morse Co., Ltd.
MONTREAL, TORONTO.



Dick's Balata Belt

An unequalled combination of essentials:—

1. Tensile strength.
2. Tractiveness.
3. Pliability.
4. Elasticity.
5. Ability to hold fasteners.
6. Resistance to stretch.
7. Uniformity.
8. Durability.

Don't accept this as a mere statement. Write our nearest Branch for Booklet that shows clearly why this original Balata Belt is the Cost and Power Saver pre-eminent.

The Canadian FAIRBANKS-MORSE Company, Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver, Victoria. 70

TIGHT JOINTS

On Steam, Water, Air, Oil, Ammonia, and Acids at All Temperatures

Place Durabla Packing in the next joints you make and be insured against costly shutdown.

Durabla Compressed Asbestos Fibre Gasket material is not affected by vibration or condensation. It will not burn out, blow out, or pulp at the joints.

Made in Canada in stock sizes 36 in. wide by 150 in. long in thicknesses of 1/64, 1/32, 1/16 and 1/8 in.

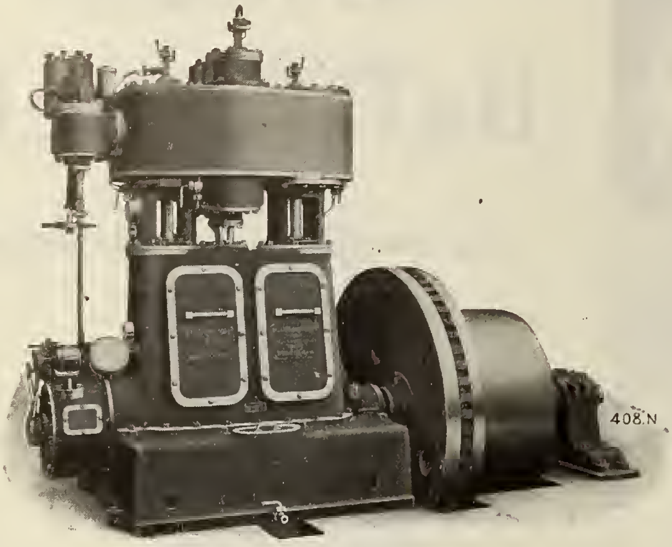
CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA

BELLISS & MORCOM LTD.

BIRMINGHAM, ENGLAND



Belliss Engine with Belt Drive

Are you getting cheap power?

Exhaust steam can be used for heating and process work, and thereby reduce power cost.

May we send you pamphlet on this question.

AGENTS:

LAURIE & LAMB, Board of Trade Bldg., MONTREAL

BOILER CHEMICALS

Made in Canada for You

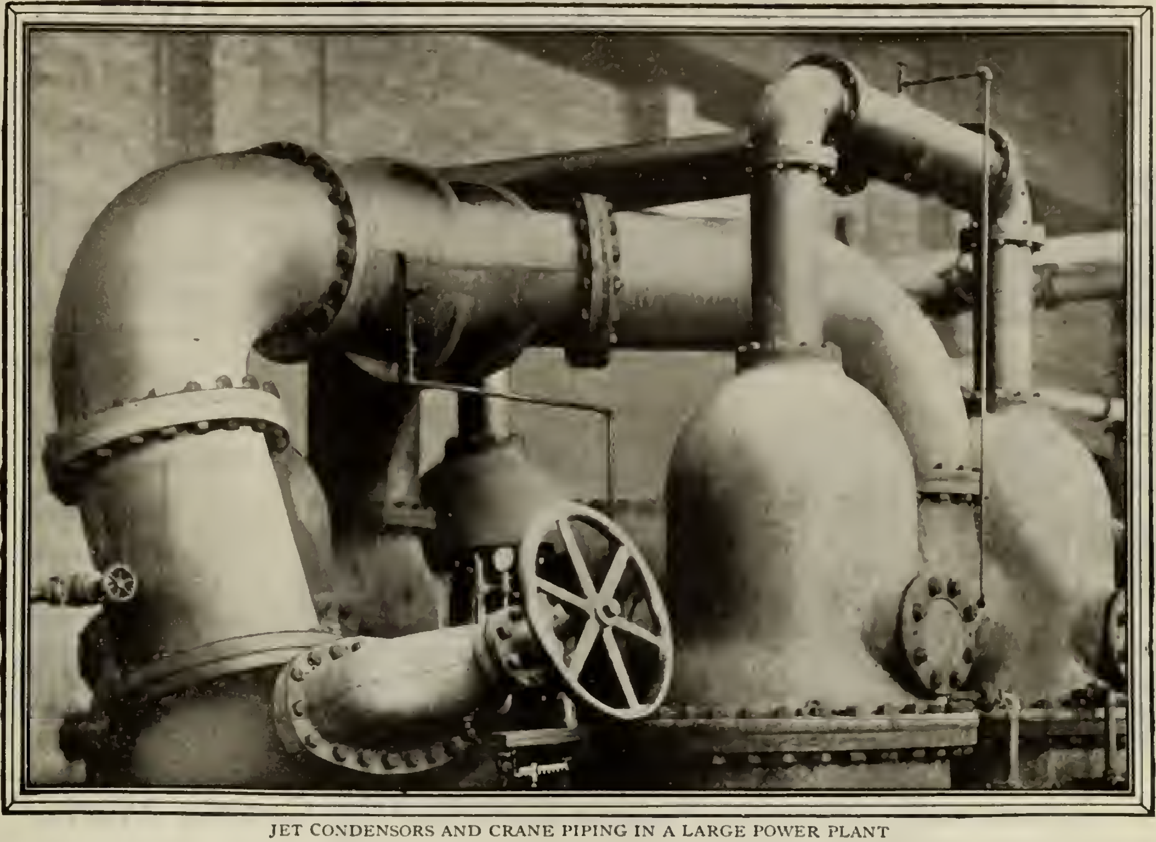
Do it Now

Not a hit-and-miss ready-made compound, but made for you on scientific principles.

Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal Factory: Cobourg



JET CONDENSORS AND CRANE PIPING IN A LARGE POWER PLANT

REDUCING YOUR CONSTRUCTION COSTS

In the construction of piping systems much time and money can be saved by the use of materials accurately made, eliminating costly hand-fitting at the time of erection. Experienced workmen, using the most modern machinery and methods, produce Crane valves, fittings, pipe bends and allied specialties to precise measurements, to make them easy to assemble. Crane equipment meets every piping need, including the severe requirements imposed by high pressures and excessive temperatures.

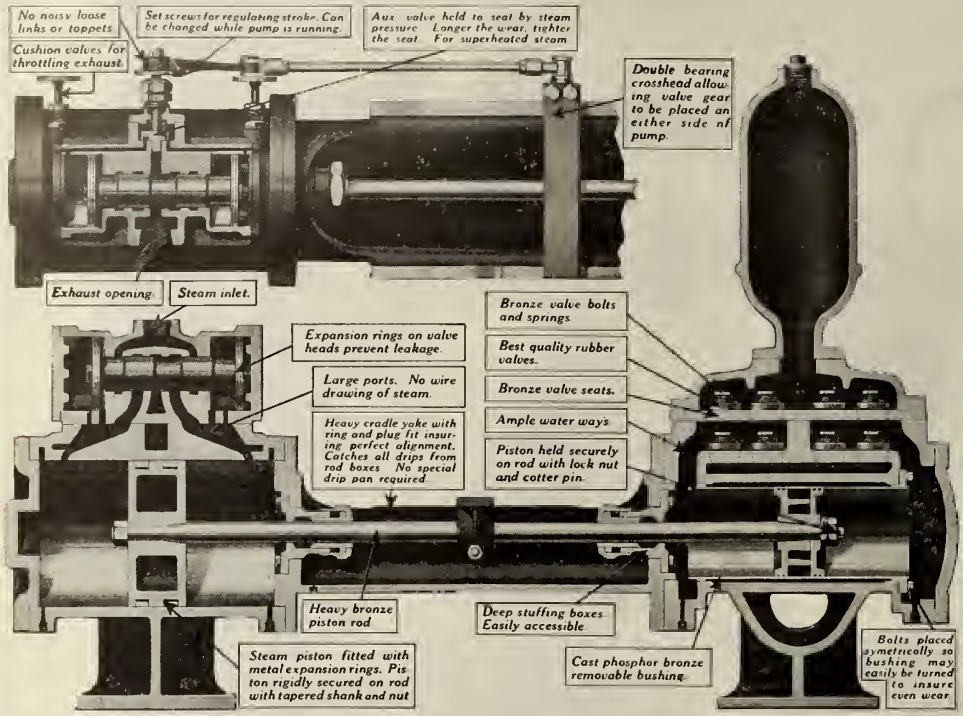
CRANE

CRANE LIMITED, GENERAL OFFICES: 386 BEAVER HALL SQUARE, MONTREAL
CRANE-BENNETT, LTD., HEAD OFFICE: 45-51 LEMAN STREET, LONDON, ENG.

Branches and Sales Offices in 21 Cities in Canada and British Isles
Works: Montreal, Canada, and Ipswich, England

Crane "Telsa" Wash Sink Faucet

AMERICAN--MARSH PUMPS


No noisy loose links or tappets
Set screws for regulating stroke. Can be changed while pump is running.
Aux valve held to seat by steam pressure Longer the wear, tighter the seat For superheated steam
Cushion valves for throttling exhaust.
Double bearing crosshead allowing valve gear to be placed on either side of pump.
Exhaust opening.
Steam inlet.
Expansion rings on valve heads prevent leakage.
Large ports. No wire drawing of steam.
Heavy cradle yoke with ring and plug fit insuring perfect alignment. Catches all drips from rod boxes No special drip pan required.
Bronze valve bolts and springs.
Best quality rubber valves.
Bronze valve seats.
Ample water ways
Piston held securely on rod with lock nut and cotter pin.
Heavy bronze piston rod
Deep stuffing boxes. Easily accessible.
Steam piston fitted with metal expansion rings. Piston rigidly secured on rod with tapered shank and nut
Cast phosphor bronze removable bushing.
Bolts placed symetrically so bushing may easily be turned to insure even wear

THE illustration tells its own story. Why the American-Marsh are the most reliable, trouble-proof and efficient pumps on the market.

Less than one-half the wearing parts found in the duplex type while a saving of 25% in steam consumption is guaranteed.

Over 160,000 in successful operation.

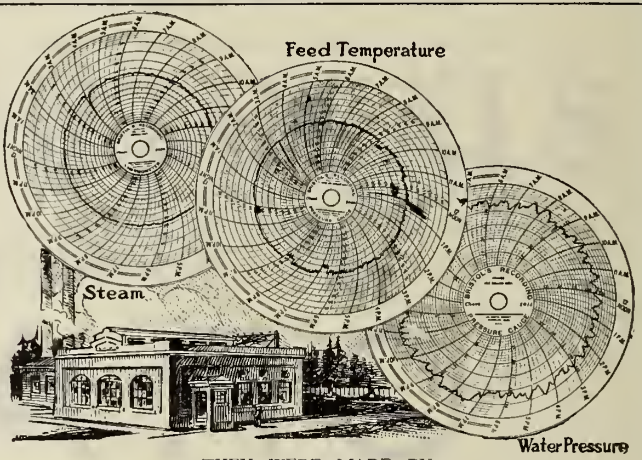
Ask for catalog.

Canadian Agents: The Arthur S. Leitch Co., Ltd., Toronto; Williams & Wilson, Ltd., Montreal. Bissett Pinder & Co., Edmonton. Stephens & Boyle. Vancouver. London Engine Supplies Co., London.

American Steam Pump Co., Battle Creek, Mich.

The History of One Day on these Three Charts

At the Winona Public Utility Company Plant.



THEY WERE MADE BY

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE
RECORDING INSTRUMENTS

and analyzed by the plant owners, as follows:

"The steam chart gives us a record of the steam pressure 24 hours per day. The fireman knows that we have a record of the steam pressure and holds the steam where it should be at all times. He also knows that we have a record of the feed water temperature, and by a glance at the chart he knows if this temperature drops and goes after the trouble, which means a saving of fuel. The water pressure gauge shows the water pressure at all times, which is supplied by a motor driven centrifugal pump operating 24 hours per day. This chart makes a record of any excessive water consumption by a slight drop in the pressure. We have some 2 inch services, which when opened reduce the pressure about 10 lbs. You will also note at 12:30 noon a fire broke out and the fire pump was put on the lines for about 20 minutes which raised the pressure to about 115 lbs. From 9 o'clock at night to 4 o'clock in the morning you will note the chart to show an almost straight line as very little water is used this time of night."

Canadian Distributors:

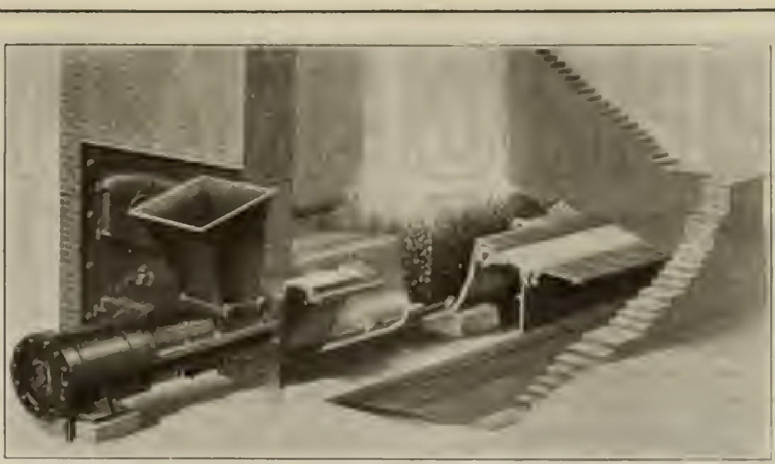
EASTERN TERRITORY: Powerlite Devices, Ltd., Toronto and Montreal.

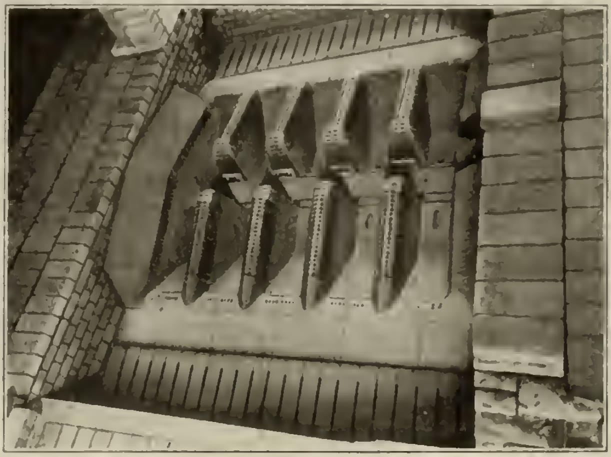
WESTERN TERRITORY: Gorman's, Ltd., Edmonton.

WRITE FOR CATALOG 1006-A.

THE BRISTOL COMPANY

Waterbury, Connecticut





Above:

"Jones Standard Side-Dump"

Opposite:

"Jones Lateral Retort"

No expensive ash pits needed with these stokers

TWO types of "Jones" Stokers that can be installed without expensive ash pit construction, bring low installation cost to practically every Canadian plant.

The "Jones Standard Side-Dump" is installed under boilers to 200 h.p. or thereabouts—the "Jones Lateral Retort" under boilers of larger size.

Both types bring the high efficiency of the superior "Jones" under-feed principle. They make "Jones" under-feed stoker firing available for every Canadian plant.

In both types the ash is deposited on side dump plates. It is then dropped into shallow ash pits below, which need be no deeper than six to eighteen inches.

Don't you want the entire story of these cheaply installed "Jones" Under-feed Stokers? Then ask for the free "Standard Side Dump" or "Lateral Retort" Bulletin. A post card will bring either.

**The Under-Feed Stoker Co. of
Canada, Limited**
146 King Street W., Toronto

The UNDER-FEED STOKER COMPANY OF CANADA LTD.

Alta. & West. Sask.: Mr. J. Twomey, Camrose, Alta.; Man & East. Sask.: W. W. Hicks & Co.,Winnipeg; British Columbia: B. C. Equip. Co., Vancouver, B.C; Quebec: Cleaton Co., (Canada) Ltd., Montreal, Que.

"Jones" and "Riley" Stokers

"Murphy" Automatic Furnaces

REFRIGERATION DEPARTMENT

Made in Canada since 1896

LINDE

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Making Plants Large and Small

Vertical Enclosed Type Machines made for capacities from one to fifty tons.

Horizontal Frame Heavy Duty Type Machines made for plants up to 300 tons capacity.

LINDE Machines embody every improvement that adds efficiency and durability, and are the ultimate development of specialized engineering and manufacturing experience during fifty years.

All present-day Linde Machines are fitted with our patent silent valves, giving increased efficiency and guaranteed to be mechanically silent in operation.

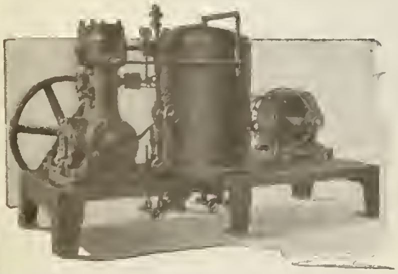
Linde Machines will do the most work for the least money.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.
TORONTO WINNIPEG VANCOUVER

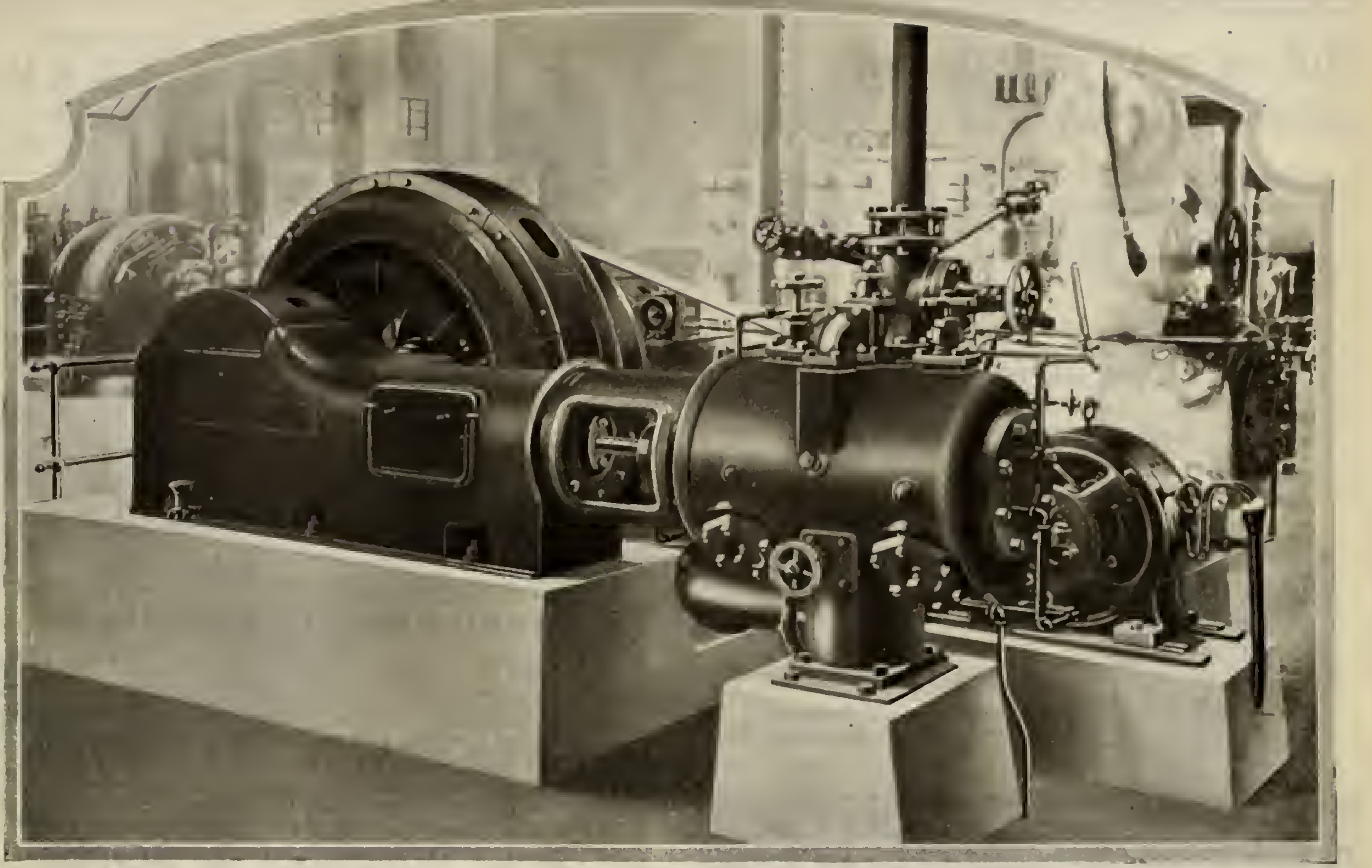
VILTER

ICE MAKING AND REFRIGERATING MACHINERY



A self contained unit built in capacities up to four tons refrigeration. Bulletin No. 29-R describing this and larger size equipments will be promptly forwarded on request.

THE VILTER MANUFACTURING COMPANY
Established 1867
242 BEECHER ST., MILWAUKEE, WIS.
Branch Office: 68 Higgins Ave., Winnipeg, Man., Canada



Two-Stage Ammonia Compressors
With Clearance Control

THE Clearance Control used on I-R two-stage, direct-connected, electric motor-driven ammonia compressors provides for:

- Operating at full, three-quarter, or one-half rated capacity;
- Adjusting the capacity of your compressor to take care of reduced winter loads;
- Operating the compressor with either low or high suction pressures;
- Starting and stopping the machine in gradual steps, resulting in less severe motor duty, and eliminating fluctuation in the electric lines due to throwing the load "all on or all off."

With the Ingersoll-Rand "Clearance Control" the clearance pockets are cast integral with the high and low pressure cylinders. Opening the clearance pockets in both cylinders maintains, at all load points, a constant ratio of compression and equal balance. When operating at partial loads the horse power required is reduced practically in direct proportion to the volume of gas delivered.

Other features of these compressors include:

Ingersoll-Rand Plate Valves for intake and discharge. Two-stage Construction (with water intercooler where desired). Enclosed Frame Construction and Automatic Lubrication.

Send for Bulletins

Canadian Ingersoll-Rand Company, Limited

Sydney Sherbrooke Montreal Toronto Cobalt
Winnipeg Nelson Vancouver

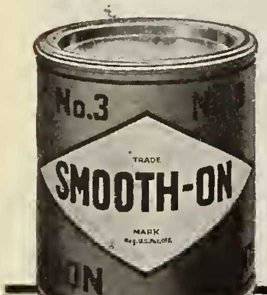
For the U.S. refer Ingersoll-Rand Co., New York.

Ingersoll-Rand

Will you make six leakproof screw-thread joints at our expense?

SMOOTH-ON No. 3 is the perfect joint filler because the metallic iron body is pressure, heat and time-proof—free from drying, shriveling and shrinkage—and differs from all other filling materials in these respects.

Smooth-On No. 3 is so thoroughly and so permanently effective in making and keeping all screw-thread joints tight, that you can't help but realize its superiority. Fair trial will more than repay your time for investigation, and your future business will justify our expense in sending the free sample which we will mail on request.



Buy in 1-lb., 5-lb. or 10-lb. gray labelled tins from your dealer, or send us his name so that we can help you get your supply.

The Canadian Asbestos Co.
36 Youville Square
Dept. 52, Montreal, Que.

Do it with SMOOTH-ON

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded by sudden flushes of water.

May we send one on trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Head Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street, MONTREAL, CAN.
WATSON & McDANIEL CO.,
No. 146 N. 7th St., Philadelphia, Pa.

REFRIGERATION SUPPLIES
REPAIRS - FITTINGS
AGENT FOR FRICK REFRIGERATING EQUIPMENT
REFRIGERATING ENGINEERS
LIMITED
457 King W. TORONTO Adel. 7753

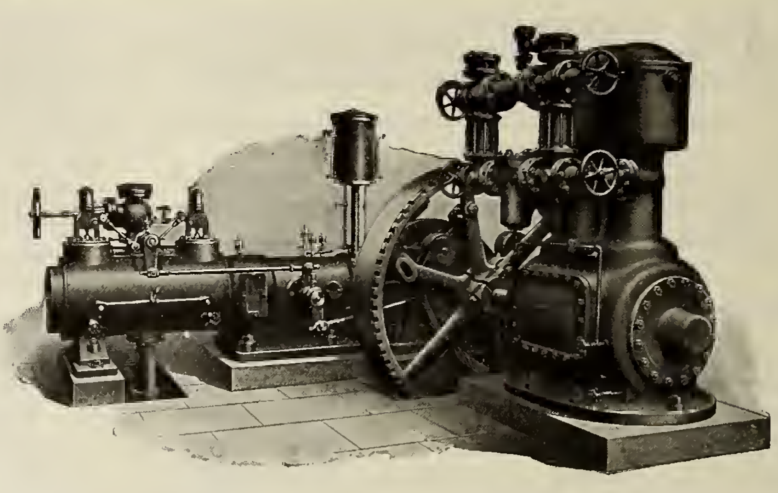
REFRIGERATING MACHINERY
Expansion Pipe Ammonia Fittings. Calcium Chloride. Ammonia. Ice Machines.
Agents for "TRIUMPH" Ice Machines.
J. L. WILSON & SONS
REFRIGERATING ENGINEERS.
3 SILVER AVE. TORONTO

FRICK COMPANY, INC. TRADE FRICK MARK WAYNESBORO, PA. U.S.A.

REFRIGERATION
Safe—Simple—Economical

Economical Refrigeration can only result from a properly proportioned plant made up of machinery designed and built right.

We offer you the benefit of our long experience and we guarantee our product. Frick machines have proven safe investments and are paying good dividends everywhere.



It will pay you to investigate.

See our installation in the new Mount Royal Hotel at Montreal.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: REFRIGERATING ENGINEERS, Ltd., Toronto

Nonpareil Corkboard with Armstrong's Mastic Finish on the walls of the Polar Ice & Coal Company, Louisville, Ky.

Armstrong's Mastic Finish

A M F—Armstrong's Mastic Finish—is designed to be used instead of cement plaster in all cold storage rooms where moisture conditions are unusual. Such are ice storages, beef and pork chillrooms, coil lofts and bunkers, sharp freezer anterooms, etc.

Armstrong's Mastic Finish is a mineral rubber compound an eighth of an inch thick ironed on Nonpareil Corkboard **at the factory.** It is dense, tough, flexible substance, perfectly impervious to air and moisture. Applied hot and soft, it is keyed into the surface under heavy pressure eliminating all air holes and bubbles. It has no odor. It does not become brittle or crack when cold, nor does it soften or peel at ordinary temperatures.

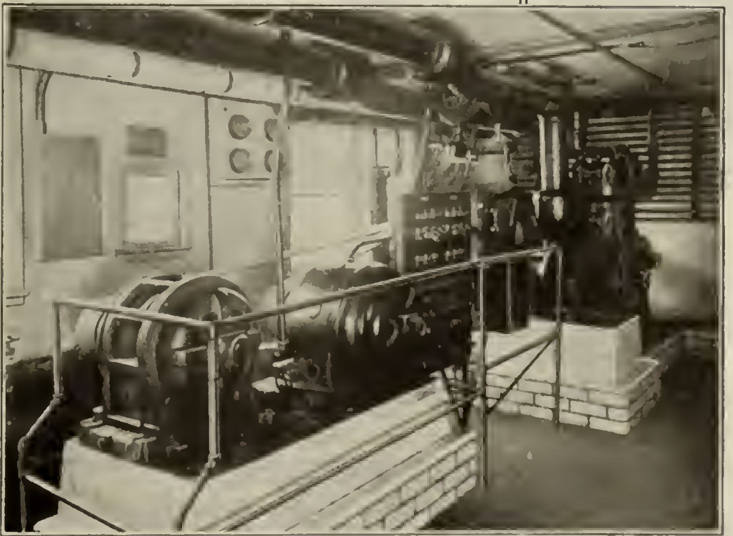
Armstrong's Mastic Finish is slightly beveled back at the edges, leaving shallow, V-shaped joints between the boards when erected. Mastic filler is flowed into these joints with a hot iron, sealing them perfectly and amalgamating with the A M F to make an unbroken finish over the entire insulation.

A sample of AMF Nonpareil Corkboard sent on request. Full information will be gladly furnished.

Armstrong Cork & Insulation Co., Ltd.,
902 McGill Bldg., Montreal, Que.; 11 Brant Street, Toronto, Ontario, Can.
Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers and tanks.

NONPAREIL CORKBOARD INSULATION

For All Cold Storage Rooms



An installation of York Enclosed Refrigerating Machines in a Candy Factory.

Mechanical Refrigeration

—is an important adjunct to many lines of industry and commerce. In moderate size installations the best results can be obtained by using the—

YORK Enclosed Machine

These machines can be driven by any available power. Their simplicity of construction permits them to be operated successfully by employes, who have had no previous experience in operating one.

They are carried in stock in all our warehouses for prompt delivery. Write our nearest office and give our engineers the opportunity to assist you in solving your Refrigerating Problems.

Canadian Ice Machine Co., Limited

TORONTO .... Villiers & Munition Sts., Eastern Harbor Terminal
MONTREAL .... 324 Craig Street West
WINNIPEG .... 1113 Whyte Avenue
VANCOUVER .... 1158 Homer Street

Representing
YORK MANUFACTURING COMPANY
York, Penna., U.S.A.

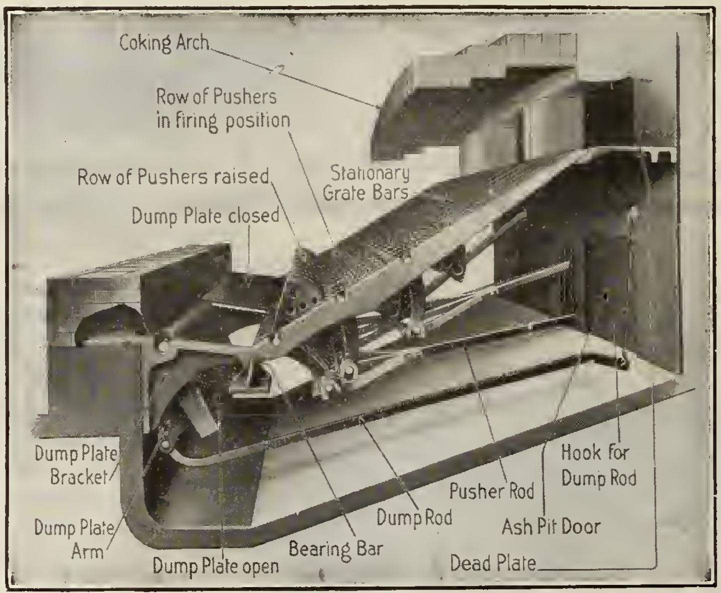
The National Hand Fired Stoker Why You Should Use It

800 tons of coal saved in six months! Such an announcement borders on the unbelievable. Yet it is the actual experience of a manufacturer who, somewhat against his will, was induced to instal the National Stoker.

During this heating season, the average outdoor temperature was 8 F. lower than that of the preceding winter. Yet the economy and efficiency realized with the National Hand Fired Stoker were so high that the plant was operated on only three boilers. Previously, four boilers had been required.

The principal advantages derived from the use of the National Stoker are saving in coal consumption, prevention of smoke with all grades of coal, increase in boiler capacity and saving of labor cost. The National Stoker ensures continuous firing and uniform conditions; a progressive distillation of volatile matter and proper provision for burning it; an even distribution of coal, and greater ease in obtaining good economy. It eliminates the loss of unburned coal with the ashes. It guarantees a clean stack which will comply with any city smoke ordinance without the use of steam jets or other devices. It offers to firemen relief from strenuous duties and from long exposure to intense heat.

With the National Stoker the heaviest labor of firing is eliminated and the number of men in the boiler room is smaller than the number required in plants with ordinary grates. Moreover, the firemen need not be skilled. Every part of the National Stoker is simple and its function can be quickly understood.



The downward sloping banks of grates operated by convenient pusher rods from the front of the furnaces, enable even "green" help to get almost perfect stoking results with almost any grade of fuel. The special Coking Arch construction, possible only with the downward slope of the fire grates, is the most successful smoke-consuming device yet developed. Visible smoke consists chiefly of very small particles of soot. Even though these particles are heated above their ignition temperature, ordinarily they burn very slowly if the air supply is insufficient, or if they are not intimately mixed with the free oxygen of the air.

In hand fired furnaces without the Arch, there is usually plenty of oxygen, but it is supplied in large streams which tend to flow through the combustion space parallel with the gases carrying the particles of soot. The oxygen may not come into contact with the particles of soot, and thus they leave the furnace and boiler setting as visible smoke. This carbon burns freely with the National.

The National Stoker abates visible smoke by effecting complete combustion with all kinds of coal—by providing a sufficient, even air supply, mixing it with the combustible gases and the particles of soot or carbon, and by maintaining a temperature high enough for the ignition of the combustible while it is mixing with the air. Thorough mixing is obtained by means of the durable fire-brick ignition arch in the combustion space and complete combustion follows:

The grates are set at a 30° incline, and allow a free and easy handling of the fuel down the grate. There is no risk of good fuel avalanching when the dumps are lowered.

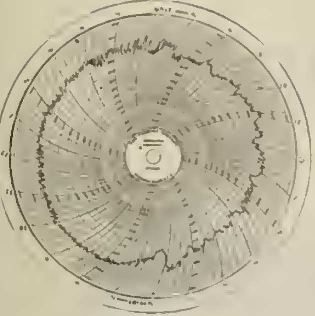
Between the grates are two or three rows of long-travel fuel-pushers. Each row is independently operated by means of a lever on the boiler front. By lowering the dump plates and raising the lowest row of pushers, ash and clinker are thoroughly cleaned from the bottom of the grates without disturbing the good coal and coke on the upper part of the grates. For this reason, there is practically no unburned carbon or coke in the ash. The fire can be cleaned without losing a pound of steam pressure.

The National Stoker voids the ash without raising it into the hot zone of the fire bed, and therefore without producing clinker. This is the reason why it has proved eminently successful in handling high ash, free burning western coals. With eastern caking coals, the pushers break up the cake so air can get through, thereby making possible a high rate of driving with only moderate draft. The National Stoker keeps the fire bed clean at all times. By thus preventing smoke, the National Stoker insures proper furnace operation, and a smokeless stack. Its remarkable economy, ease of operation, and low cost are making this Stoker the choice of the more progressive manufacturers and other users of steam power up to 500 h.p.

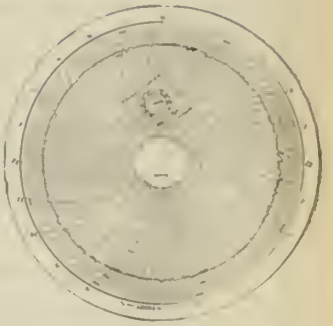
We gladly send a fully illustrated pamphlet, explaining the National Hand Fired Stoker, on request—and entirely without obligation to you.

Engineering and Machine Works of Canada, Limited
ST. CATHARINES, ONT.

Eastern Sales Offices: HALL MACHINERY CO., Sherbrooke, Quebec, and Birks Bldg., Montreal



I.



II.

Have you these Vital Operating Records?

FEED WATER TEMPERATURE

Chart I. is a record from a Foxboro Recording Thermometer in a textile mill power plant. Load variations during the day are plainly shown. The fidelity with which the slightest variations are recorded is characteristic of all Foxboro charts.

STEAM PRESSURE

Chart II. records the steam main pressure at a large central station. In this case the Foxboro Recording Gauge is installed in the chief engineer's office.

FLUE GAS TEMPERATURE

Chart III. from Foxboro Flue Gas Recording Thermometer in a paper mill power plant. The Foxboro type of recorder is acknowledged by experts to be the most satisfactory for temperatures up to 1,000 degrees Fht.

ECONOMIZER TEMPERATURES

Chart IV. is a Foxboro record of temperature of water entering and leaving the economizer at a large western plant. Foxboro two-pen recorders are ideal for convenient comparison of two temperatures or pressures.

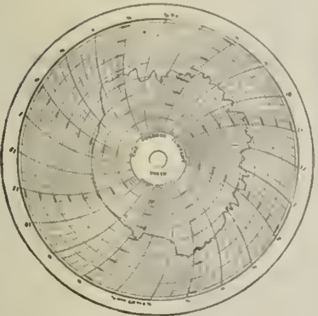
CONDENSER DISCHARGE TEMPERATURE

Chart V. from Foxboro Recording Thermometer in use at the plant of a chemical company. The efficiency of the condenser can be closely controlled by maintaining correct inlet and discharge temperatures.

DRAFT

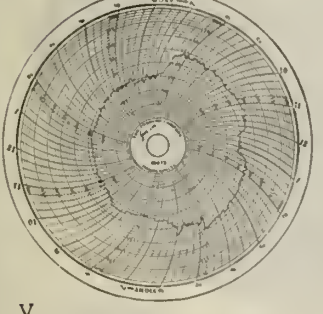
Chart VI. is a Foxboro Triplex Draft Gauge three-pen record of pit pressure, draft over the fire and draft in the last pass in an 800 h.p. boiler equipped with underfeed stoker. The sensitiveness of Foxboro instruments needs no comment.

Write for Recording Thermometer Bulletin CF-104-1 and Recording Gauge Bulletin CF 98-2.



III.

IV.



V.

VI.

THE FOXBORO CO., INC.
Neponset Ave., Foxboro, Mass., U.S.A.

New York, Chicago, Boston, Philadelphia, Pittsburgh, Cleveland, Rochester, Birmingham, Tulsa, Los Angeles, San Francisco, Portland, Ore.

PEACOCK BROTHERS, LTD., 179 Delorimier Avenue, Montreal, Canada.

FOXBORO

REG U.S. PAT. OFF.

THE COMPASS OF INDUSTRY

Diamond Soot Blowers Save Fuel at all ratings

HERE is a comparison between blowing a boiler by the hand lance method and by mechanical soot blowers. A 500 h.p. boiler is assumed, 200 lb. steam pressure, operating at 175 per cent rating, on a basis of the boiler being operated 300 days of 20 hours each per day, with an evaporation of 8 lbs.

Steam consumption is figured on the basis of each soot blower valve being open a total of 60 seconds twice a day in the case of the independent valve blower and 30 seconds in the case of the Valv-in-Head blower. Hand lance steam consumption is figured on a total flow of 20 minutes per day through a ¾" nozzle.

Operating Cost per Year with Hand Lance

Steam	$300
Labor (2 hrs. per day)	240
Maintenance	25
	$565

Operating Cost per Year with Mechanical Blowers

	Independent Valve Type	Valv-in-Head
Labor	$ 60	$ 36
Steam	184	92
Interest at 6 per cent.	40	45
Depreciation and maintenance 20 per cent.	132	148
	$416	$321
Decrease in operating cost due to mechanical blowers	$149	$244

A boiler operating under the conditions named would consume 10,500 tons of coal in a year's time. Figured at $5.50 a ton, this would amount to $57,700 per year.

2% saving in fuel would amount to $1150
4% saving in fuel would amount to $2310
6% saving in fuel would amount to $3460

From the above it will be seen that soot blowers commonly pay from 125 per cent to 800 per cent per year on the investment.

Ask for Bulletin 287

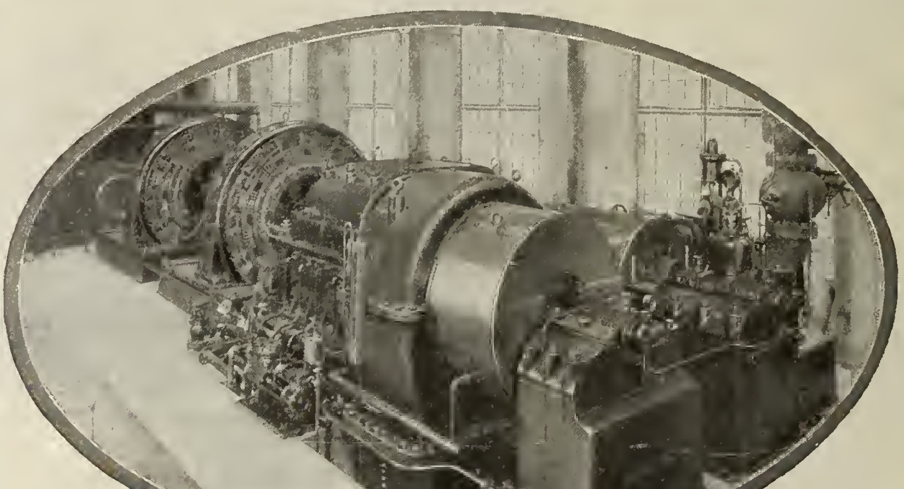
DIAMOND SPECIALTY LTD.
WINDSOR ONTARIO

Diamond

Soot Blowers-Save 4 to 8% Fuel

De Laval

DC Turbo Generator



THIS De Laval compound DC turbo generator at the plant of a large cement company is rated at 3,750 K.W., but will carry 4,500 K.W. for two hours without undue heating. The compound turbine with speed reducing gears, together with high superheat and high vacuum, realizes the highest thermal efficiency. The use of two turbine shafts eliminates distortion and vibration tendencies.

Industrial plants find that DC power distribution pays because it permits of each and every machine being operated at the exact speed most favorable to quantity or quality of output and it is also indispensable for cranes, elevators, blowers and other variable speed apparatus.

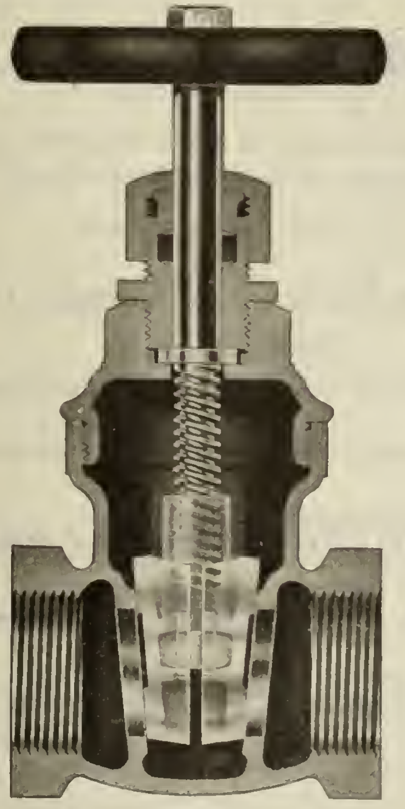
Ask for special publication No. 100

De Laval Steam Turbine Co.

TURBINE EQUIPMENT CO., LTD., 73 King St., West, Toronto.
THE E. LAURIE COMPANY, 243 Bleury St., Montreal, Que.

320

Efficient—Dependable
JENKINS
Type "K"
Bronze Gate Valves



Sectional View of a Jenkins Type "K" Gate Valve.

HERE'S something different from the ordinary type of Gate Valve.

Cast from virgin metal of the very highest quality and so carefully proportioned that there is no weakness at any point. Spindles are made of Manganese Bronze, and all parts are machined to gauge.

These Valves are remarkable for their reliability, their easy operation and the simplicity of their closing mechanism. Being of the split-wedge type they can be operated in any position without danger of the discs jamming.

Type "K" Valves are suitable for 125 pounds working steam pressure or 175 pounds working water pressure.

Write for free copy of Catalog No. 9 and read about these Jenkins Models in detail.

JENKINS BROS., LIMITED
HEAD OFFICE & WORKS—103 St. Remi St., Montreal.
SALES OFFICES—Toronto, Vancouver.
EUROPEAN BRANCH—London, W.C. 2, Eng.
FACTORIES—Montreal, Bridgeport, Elizabeth.

Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

Boiler Setting
Service

THE Gates Engineering Co., Limited, are in a position to contract for and specify on all boiler brick work with the least possible delay. Our Engineering Department is qualified to look after your interests, having made a close study of Combustion Problems.

Our Motto—Service and satisfied clients. The confidence of those who use Gates' Patented Air-Cooled Arch, etc., is unqualified, and is retained, because of the low maintenance cost and the guaranteed results.

Ask for our Descriptive Catalog.

Gates Engineering Co., Limited
314 Notre Dame Street W., Montreal

The Gold Brick Won't Stand Fire

There is a definite standard of fire brick value; it is not the cost per thousand brick, because

1st All fire brick at a given cost have not the same production value. One will produce more than another: therefore

2nd The actual standard is what a brick will do for each dollar—how many tons' production per lining, or how many months between replacements per dollar of first cost.

We are prepared to show you the results of exhaustive tests in actual service.

Buy ELK value in fire brick.

Elk Fire Brick Co. of Canada, Limited
Hamilton, Canada

Power House

is a dominating factor in maintaining power plant efficiency in equipment and service

◆

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge. Every issue is full of real worth while ideas.

Two Issues per Month

24 Issues (one year) $2.00

Special Offer

48 Issues (two years) $3.00

Relining furnaces? Get Plibrico here---

SOMETIMES when furnace linings are needed, they're needed quick. Then it is that the engineer is glad that Plibrico—the one-piece lining—can be had from warehouse stocks close to him, where ever he is. In Canada a 'phone call, wire or letter will start Plibrico on the way if addressed to:

Montreal—Beveridge Supply Co.
Toronto—Shell, Bar, Boico Supply Co.
Vancouver—Evans, Coleman & Evans.
Winnipeg—Winnipeg Supply & Fuel Co.
Saskatoon—Building Products & Fuel, Ltd.
Regina—Dominion Lime & Coal Co.

When you need furnace linings in a hurry order Plibrico—you'll get long life in addition to speed of delivery.

Plibrico is delivered only in steel containers of distinctive appearance, as shown above.

Greetings:

The spirit of the season prompts us to extend our thanks to our many business friends for their steady and increasing patronage.

During the year 1924 we shall endeavor to show our appreciation by giving you the best service within our power.

Best wishes for a Merry Christmas and a Happy New Year.

Boiler Repair & Grate Bar Co.
84 Church St.
TORONTO

Babcock & Wilcox, Limited, of London, England.
The Goldie & McCulloch Co., Limited, of Galt, Ont.
and
The Babcock & Wilcox Company of New York

wish to announce the formation of a new Company
known as

Babcock-Wilcox & Goldie-McCulloch, Limited

for the manufacture of Steam Power Plant Equipment and Accessories,
With Head Office and Works at Galt, Ontario.

The constituent Companies desire to extend to their clients
grateful thanks and appreciation of the confidence
extended to them in the past and express the hope
that the new Company will continue to
deserve and receive it in the future.

* * *

The Goldie & McCulloch Co., Limited

will continue in business as manufacturers of Safes, Vault
Doors, Vault Linings, Safety Deposit Boxes, etc.,
with Head Office and Works at
Galt, Ontario.

November, 1923.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

J. MACTAGGART
News Editor

Compliments By Mail

THE daily mail brings many compliments but it's usually unwise to pass them along to Power House readers—well, because space is limited and compliments seem sort o' personal, to say the least of it. Here's two or three sentences, however, out of the mail the other day.

The first is from a letter by F. E. Cole, of Stratford, Ont. He says: "I certainly enjoy Power House now, and think it is the best paper on the market. I look forward to every issue and must admit it is a very great help to me in my work."

Going further—to W. Forster, in far off Winnipeg—read this: "Enclosed find a $6 money order for two subscriptions to Power House for friends of mine. I like the paper very much and hope to be able to get many more subscribers, especially after thing get a little quieter at the plant."

The last, from Fred Heinrich, of Vancouver, reads: "A salesman here has been trying to sell me some equipment I have never seen advertised in Power House. I don't know anything about it. Can you tell me if it will do what the salesman says it will do?"

Now let's look at to-day's bill of fare. While some issues may be better than others—that's largely a matter of taste—there's usually a well balanced ration in every number. Turn the pages from cover to cover and you're likely to be pleased. There are big articles and little articles; ideas that have worked and ideas that look as if they ought to work and many other interesting and worth-while things. Don't miss any of them.

* * * *

Cutting Steam Costs

IN NO direction is power plant engineering making more progress than in improvements in the use and design of steam boilers. For many years the world "tolerated" boilers as they were, occasionally it is true bringing out new designs, but making little effort to increase efficiencies or lower operating costs. Then a movement toward a more scientific attitude took place; the CO_2 recorder, and kindred devices, were introduced, and experts began telling boiler users that they were obtaining ridiculously low efficiencies.

As a rule such accusations fell on deaf ears for the engineers of those days were quite satisfied that they knew all it was necessary to know about boilers, and they laughed at the "trimmings" which the new school of thought wanted them to install in their boiler rooms.

There was some excuse for this attitude. Coal was cheap. Labor cost little more than half of what it does to-day, and the burdens of a sales tax had not to be met. Hence it came about that a few extra tons of coal a day did not matter very much, and boiler users preferred to carry on as they were rather than incur further capital charges by purchasing new equipment.

There were, of course, exceptions, but taking boiler rooms as a whole, the evidence seems to indicate that the average thermal efficiency was much less than 50 per cent. Then came the World War and a scarcity of fuel, with an increase in the cost of everything connected with steam generation on the one hand, and the necessity of reducing costs on the other, resulting in greater attention being given to the production of steam and to the improvement of boilers themselves.

Of recent developments the most notable is the coming of higher pressures, but not less important is the potentialities of low temperature distillation in the conservation of fuel. In this connection it is hoped in the December 20 issue of Power House to give readers V. Z. Caracristi's story of Henry Ford's attempts to "burn coal twice" at Walkerville.

* * * *

Coal a Source of Wealth

COAL, besides being energy in material and bulky form, is also the source of innumerable mineral products. More than one thousand coal products as vital to the Dominion as fuel itself are to-day in use. The full utilization of the whole range of values, including energy, to-day still transported in the form of coal, imposes itself in the near future.

This utilization, at present confined to the coke and gas industry whch can still be described by the term "by-product" production as it takes only half the field, must ultimately broaden itself, and become an economic force covered by the term "multiple production."

The reason for the use of the term "multiple production" at once becomes apparent when it is remembered that one ton of bituminous coal gives on an average 10,000 cubic feet of illuminating gas, 20 pounds of ammonium sulphate, 2½ gallons of benzol and 8½ gallons of tar, which represent only the primary products, while other chemicals, drugs and dyestuffs could be extracted.

If the price of one ton of coal at the mine is $1.52, the multiple products of the same ton of coal have a collective value of at least $16.

The illuminating gas and the benzoal are, the one a perfect fuel, the other an equivalent of gasoline as a motor fuel. Multiple production would make both gas and benzol important sources of power. Moreover, with the advent of industrial alcohol as fuel it must not be forgotten that gasoline is not miscible with alcohol, while it can be mixed with benzol and such mixture of gasoline and benzol can be mixed with alcohol, offering an excellent fuel for internal combustion engines.

Furthermore, ammonium sulphate has great value both as an artificial fertilizer and as a source for the extraction of ammonia, serviceable for medicinal, refrigerating and other purposes. Tar, is not only a road building and waterproofing material, but primarily is the basis of the great coal tar industry that gave Germany its industrial supremacy at the beginning of the World War.

Though the application of electricity has made great headway in the present decade, multiple production has not yet been considered for general adoption, its importance not yet having been grasped. Yet both are molding the future industrial order and as economic forces are bound to cause revision in popularly accepted ideas of economics.

Combustion Problems of Canadian Power Plants

*By THOMAS A. MARSH

Selection of Proper Fuel and Stokers, Setting of Boilers at Liberal Heights and Rigid Application of the Gospel of "Clean and Tight" Dominant Factors in Producing Cheaper Steam

THE basic problem that confronts all power producers is "How to produce cheaper steam." Cheap power or steam is a term too often only partially comprehended. Some engineers casually analyze steam costs on the basis of fuel costs per thousand pounds of water evaporated; others add firing labor and maintenance, but few indeed consider the complete and ultimate cost involving items of fuel charges; labor charges; investment charges (interest-depreciation-obsolescence); maintenance and outage charges. charges.

The solution of the problem is, of course, to have the sum of those items of cost at a minimum per unit of output, be it KWH, per ton of metal or per pair of shoes.

The problems as applied to coal burning are: The selection of fuel; the selection of stoking equipment; the design of the furnace; the operation of the plant.

Selection of Fuel

In analyzing a new power plant problem, or in selecting fuel for an existing plant, the item of selection of fuel is extremely important. Sometimes the coal cheapest in first cost makes the cheapest steam, frequently it does not. The same is true of the most expensive coal. So far as apparent steam costs are concerned, it is a simple matter to analyze coals of any heat content. Fig. 1 indicates such an analysis. This is one important consideration in coal selection. Other important items bearing on fuel selection are:

- Ability to carry the plant load;
- Reliability of supply;
- Mine equipment;
- Mine preparation;
- Ability of producer to give uniform quality;
- Transportation facilities;
- Adaptability to stoking equipment (installed or contemplated);
- Service (engineering assistance);
- Storage properties of coal;
- Boiler capacity obtainable;
- Maintenance of furnaces and stokers;
- Labor of firing;
- Responsiveness to meet sudden load demands;
- Smokelessness;
- Cost of ash removal.

The reason for each of these items is so obvious that discussion is unnecessary, but it is well to keep the entire list before us in selecting fuel lest we overlook one or more to the detriment of ultimate costs of steam.

In Canada there are coals of almost all descriptions, from lignite to high-grade bituminous. These coals have various characteristics. Fig. 2 indicates the general coal classification and approximate analysis. To some, this appears a complex problem, but when we change the chemical terms of H_2O, vol., fixed carbon and ash to the simpler terms of water, tar, coke and dirt, the problem is within the grasp of every man.

Composition of Coal

Coal is composed of just these four constituents. Whether a coal is a lignite or anthracite is largely one of water and tar content. Bituminous coal means tarry coal (30 to 40%). Semi-bituminous means half tarry (15 to 20%). Tar tends to make smoke, therefore the bituminous coals are the smoke coals and require special furnace design to permit the burning of the tars in the furnace, and, on the other hand, the semi-bituminous coals are smokeless coals. Anthracite, or hard coal, has practically no tar and is smokeless.

Some coals are high in ash and some low. About 10% is commonly considered a dividing point on this item. Some are very high in ash as, for instance, Iowa coal with 30 to 40% of ash. Such coal is inert and unresponsive in the ordinary furnace, and, due to the large percentage of non-combustible (52%), requires very liberal grate areas and long arch construction to produce reasonable ratings.

Of other fuels, the lignites are high in moisture and present a problem of their own. This problem has been partially met by the stoker, but much remains to be done. There are limits to combustion rates and quality of coal which should be extended. Excellent results have been obtained with Soruis and Drumheller by the use of liberal grate areas, long arches and vertical reflecting bridgewalls, but there must be greater possibilities by means of air control, preheated air, powdered fuel and low temperature distillation. Much has been done and there are many successful installations using these fuels, but the art of burning coal is in its infancy and much development may be expected.

Analysis Means Little

The analysis of coals given above really indicated little. What we are really interested in regarding a fuel is:

- Storing qualities.
- Firing characteristics:
  - Slow or responsive;
  - Burn to clean ash or retain coke;
  - High or low ash;
  - Clinkering or non clinkering;
  - Smoky or smokeless (relative only).

These are practical considerations known to the operating engineer of every plant and considerations which should be given weight.

Dissimilar as are the coals listed above in Fig. 2, both in chemical analysis and in firing characteristics, it must be evident that no one stoker or furnace is suitable to all.

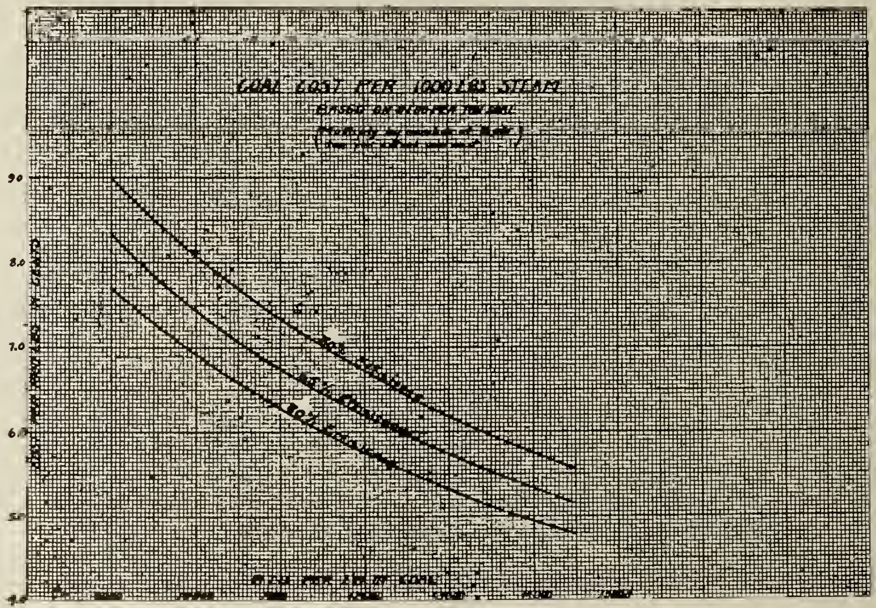


Fig. 1.

---

*Chief Engineer, Green Engineering Co. Contributed to Power House through the courtesy of A. J. Taylor, president, Combustion Engineering Company, Toronto.

The grate areas necessary for lignite would be excessive for a good grade of bituminous or semi-bituminous coal.

The arches and brickwork required to build up furnace temperatures with lignite would present an impossible maintenance problem with high-grade coals.

The furnaces used with high-grade coals cannot be successfully operated with lignite or 30% ash coal.

Pulverized coal perhaps should be considered as an exception to this consideration, as coals of dissimilar characteristics act quite similar in a pulverized fuel furnace.

Recognizing the inadequacy of any one stoker to burn all coals, the trend in the stoker industry has been toward combinations of equipment under one organization in order to be able to treat each problem in an unbiased manner and in order to make available the best engineering experience.

This is unquestionably a logical development and one advantageous to both customer and manufacturer and leads into a discussion of stokers:

Designed in 1785

The earliest mechanical stoker for steam boilers was probably designed by James Watt in the year 1785. The mechanism was simply a device to push the coal, after it was coked at the front of the grate, back toward the bridgewall. The suggestion of Watt was followed by numerous patents in Europe for mechanical stokers, but none of these have been adopted to any considerable extent because of their supposed lack of adaptability to boiler practice on this continent. Their non-adoption here was partly due to lack of knowledge of the art.

Another objection was that, in many cases, the grates were so placed as to be almost inaccessible either for examination or altering the condition of the fire by hand, or for renewing worn out parts.

In the early stages, stokers were exceedingly unmechanical, having parts not readily renewable, exposed to the heat with very poor mechanism for driving and adjusting. This, with the little knowledge then existing as to draft requirements, coal characteristics and furnace design, made early installations of limited performance, and resulted in numerous failures.

Much has been written of the early history of combustion and stokers. The items affecting our present coal consumption and the economy of existing plants are the types of stokers and furnaces used during the last twenty years. Few older plants are in service to-day and therefore do not affect our problem.

At the beginning of the century, many plants were installed which are in service to-day, sometimes advisedly, but frequently inadvisedly; however, they are in operation and are a factor in our fuel consumption.

Four Types of Stokers

At that time there were four types of stokers—the front inclined stoker, the side inclined stoker, the chain and traveling grate, the underfeed.

In general, large central stations in the United States using coals other than anthracite, used inclined or underfeed stokers. In the Pittsburgh district, the field was divided between the inclined type and the chain grate. In the west, all types had a share, with the chain grate predominating.

Forced draft was used only with the underfeed stokers, although in one or two isolated cases attempts were made to house in inclined overfeeds and chain grate stokers and put them under pressure.

Such results were unsatisfactory, as there was no adequate control of the fuel bed in conjunction with air pressure.

At the beginning of the century, most plants operated at from 100 to 125% rating, and 150% rating was rare indeed. In 1910 the demand for steam had increased and 150% rating was the average rating with 175 to 200 in the occasional plant. By 1915, 200% was common and 250% was reached in some plants.

By 1920, ratings had reached 300%, with some plants reaching 400% on peaks, and the end is not yet with superstation stokers and pulverized fuel.

Until 1910, the majority of plants used natural draft. About that time the multiple retort underfeed stoker entered the field and ratings of 250 and 300% were soon reached.

During the ensuing ten years, the multiple retort underfeed stoker was developed by several companies and unusually good results were obtained with Eastern coals, as high ratings could be reached with excellent efficiency and low banking losses. Maintenance in general was low and the net results were lower steam costs and increased capacity.

The successes of this type of stoker in the East caused Western engineers to attempt similar installation in the West. These were in general not so satisfactory, as the Western coal clinkered more readily, sometimes necessitating a discrimination between coals, resulting in the more costly coal being selected and increasing the cost of steam power.

TABLE OF CONSTITUENTS OF COAL

	% H_2O	% Vol.	% Fixed Carbon	% Ash	B.t.u. per lb.
Anthracite	2.8	1.2	88.2	7.8	13,300
Semi-Anthracite	2.0	6.6	58.2	33.2	9,700
Semi-Bituminous	4.6	13.5	76.7	5.2	14,400
Eastern Bituminous	8.6	32.4	51.3	7.7	12,200
Western Bituminous	10.1	33.2	42.0	15.7	12,000
Iowa High Ash Bit.	20.2	27.9	20.7	31.2	7,499
Sbu. Bituminous	22.4	41.2	32.2	4.2	6,100
Lignite	34.4	25.9	30.9	8.8	7,200

Figure 2

Application of Draft

The development then led to the application of the forced draft traveling grate with compartments or air zones to Western fuels. This stoker was designed and developed in the anthracite fields for the burning of small sizes of anthracite. Later it was found that it would burn coke braize, which opened another field. The stoker was a success from the start with Western high ash fuels, and is the standard at present in the high ash field.

About this time, the single retort underfeed with side grate bars was developed and has found a wide application with coals having any tendency to coke, coals severe in maintenance of grate bars and in installations limited as to ash pits. This stoker, to quite an extent, commercially replaces the older inclined overfeed natural draft types of the previous decade.

These are the general stoker types, selection of which must be made with a thorough knowledge of the fuel situation. Underfeed stokers handle coking coals satisfactorily. Clinkering high ash coals are best burned on traveling grates with forced or natural draft, as the load may demand. Usually, however, the coal market, load and physical conditions make the problem pretty clear cut.

Pulverized coal burning has made progress during the last twelve months. A good percentage of the central stations in the United States are adopting this firing system. Almost every power station design to-day involves a careful analysis of stokers as compared to pulverized coal, with a rapidly increasing number decided in favor of the latter.

The higher combustion efficiencies of pulverized coal and its ability to handle all coals is seldom questioned. The figures that must be considered are investment and preparation costs. Modern designs and improved equipment, however, are continually increasing the field, so it seems evident that more and more installations will be seen.

Expect Better Designs

As always in history, the entrance of a new competitor in the field has stimulated better efforts from the existing contenders, so daily we may expect improved stoker and furnace designs. This actually is going on to-day. The competition between these two firing methods will be most interesting during the ensuing years, but it should be realized that there will always be a field for pulverized coal and a field for stokers. Sometimes the line is distinct, sometimes indistinct. Developments of each equipment will vary the limits of adaptability.

In the future, we may consider each of the present-day methods as crude. Engineers here and abroad are working feverishly on low temperature distillation processes and many experimental installations are to-day under construction or contemplated.

The application of such systems would at once solve our problems of low-grade fuel utilization, domestic and industrial fuel, transportation (if located at mines), and give a supply of valuable by-products in addition.

Design of the Furnace

The furnace is the chamber between the grate which supports the fuel and the boiler which absorbs the heat. In the furnace, combustion should be completed. The size of furnaces and their shapes depend on the characteristics of the stoker, the coal and the rating. Furnace design requires experience and knowledge of the problems involved, both theoretical and practical, and should be entrusted to the best talent available.

Furnace design has been an evolution. The old low-set boilers of ten and fifteen years ago are no longer approved, but have been superseded with furnaces of liberal design.

As to furnace size, the Stoker Manufacturers' Association have agreed on minimum heights at which boilers should be set. These are shown in Fig. No. 3. No new boiler should be set at lower heights, and more is preferable considering the problem in its elements.

A pound of coal is a cube three inches on a side. It must combine with a cube of air six feet on a side. This states the problem in units we can all grasp. True, the problem is not all one of volume. Effective volume and the time element enter strongly into the calculation for the completion of the reactions of combustion from the above basis. However, you can readily appreciate the need for liberal areas of air and gas passages and of liberal furnaces for a reaction involving such volumes. Consider also the high volatile coal (30 to 40%). Substantially all of this must be burned in the furnace without flame actually passing into the boiler heating surface if anything approaching smokelessness is to be obtained.

A Rule of Thumb

As to a unit for furnace volume, a rule of thumb has been during the past few years: "Two cubic feet of furnace per horsepower developed." This is not specific and does not provide for variations in fuel. A better basis is B.t.u. liberated per cubic feet of furnace per hour.

Stoker furnaces have been designed on the basis of 18,000 to 24,000 B.t.u. liberated per cubic foot of furnace per hour. Just how large to make the furnace depends on the load factor at which it will be operated.

The design should be made to meet the average conditions with some sacrifice for occasional peaks.

Operation of the Plant

With an engine turbine or almost any other equipment in the power plant other than stokers, the efficiency is "built in" to the design at the factory. With stokers and furnaces this is only partially the case. One operator can, with certain stokers, obtain 75% efficiency. while a less able or careless operator will obtain 55 or 60% with the same equipment. This is one argument for pulverized coal.

Considered basically, we are dealing with two fundamentals, namely, pressure, either of air, water or steam, and heat transfer, through either steel, water, masonry or other parts. Pressure can only be maintained by tightness. Heat transmission is dependent on cleanliness.

We must not belittle the talent required to keep a power plant clean and tight. To do so requires not only knowledge of what to keep clean and tight—how to do it—but how to maintain it so. The problem resolves itself to one of knowledge, experience, organization and application, just as any other real proposition.

SETTING HEIGHTS FOR VARIOUS TYPES OF BOILERS EQUIPPED WITH STOKERS

(Min. = absolute minimum; P.M. = preferred minimum, i.e., the minimum heights recommended.)

TYPE OF BOILER	TYPE OF STOKER TO BE INSTALLED													
	MULTIPLE-RETORT UNDER-FEED		SINGLE-RETORT UNDERFEED				SIDE OVER-FEED		FRONT OVER-FEED		CHAIN GRATES			
	Taylor, Westing-house, Riley, Jones A-C, Detroit		Type E		Jones Single-Retort, Detroit Single-Retort		Murphy, Detroit		Roney		Natural Draft		Forced Draft	
	Min.	P.M.	Min.	P.M.	Min.	P.M.	Min.	P.M.	Min.	P.M.	Min.	P.M.	Min.	P.M.
WATER-TUBE:														
Horizontal..........	10′	12′	10′	12′	8′	10′	8′	11′	8′	10′	10′	12′	12′	14′
Inclined (Hor. M.D.)	7′	8′	6′	8′	6′	8′	5′	7′	6′	8′	6′	8′	7′	8′
Inclined(Vert. M.D.)	5′	6′	5′	6′	3′6″	5′	3′6″	5′	3′6″	5′	3′6″	5′	6′	8′
Vertical (Hor. M.D.)	3′	4′	3′	4′	3′	4′	3′	4′	3′	4′	3′	4′	3′	4′
Vertical (Vert. M.D.)														
150-hp...........	4′6″	5′	4′6″	5′	4′6″	5′	3′3″	....	3′6″	4′6″	4′1″	4′7″	5′	5′ 6″
250-hp.	5′6″	6′	5′6″	6′	5′6″	6′	3′3″	....	3′6″	4′6″	4′1″	4′7″	5′	5′ 6″
500-hp...........	6′	6′6″	6′	6′6″	6′	6′6″	3′3″	...	3′6″	4′6″	4′1″	4′7″	6′	6′ 6″
HORIZONTAL RETURN TUBULAR:														
72-in.	8′	10′	8′	10′	7′	10′	7′	8′	6′	8′	7′	8′	8′	10′
84-in.	8′	10′	8′	10′	7′	10′	7′	9′	6′	8′	7′	8′	8′	10′

Fig. 3.

The application of these words in the power plant requires, so far as the fuel is concerned: clean fuel free from dirt; clean ash pits; clean furnaces free from slag formations; clean boilers, no soot; clean breeching, no undue soot accumulations; clean stacks; tight fires, no air holes; tight ash pits, no air leakages; tight furnaces, no air leakage; tight boiler settings, no air infiltrations; tight baffles, no short circuits; tight breeching, no air leaks; tight stack, no air leaks.

In the water circulation the words apply to: clean water; clean pumps; clean lines and valves; clean boilers, no scale or sediment; tight pumps; tight lines and valves; tight boilers; tight blowoffs in other valves; tight steam lines.

In addition to the items specifically mentioned, there are many other little nooks and corners to look for the application of the words "clean and tight."

In general, the entire boiler room should be kept CLEAN. Cleanliness in general has much to do with operating economy. Piles of rubbish—waste material and dirt—around a boiler room almost invariably indicate a similar condition inside boilers and other parts of the system.

Is It Clean and Tight?

If the operating engineer will consider every point throughout the entire path of the coal, the air, the water, and the steam, and apply the two questions, "Is it clean?" and "Is it tight?" and not be satisfied until he can answer positively, that power plant will show economy far above the average.

It is not necessary in most stations to consider redesign of equipment. It is the function of expert furnace designers to decide whether furnaces should be changed, boilers raised, and other physical changes made to the plant.

It is the function of the engineer to determine whether new boilers, economizers, stokers or other equipment should be installed, but it is also his function to produce results with the existing plant and equipment.

The engineer who has learned the meaning and application of these two words, and can maintain his equipment "clean and tight," is the engineer who will make the record for high economy.

In conclusion, it is to be hoped every Canadian engineer will bear in mind the four items:

1. Select fuel based on all items involved.

2. Select stokers that will make cheapest ultimate steam.

3. Set boilers at liberal heights to permit ample furnace designs.

4. Get religion on the gospel of "Clean and Tight" as applied to operation.

Operating the Steam Engine in the Power Plant

*By CHARLES L. HUBBARD

Gains in Economy by Using a Condenser Depend Upon Degree of Vacuum Maintained and the Mean Effective Pressure of the Engine When Running Non-Condensing

THE interests of the plant owner and superintendent, as regards the steam engine, are essentially different from those of the designing or mechanical engineer, although based on the same underlying principles.

The owner is chiefly concerned with matters relating to types, selections, and operation, while details of construction, except in a general way, are best left to the judgment and experience of the designing engineer.

These principles, while elementary to the engineer, are not always fresh in the minds of those in charge of a plant, and furthermore, as being practical application has an important bearing upon matters with which they are intimately connected, it seems best to devote a limited amount of space to going over these principles briefly before considering the selection and operation of engines.

Explanation of Terms

In dealing with steam apparatus we are constantly coming in contact with the term "pressure," expressed in a variety of ways, as absolute pressure, gauge pressure, vacuum, inches of mercury or water, barometric pressure, and so on. In order to understand clearly what follows, these terms should be well fixed in the mind of the reader.

Absolute pressure, as the name indicates, starts from zero or no pressure. Gauge pressure means a pressure above that of the atmosphere, and starts at 15 pounds per square inch (14.7 pounds accurately) absolute. For example, gage pressure plus 15, equals absolute pressure, and absolute pressure minus 15, equals gage pressure.

A vacuum, as used in engineering work, means any pressure below that of the atmosphere, and is commonly expressed in inches of mercury. A column of mercury having a sectional area of one square inch, and a height of one inch, weighs very nearly 0.5 pound, so that when placed in a U-tube, as in Figure 1, the balance column "H" represents a pressure of 0.5 pound for each inch in height. If in Figure 1, H=10 inches, and the right leg of the U-tube is open to the atmosphere, the absolute pressure in chamber "A" will be $15+\frac{10}{2}=20$ pounds per square inch. To change inches of mercury to pounds pressure per square inch, divide by two. To change pounds per square inch to inches of mercury multiply by two.

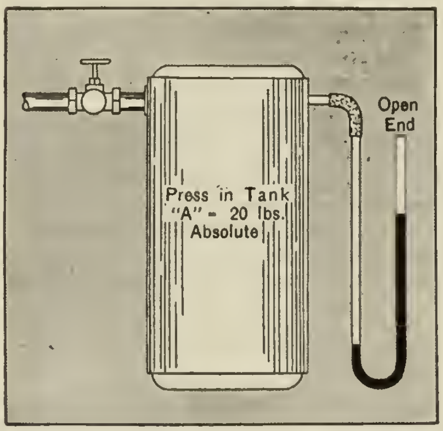


Figure 1: A vacuum is commonly expressed in inches of mercury, the difference in height between the two levels of mercury in a U-tube.

Atmospheric Pressure

The atmospheric pressure is very nearly 15 pounds per square inch absolute, (zero gage pressure) which corresponds to 15×2=30 inches of mercury.

Barometric pressure is the absolute atmospheric pressure expressed in inches of mercury, as above, and may be taken as 30 for ordinary power plant purposes.

The pressure in a condenser is commonly spoken of as so many inches of vacuum. For example, a condenser pressure of 26 inches of vacuum means that the pressure within the condensing chamber is less than that of the atmosphere, by an amount measured by 26 inches of mercury column. That is, the condenser pressure is 30—26—4 inches of mercury, or=2 pounds per square inch, absolute.

Now as to the meaning of the terms "work" and "power" and the relation between them. A force or pressure active through space produces work. The unit of work is the foot-pound, and is the work done in raising a weight of one pound, one foot in height. A force of one pound acting in any direction, through one foot of space, produces the same amount of work.

Rate of Doing Work

Power is the rate of doing work, or the amount done in a specific time. The unit of power is the horse-power, which is equivalent to 33,000 foot-pounds per minute. As work may be transformed into heat, in the ratio of 778 foot-pounds

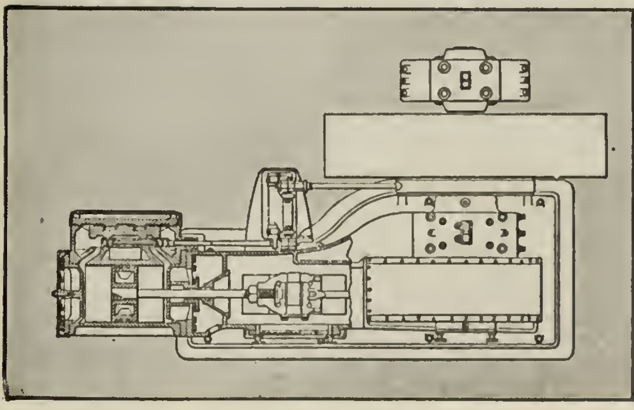


Figure 2: The essential features consist of a closed cylinder fitted with a piston and rod, and a valve so arranged as alternately to admit and exhaust steam.

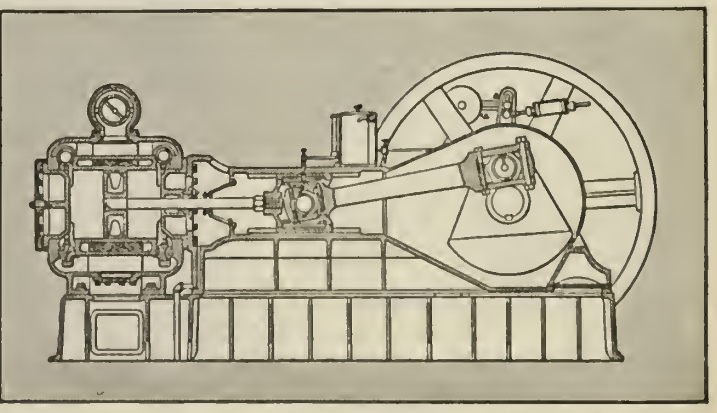


Figure 3: In the four-valve engine four separate valves, as the name implies, take care of inlet and exhaust; two for each end of the cylinder.

---

*Consulting engineer on power house problems. Reprinted in Canada by special permission from Factory, the Magazine of Management.

per B.t.u. and vice versa, it follows that one horse-power represents the equivalent of $\frac{33{,}000\times 60}{778}=2{,}546$ B.t.u. per hour.

The steam engine converts heat into work and steam is the medium for transferring the heat from the boiler furnace to the engine. The essential features of an engine are very simple, and consist of a closed cylinder fitted with a piston and rod, and a valve so arranged as alternately to admit and exhaust steam from each end of the cylinder. In operation, high-pressure steam is admitted to one end of the cylinder until it is partially filled. The valve then closes, and the piston which has been pushed forward by the pressure of the steam back of it, continues to move to the end of its stroke, due to the force exerted by the expansion of the steam which was trapped in the cylinder at the closing of the valve.

Belt Takes Power

During the forward stroke of the piston the low-pressure steam in front of it is forced out through the exhaust valve into the atmosphere or condenser. At the end of the stroke the admission and exhaust valves are reversed, and the operation is repeated on the return stroke. The reciprocating motion of the piston is made to give a rotary movement to a shaft and fly-wheel, from which the power thus generated is taken off by a belt, gearing, or other means.

The general construction of a simple slide-valve engine is shown in Figure 2, and requires no description for the power plant engineer.

In case of an engine exhausting into the atmosphere, there is a back pressure of 15 pounds per square inch, plus the frictional resistance of the exhaust pipe which amounts to the equivalent of about two pounds per square inch in the average case, making a total of approximately 17 pounds absolute. The back pressure is constant throughout the stroke, from the opening to the closing of the exhaust valves, while the forward pressure varies, constantly falling from the time the admission valves are closed (cut-off) until the end of the stroke, due to the expansion of the steam. The actual working force acting on the piston at any point during the stroke is called the effective pressure. It is evidently the difference between the forward pressure, and the back pressure at that particular point.

Table I

Cut-off	Percentage of Clearance							
	1	2	3	4	5	6	7	8
1-10	.344	.357	.369	.381	.392	.403	.413	.423
1-8	.397	.408	.419	.429	.439	.448	.457	.466
1-6	.475	.484	.493	.502	.510	.517	.524	.531
1-4	.603	.609	.615	.621	.626	.631	.636	.641
1-3	.704	.708	.712	.716	.720	.724	.728	.731

The work in foot-pounds done per stroke of the piston, is equal to the average or mean effective pressure in pounds, acting throughout the stroke, multiplied by the length of stroke, in feet.

Mean Effective Pressure

Neglecting the cylinder losses, (condensation, radiation, leakage, and so on) the mean effective pressure may be computed from the initial or boiler pressure when the point of cut-off and clearance (waste or dead space in cylinder at end of stroke) of the engine are known by means of Table I and the formula $P=(p\times f)-b$, in which

P=mean effective pressure, in pounds per square inch.

p=initial pressure, in pounds per square inch, absolute.

f=factor from Table I for the given cut-off from clearance.

b=the absolute back pressure,=about 17 pounds per square inch for non-condensing engines, and 3 pounds in the case of condensing engines.

As an example, to find the mean effective pressure (m.e.p.) for an engine having a clearance of 5 per cent. cutting off at one-fourth stroke, supplied with steam at 80 pounds gage pressure (95 pounds absolute) and exhausting into the atmosphere against a frictional resistance equivalent to two pounds per square inch (17 pounds absolute), we would proceed as follows:

Substituting in the formula, we have $P=(95\times 0.626)-17=42$ pounds.

The actual pressure will be somewhat less than this, due to the various cylinder losses, "wire-drawing" through the steam passages, and so on, depending upon the type and speed of engine. For an accurate determination of the m.e.p. a diagram must be taken with a steam engine indicator, but for approximate work the result computed by the formula may be corrected by the following factors for different types of engines:

Table II

Type of Engine	Factor
Simple high-speed	0.70
Simple medium-speed	0.85
Simple slow-speed	0.90
Compound high-speed	0.65
Compound medium-speed	0.80
Compound slow-speed	0.85

In case the engine in the above example was of the simple medium-speed type, the m.e.p. would be very close to $42\times 0.85=36$ pounds.

The horse power of an engine is given by the formula:

$$H.P.=\frac{P\times L\times A\times N}{33{,}000}$$

in which

H.P.=horse-power of engine.

P=m.e.p. in pounds per square inch.

L=Length of stroke in feet.

A=area of piston, in square inches.

N=Number of strokes per minute,= revolutions of shaft×2.

Suppose in the case already referred to, the engine had a cylinder 14 inches in diameter, an 18-inch stroke, and made 200 revolutions per minute, what would be the horse-power? Here we have:

P=36

L=1.5

A=154

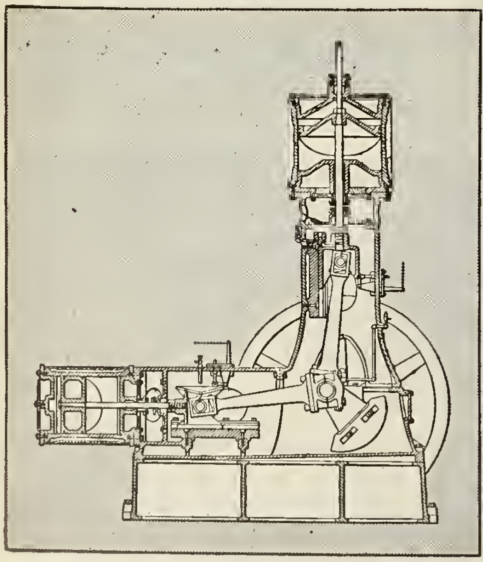


Figure 4: By compounding engines there is a 10 to 15% gain in economy. Placing the cylinders at an angle saves space.

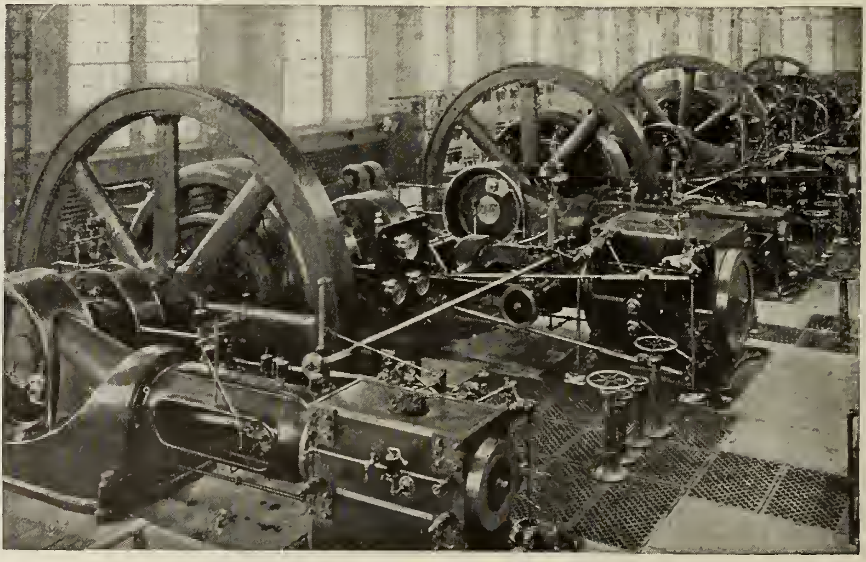


Figure 5: Cross compound engines are really two separate engines, except that they use the same main-shaft and fly-wheel. This type requires more floor space than does the angle or the tandem compound engine.

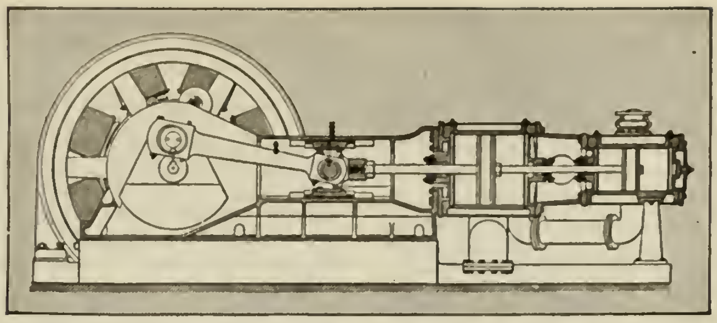


Figure 7: Tandem compound engines have two cylinders arranged in tandem, as the name implies. All other parts of the engine are used in common.

N=400

$$\text{or H.P.}=\frac{36\times1.5\times154\times400}{33{,}000}=100$$

Now let us consider engine efficiency. The efficiency of an engine is expressed in two ways, the mechanical efficiency and the thermal efficiency. The power of an engine computed by the method just given or from an indicator diagram is called the indicated horse-power, and includes the work or power required to overcome the friction of the engine itself. The delivered or brake horse-power is the power actually delivered by the engine shaft, and is equal to the indicated horse-power less the power required to drive the engine, considered as an independent machine.

Brake Horse Power

The brake horse-power of small-and medium-size engines is measured directly by means of a pony brake or dynamometer. (See Figure 8.) In case of very large machines, the indicated horse-power is computed from indicator cards taken with the engine running free, without load. This gives the power required to drive the engine alone, and is commonly called the "friction load." The brake horse-power in this case is found by first computing the indicated horse-power at full load, and subtracting the friction load.

The ratio of the brake horse-power (b.h.p.) to the indicated horse-power (i.h.p.) is called the mechanical efficiency, and commonly runs from 85 to 95 per cent. at normal or full load. For engines of the type and size commonly employed in industrial plants 92 per cent. may be taken as a fair average for approximate work. As the frictional horse-power is fairly constant for all loads, the machine or mechanical efficiency for the underloads is necessarily much less.

In determining the power of an engine for a plant operated on a system of electrical transmission, which is quite generally used in new construction, it is necessary to consider not only the machine efficiency of the engines but of the generators and motors as well. Generator efficiencies vary from 90 to 97 per cent. at rated load, tending to rise with the size of unit. For preliminary calculations a value of 94 per cent. may be used.

Motor Efficiencies

Motor efficiencies vary widely with the size and load, and may be taken approximately as follows:

Table III

Motor Efficiencies

Efficiency at Different Loads

H.P. of Motor	50%	75%	100%	130%
1	0.51	0.54	0.55	0.52
2	0.61	0.64	0.65	0.62
5	0.70	0.74	0.75	0.72
10	0.74	0.77	0.78	0.87
50	0.83	0.87	0.88	0.90
75	0.86	0.89	0.90	0.90
100	0.88	0.91	0.91	0.91
150	0.90	0.92	0.92	0.91
200	0.91	0.93	0.93	0.91

The combined efficiency of a system of power generation, transmission and transformation, is the product of the various efficiencies used in the system.

For example, the indicated horse-power of an engine for delivery of 500 brake horsepower through ten 50 h.p. motors,

$$\text{should be}\ \frac{500}{0.92\times0.94\times0.88}=658\ \text{i.h.p.}$$

The thermal efficiency of an engine or turbine is the ratio of the heat converted into useful work to that supplied, measured above the heat in the liquid at exhaust pressure. This is equal to:

$$\frac{2{,}546}{W\ (H\text{-}q)}$$

in which

2,546=the heat equivalent of one horse-power, in B.t.u. per hour.

W=pounds of steam required per b.h.p. per hour.

H=heat in one pound of steam at initial pressure=(latent heat of vaporization×quality of steam)+heat in the liquid.

q=heat in the liquid at exhaust pressure.

Example—To find the thermal efficiency of an engine operating under the following conditions:

Initial steam pressure (gage)	130 lbs.
Quality of steam	97%
Exhaust pressure (gage)	2 lbs.
Steam per b.h.p. per hour	30 lbs.

we proceed as follows:

From a Steam Table we find:

Latent heat at 130 pounds pressure	=865 B.t.u.
Heat in the liquid at 130 pounds pressure	=327 B.t.u.
Heat in the liquid at 2 pounds pressure	=187 B.t.u.

Hence H=(865×0.97)+327=1,166 B.t.u.

Substituting the above values in the formula gives an efficiency of $\frac{2\,546}{30\ (1{,}166-187}$ =0.0867 of 8.67%, which means that only 8.67% of the heat contained in the steam supplied to the engine is employed in doing useful work. Most of the remaining passes out with the exhaust in the form of low-pressure steam and water, while a small amount is lost by radiation from the engine cylinder and adjacent parts. The actual efficiency will, of course, vary in different cases, depending upon the size and type of engine conditions under which it is operated.

When W is given in pounds of steam per kilowatt hour, as is often the case where electric transmission is employed, the formula becomes:

$$\text{Efficiency}=\frac{3.413}{W\ (H-q)}$$

In case of superheated steam, the value of H may be taken directly from a table giving the properties of superheated steam, or may be computed from

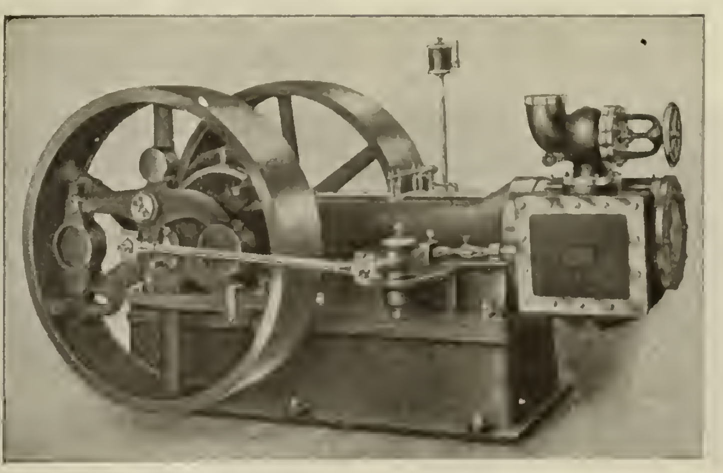


Figure 6: "Automatic engines" have a governing device consisting of two weights attached to a pivoted lever in the fly-wheel. As the weights fly outward cut-off is shortened

saturated steam by the methods given in a previous article.

Operating Economy

The operating economy of a steam engine is commonly given in pounds of steam per i.h.p. per hour, although in electrical work it is often expressed in pounds per k.w. per hour, as noted above. The power developed per unit weight of steam supplied varies with the initial pressure, ratio of expansion, type and size of machine, and its general condition.

The following table gives the approximate water-rates for non-condensing simple engines of different types supplied with steam at 100 pounds pressure.

When the water-rate per brake horsepower is required, it may be obtained approximately by dividing the figures in the table of steam consumption given below by 0.92.

Table IV

Pounds of Steam per i.h.p. per Hour
Type of Engine

I.H.P. of Engine	Single-Valve, Throttling	Single-Valve, Automatic	Four-Valve, Automatic	Corliss
40	42 to 46	33 to 36		
60	39 to 43	30 to 33	26 to 28	
80	38 to 42	29 to 32	25 to 27	25 to 27
100	38 to 42	28 to 31	25 to 27	25 to 27
150	37 to 41	28 to 31	25 to 27	25 to 27
200	37 to 41	28 to 31	24 to 26	24 to 26
250	37 to 41	28 to 31	24 to 26	24 to 26
300	37 to 41	28 to 31	24 to 26	24 to 26
400	37 to 41	28 to 31	23 to 25	23 to 25
500	37 to 41	28 to 31	23 to 24	23 to 24

Valves and governing devices will be touched upon briefly in a following article in Power House, but it may be as well at this point to distinguish between throttling and automatic engines, as these terms appear in Table IV. In throttling engines speed regulation is secured by throttling the supply pipe at the cylinder, thus reducing the initial pressure when less speed is required, and vice versa.

Varies Quantity of Steam

In case of the automatic engine, speed regulation is obtained by means of a governing device attached to the admission valves which changes the point of cut-off and thus varies the quantity of steam admitted to the cylinder per stroke.

It will be noted from the table that automatic engines are considerably more economical in the use of steam. The governing device of an engine of this type is shown in Fig. 6, and consists of two weights attached to a pivoted lever in the fly-wheel. When the speed reaches a given maximum, centrifugal force throws the weights outward, against the tension of the spring, thus swinging the arm a small distance on its pivot and so reducing the throw of the valve rod by suitable levers, and shortening the cut-off.

Mention has already been made of the loss resulting from cylinder condensation. The most effective method of reducing this is by compounding, that is, expanding the steam in two cylinders instead of one. The same process is also carried out in three cylinders in some cases, but the triple expansion engine is rarely used at the present time owing to the excessive cost of construction. Furthermore, the high rate of expansion, and reduction in cylinder condensation, which may be realized both in the uniflow engine and steam turbine make it possible to secure efficient results without the expense involved in the building of multiple expansion engines.

Surplus of Exhaust

Compound engines are still employed in plants where there is a surplus of exhaust which cannot be utilized and it is, therefore, desirable to secure as low a water-rate as possible.

If a given weight of steam is expanded through the same range of temperature in two cylinders, one exhausting into the other, instead of in a single cylinder, the resulting condensation will be considerably reduced owing partly to the smaller temperature range in each cylinder and partly to the fact that the heat transferred from the walls of the high-pressure cylinder to the steam during the exhaust period is utilized in doing useful work in the low-pressure cylinder, instead of being wasted as in the case of a simple or single cylinder engine.

If steam at an initial pressure of 100 pounds is admitted to the high-pressure cylinder and expanded down to 35 pounds, then exhausted into a second, and expanded to 2 pounds, the temperature range in the first cylinder will be 338—281= 57 degrees, and in the second, 281—219=62 degrees. While the total temperature range is the same as before, that in the high-pressure cylinder is only about one-half as great, and we may assume the condensation to be reduced approximately in the same proportion.

As re-evaporation takes place to some extent as the steam passes to the low-pressure cylinder, the greater part of the wasteful condensation will take place in the second cylinder where the temperature range is only 62 degrees, as against 338—219=119 degrees in the simple engine.

High Pressure Economical

While the immediate effect of compounding is a reduction of cylinder condensation, another advantage which tends to reduce the steam consumption is the ability to use high initial pressure and higher ratios of expansion, both of which are in the line of economy.

A comparatively small amount of fuel is required to raise the steam pressure from 80 or 90 pounds, the common practice for simple engines, to 120 or 160 pounds, which may be used to advantage in those of the compound type, thus increasing the power of a small cost.

The actual gain in economy by compounding non-condensing engines will usually run from 10 to 15%; hence, in using Table IV, multiply the figures by 0.85 to 0.92.

The disadvantages are the higher first cost, the greater number of parts to care for, increased space, and greater radiation losses. The types most commonly employed where space is limited are the tandem and angle engines,

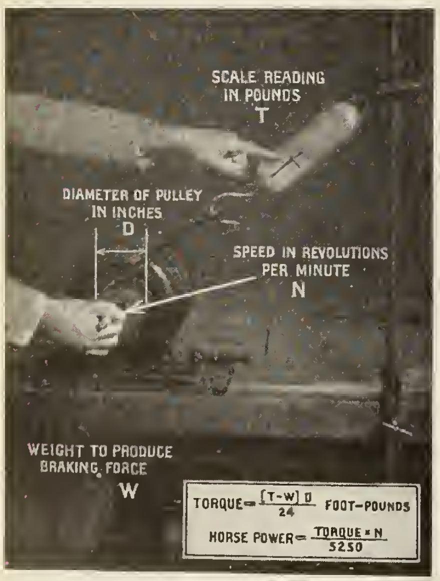


Figure 8: The horse-power of small engines is measured directly with a Prony brake. This laboratory model shows the principle upon which it works.

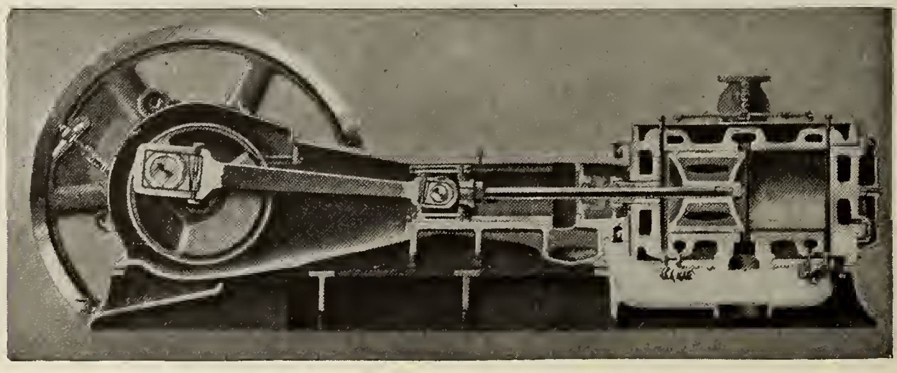


Figure 9: Multiple expansion engines involve complicated mechanical construction and increased cost. In the uniflow engine, however, reduced cylinder condensation is obtained without superheat and simplifies the mechanical construction at the same time, as this illustration well shows.

shown in Figures 7 and 4 respectively.

Cross compound engines are made up of two complete machines (see Figure 5), except for the main-shaft and flywheel, and, therefore, require more floor space.

Effects of Condensing

Now a word as to the effect of condensing. So far as the design of the engine itself is concerned, there is no difference between the condensing and non-condensing types, the only distinction being that in the first case the exhaust pipe from the engine is connected with a condenser instead of discharging into the atmosphere. If 24 inches of vacuum is maintained in the condenser, the back pressure will be reduced from 16 or 17 pounds absolute to 3 pounds absolute. As this reduction in back pressure extends throughout the entire stroke it is equivalent to increasing the mean effective pressure at least 16—3=13 pounds per square inch. The vacuum commonly maintained in average practice, with reciprocating engines, will run from 22 to 26 inches, depending upon various operating conditions. The lower figure corresponds to that obtained by the equipment usually employed with engines under 100 h.p., and the higher for larger sizes.

Depends on Vacuum

The gain in economy by the use of a condenser will depend upon the degree of vacuum maintained and the mean effective pressure of the engine when running non-condensing. This, under ordinary conditions, should, theoretically, vary from 20 to 30%, but is found to be considerably less in actual practice, and will run from 12 to 15% in the case of simple high-speed engines, up to 21 to 24% for slow-speed compound machines.

The saving for medium-speed simple engines will be from 15 to 18% and 18 to 21% for compound engines of the same type. These figures may be used in connection with Table IV when computing the water-rate for condensing engines.

Engines are designed to operate most economically at a given ratio of expansion. When working at a given speed and initial pressure, any reduction of load in case of an automatic engine is offset by shortening the cut-off, thus increasing the expansion and temperature range which results in lowering the steam economy through increased cylinder condensation and decreased mechanical efficiency.

Table V gives the approximate effect of underloading non-condensing engines, and may also be used for condensing, as the variation will be slight.

Table V

Type of Engine	Ratio of steam consumption per i.h.p. to that at full load for different underloads.		
	¾ load	½ load	¼ load
Compound high-speed	1.03	1.21	1.78
Simple high-speed	1.01	1.07	1.23
Compound low-speed	1.09	1.32	1.88

Theoretically, the efficiency of an engine increases with the temperature range.

In actual practice this does not hold true because a point is reached where cylinder losses more than offset any gain in steam economy. Furthermore, the cost of construction and maintenance increases rapidly at the higher pressures. Practical experience has fixed certain limits which are usually followed in the design and construction of the different types of machines. These are about as follows:

Table VI

Type of Engine	Initial Pressure (gage)
Simple high-speed	80 to 120
Simple low-speed	70 to 110
Compound high-speed	120 to 160
Compound low-speed	150 to 190

Ratio of expansion, like the initial pressure, has been fixed by practice and may be taken as follows:

Simple non-condensing	3 to 4	expansions
Simple condensing	4 to 5	"
Compound non-condensing	10 to 12	"
Compound condensing	14 to 18	"

U.C.C. of E. Banquet in Toronto

Canada Council and Queen City Council Entertain Hamilton Members in Oddfellows Hall

GOOD-FELLOWSHIP was the outstanding feature of a banquet on Nov. 19, in Oddfellows Hall, Toronto, when Canada Council and Queen City Council, No. 27, U. C. C. of E., entertained members and guests from Hamilton council, No. 60. Few meetings have been jollier and certainly none have been more successful in cementing the bonds of friendship and promoting the spirit of progressiveness abroad.

After a brief business meeting of Canada Council, about 120 members and visitors sat down to a delicious repast supplied by Queen City Council. Song sheets, which included all the old favorites, were distributed, and when the ever delightful Herb E. Terry led the singing, ably assisted by Howard Fletcher at the piano, it was evident to everyone that engineers are truly only grown up boys.

Worthy Chief Charles L. Holmes, who was chairman and toastmaster, opened the evening with a toast to H. M. the King. S. Cosford of Hamilton followed with a toast to the Grand Council. J. L. Cudbird, Grand Guard of the Grand Council of America, after patiently enduring a five minute barrage of "He's a Daisy," when he rose to speak welcomed the visitors and emphasized the advantages to be gained by the organization of a ladies' lodge in the "Pittsburgh of Canada," similar to Queen City Lodge in Toronto. He reminded those present of the annual convention next August in Chicago, and pointed out how vitally interested every member should be in enlarging the scope of the U. C. C. of E. in Canada.

Grand Chaplain Replies

Thos. McAree, Past Worthy Chief, proposed the toast of the Ladies' Grand Council, which was responded to by Mrs. George Aldridge, Grand Chaplain. "There is opportunity for everyone to become a grand officer of this splendid organization, if they only work hard enough," Mrs. Aldridge asserted, urging those present to attend the national convention.

Mrs. A. M. Auchterlonie, president of Queen City Council, the next speaker, demanded the "men of Hamilton" induce their ladies to organize a lodge. Thirteen new members have been initiated in the Toronto lodge alone this year and Queen City ladies, Mrs. Auchterlonie said, are looking forward with anticipation to the time when they can be entertained by Hamilton.

The honor of giving the last toast was awarded Past Grand Worthy Chief Terry, and he aroused enthusiasm by asking members to welcome the visitors with three hearty cheers. Alex. Leckie of Hamilton, coyly suggested in replying, that it probably would be wise for Toronto engineers to bring their ladies with them when they went "visiting." Thos H. Fenner, in a brief speech, declared he hoped to be a member of the U.C.C. of E. before the dawn of another banquet. Campbell Bradshaw, of "Power House," in thanking the "fair ladies" and "strong men" for their hospitality, said he only wished his newspaper occupied the niche in the journalistic field that the U.C.C. of E. occupied in fraternal circles.

Ladies Stimulate Interest

R. B. Hornby, of Hamilton, a stalwart champion of women's rights, said he thought the ladies gave the meeting more spirit and stimulated interest in the "doings" of the lodge—"no longer are the circulars stuck behind the kitchen clock till the day after the meeting," he declared.

Mr. Holmes, in the final speech of the evening, thanked the ladies for an excellent repast.

Delightful solos were rendered during the evening by Mrs. Albert Darbyshire, Miss Gladys Blythe and Miss Dora Ball, and after supper the floor was cleared and the "Power House" orchestra appeared. Everyone joined in a good old "Paul Jones," and went home wishing the U.C.C. of E. "Godspeed" in all the years to come.

W. F. Drysdale was the speaker at the Electrical Club of Montreal, at a luncheon at the Queen's Hotel, Nov. 28.

The Mildmay Electric Co., Mildmay, are in the market for transformers and equipment for a proposed extension. D. McKerracher, Walkerton, Engr.

Endorse Stand of Power House on Boiler Law

Ontario Manufacturers, Engineers, and Insurance Men Demand Proper Inspection—Deputy Minister of Labor Ballantyne Admits Dual Control is Bad and Declares He'll Recommend Change to Dr. Godfrey

THAT the Conservative administration at Queen's Park has promptly heeded the warning, sounded in the June 5 issue of Power House, deploring the ridiculous and expensive division of authority in the inspection of steam boilers and pressure vessels in Ontario, was apparent from the conference called by the Department of Labor on Nov. 19 to consider the "holes" in the law exposed in the article in question.

Invitations to the parley emanated from the office of James H. H. Ballantyne, deputy minister of labor, and included all parties interested in the design, construction, sale and operation of steam boilers and pressure vessels, representatives of Power House being asked to take part in the proceedings at Spadina House.

That the conference included all factions, affected by the legislation, is apparent from the following list of those present: James H. H. Ballantyne, deputy minister of labor; D. M. Medcalf, chief boiler inspector; James T. Burke, chief factory inspector; R. Burns, boiler inspector; A. R. Goldie, Wm. McKay, and Arthur K. Spotton, of Babcock-Wilcox & Goldie-McCulloch, Galt; William Inglis, John Inglis Co., Toronto; Colin Campbell, Campbell Steel and Iron Works, Ottawa; Ibbotson Leonard, E. Leonard & Sons, London; Logan M. Waterous, Waterous Engine Works, Brantford; C. W. Snider, Waterloo Mfg. Co., Waterloo; J. E. Waterhouse, Engineering & Machine Works of Canada, St. Catharines; M. J. Quinn, National Equipment Co., Toronto; F. W. Sherer, Dominion Boiler and Radiator Co., Toronto and Brantford; M. J. Levy, Levy and Westwood Machinery Co., Toronto; Henry R. Flett, Taylor Forbes Co., Toronto; A. Taylor, Boiler Repairs, Toronto; H. Macdonald, Canadian Manufacturers' Association, Toronto; H. M. Roberts, Boiler Inspection and Insurance Co., Toronto; A. Mills; R. Fullerton, Travelers' Indemnity Co., Toronto; J. O. B. Latour, Employers' Liability Assurance Corporation Co., Toronto; Geo. J. Soucy, Canadian Association of Stationary Engineers; J. H. Valin and H. E. Leverington, hoisting engineers; J. H. Bell, stationary engineer; J. M. Brown, chairman of the Board of Stationary Engineers; and Arthur Murphy, editor of Power House.

After explaining briefly his reasons for calling the meeting and thanking those present on behalf of the Department of Labor, Mr. Ballantyne was appointed chairman, and the success of the conference is due largely to the capable manner in which he presented the questions for consideration.

Seeks Weak "Spots"

In his opening remarks the deputy minister of labor pointed out that before any changes were made, the existing legislation should be thoroughly examined and its weak points studied so that all parties affected might have opportunity to discuss the matter.

"You are aware," said Mr. Ballantyne, "at the present time there are two Acts which deal either in whole or in part with the boiler industry within the province. The one is The Steam Boiler Act, and the other is section 57 of the Factory, Shop and Office Building Act. The very fact of having two statutes dealing with the boiler industry, either in whole or in part, implies a duality of functions within the Department.

Every effort is being made to fill the pages of Power House with articles, ideas, news, and so forth, of value to engineers. Because of this, send suggestions, ask questions, look upon the paper as your very own. Any time anybody wants anything, write in, every effort will be made to get it for you. And another thing: Send news, ideas you are using, pictures—anything of interest to others. And what are others interested in? Why, they are interested in the things you are interested in.—THE EDITOR.

"The Steam Boiler Act and Regulations deal specifically with the construction and inspection of new boilers—using the term 'boiler' in the sense that it is defined in the Act—and it also deals almost exclusively with second-hand boilers bought, sold or exchanged."

The minister dealt briefly with the problems of annual inspection, the inspection of steam boilers by stationary engineers, and the responsibility of the owner in regard to annual inspection.

Mr. Medcalf then pointed out the defects of the present system, as he saw them, emphasizing the fact that endless confusion and irritation resulted from the dual control within the department, and that the failure of the present inspection system was due in large measure to it.

Explains Working of Act

Mr. Burke explained the working of section 57 of the Factory Act in its relation to the inspection of steam boilers. At present if a boiler is insured with one of the authorized boiler insurance companies it complies with the statute, or it may be inspected by a qualified engineer who is not in charge of the boiler as operator and in addition, by Order-in-Council, by an inspector of the Steam Boiler Inspection Branch.

"We have no boiler inspectors," said Mr. Burke. "If there is any weakness at all it is probably in that part of the statute, but I find from our files that in our fiscal year just closing, we received the inspection of 1442 boilers and 257 pressure vessels. This matter of course relates to engineers' inspection and I find that the inspections were made by 14 first-class engineers, 340 second-class engineers, 91 third-class engineers, 10 fourth-class engineers and 6 hoisting engineers.

Mr. Burke then showed that the province was gradually approaching a condition similar to that which exists in England where a large percentage of the boilers are insured. He also maintained that the right to make boiler inspections should not be taken from the stationary engineer, because in his opinion it might work hardship in many cases and he considered the stationary engineer more capable than an outsider of making the inspection.

Mr. Medcalf questioned several of Mr. Burke's statements, giving specific cases of boiler explosions which were not included in the chief factory inspector's report.

Victims Every Year

"There is no year passed but had some persons killed in explosions," stated Mr. Medcalf. "I can go through every report to show you that this boiler inspection should really come under the jurisdiction of the Boiler Inspection Department. I venture to say that we have had 15 explosions in the last ten years that were not mentioned at all by Mr. Burke, showing that the factory inspectors really do not know about these explosions when they occur. For example, there were three explosions this past year that they know nothing at all about."

A general discussion of the Act followed the explanations of the working of the two branches of the department.

Mr. Soucy maintained that stationary engineers were not as a class capable of inspecting boilers, but that they should be required to pass an examination to determine their capabilities, proving his statements by citing cases that had come to his attention where the safety valves had been tampered with.

In one case, referred to by Mr. Soucy, the safety valve was loaded down with bricks, pieces of iron and other weights so that it could not be opened without an enormous pressure. In another case, the safety valve was held down by a stick from the ceiling to the lever of the safety valve. This latter example was in an office building in Toronto where several hundred people are employed every day.

Wants One Branch

Wm. Inglis thinks boiler inspection ought to be all under one branch. "Why have two departments?" asked Mr. Inglis. "When you start to build your boiler, an inspector of your department looks after the whole thing. Why can't you get inspectors to carry out the whole thing in accordance with the regulations of each province? It is carried out in that way in accordance with the new Act they have for all Canada. The Interprovincial Act covers the whole thing. They have their own inspectors in the different provinces, and we cannot carry it out in this province unless we follow the example of the other provinces. With the interchange of boilers from one province to another province there is no jurisdiction over them. I think that the whole thing should be under the Steam Boiler Branch."

In reply to Mr. Soucy's statement that there were many boilers in the province in a dangerous condition, due to lack of proper inspection, the chairman asked how many inspectors it would take to carry on an inspection such as was outlined, pointing out the enormous size of the province and the expense that would be incurred keeping a staff of inspectors large enough to check up violations.

"At the present time we have a staff of 19 factory inspectors, limited in their power so far as they may enter or keep out of certain places and they do not cover adequately the province so far as adequate inspection of steam boilers is concerned even in reporting violations, far less dealing with the violations themselves," said Mr. Ballantyne.

Discussion followed along general lines for some time, various questions in regard to details of the working of the Act being brought up and no little time was devoted to criticism of officials of the department.

To Shelve Criticism

J. E. Waterhouse summed up the discussion by saying, "I do not think that we can get anywhere by criticizing department officials. It seems to me here is the situation in a nutshell: we have the Steam Boiler Branch that receives blue prints of boilers and specifications. That branch O.K.'s them or not according to their merits, oversees the construction of boilers according to these plans and specifications, up to the point of completion; then has absolutely nothing to do with that boiler again unless it should undergo extensive repairs or be removed. At the point of completion the boiler comes under another branch. Both of these branches may be efficient in the extreme,—we have no reason to believe otherwise, and yet it is not a commonsense situation. The record pertaining to a boiler should be under some official or under some branch from the time the blueprints are approved until that boiler goes out of use."

In reply to the question of Arthur Murphy, asking if any good reason existed for having dual control, Mr. Ballantyne said he did not agree as the head of the department with the duality of function.

"As a matter of principle I think it is a bad thing and I am prepared to recommend to Dr. Forbes Godfrey that a change be made."

Several good suggestions were made by Mr. Waterhouse to secure efficient inspection and check up violators of the Act, by making use of the factory inspectors to report through Mr. Burke to Mr. Medcalf any cases which came to their attention. It would add practically nothing to the work of the factory inspectors and would certainly cut down the expense of the work.

Divide Up Province

Mr. Burns suggested having the province divided into districts or zones with an inspector in each, in that way tending to keep the inspection fee uniform, and as each inspector would be kept busy the whole time, the system would be self-supporting.

Ibbotson Leonard stated that a gentleman from British Columbia assured him that their department was self-supporting and brought a small revenue to the province, and if that system worked out satisfactorily in British Columbia he could not see why it should not work out satisfactorily in Ontario.

M. J. Quinn in reply to questions regarding the enormous expense which might result from attempts to have an efficient inspection system, said that the very basis of this question was to bring out means for protecting the public and no matter what it cost, the people that it serves would bear the expense.

"Is it going to be by distributed authority or splitting it up against various departments, or going to be by centralizing or making laws of such a character that one department will know that every boiler is safe within the meaning of the Act. I want to move a resolution, if it is in order, and I think it is one that might properly come before the meeting, that in the judgment of this meeting, it is desirable that inspection of boilers and pressure vessels shall all be placed under the Boiler Inspection Department of this province, but I want to add a rider to that, an expression of opinion, that the factory inspection department should be used and utilized to the fullest possible extent."

This motion was seconded by Mr. Leonard and carried without a single dissenting vote. The meeting then adjourned until the afternoon, the morning session having brought out two main issues; first, that all parties interested in the manufacture, sale, or use of steam boilers, represented at the meeting, desired a change in the laws dealing with the inspection of boilers, and that all inspection of boilers and pressure vessels in the province should be under the control at all times of the boiler inspection department.

Discuss Proposed Act

The afternoon session was taken up discussing the proposed act respecting steam boilers which was tentatively approved by a conference in 1915. H. M. Roberts stated that the copies of the proposed act, distributed at the meeting, differed quite materially from that of 1915.

Acting on the suggestion of the chairman, an attempt was made to define the term steam boiler. Mr. Leonard suggested that to facilitate matters it would be better to designate the act as "An Act referring to steam boilers and unfired pressure vessels," and moved that this act be adopted. Wm. Inglis seconded the motion.

Mr. Roberts said that certain changes were desired by the insurance companies and considerable change in details would have to be made, so that it would be best to refer the act to a committee before final adoption.

Of vital importance to the Canadian manufacturer is the problem of proper inspection of boilers imported from the United States.

J. E. Waterhouse here offered the suggestion that the Department of Customs be utilized to inform the Chief Boiler Inspector when and where any boiler had entered the Dominion. The boiler inspection department could then deal with the matter.

Boilers shipped from Quebec to northern parts of the province frequently escaped inspection, which was unfair to Ontario manufacturers.

The inspection of boilers when installation has been completed met with the approval of all at the conference. In this way not only the boiler, but the whole piping system of a plant would be inspected.

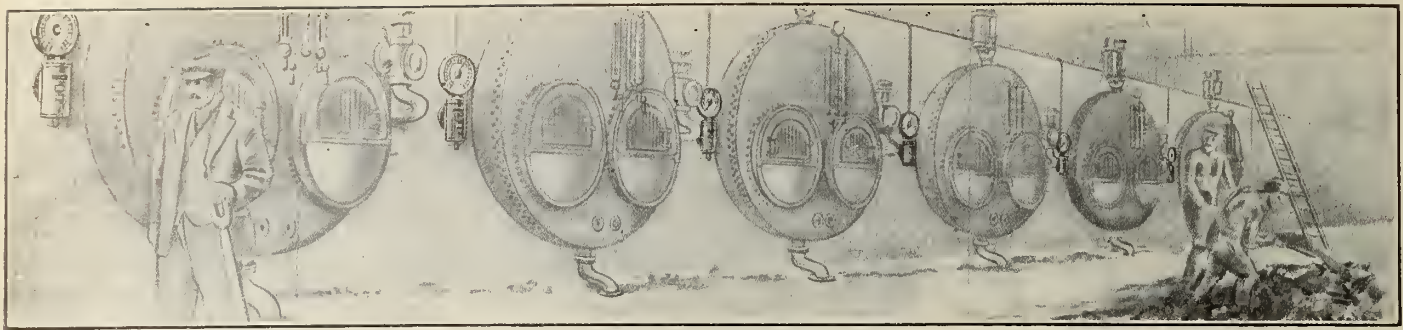
Urges Advisory Board

Mr. Roberts suggested that an advisory board representing all parties interested in steam boilers and pressure vessels should advise the steam boiler branch and make recommendations to the minister respecting the design, construction and installation of boilers, but not to interfere in any way with the carrying out of the regulations.

Mr. Medcalf stated that he would welcome any advance along these lines, but seemed to fear that such a board might overstep its powers. "I can not welcome any interference with the regulations," he said.

Registration of all boilers in the province was favored; however, subsequent discussion brought out that annual inspection of all boilers would automatically look after it.

(Turn to page 45)



Easy Engineering Lessons in the Power House

By M. BARRY WATSON, B.A.Sc., M.E.
Director of Engineering, Central Technical School, Toronto.

ALL boilers should have at least one thorough inspection, as well as several external inspections each year. This is necessary to insure that no undue corrosion or weakening of the stress-carrying parts of the boiler has taken place.

If all operating engineers were trained in the inspection of steam boilers, and could be depended upon to inspect their own boilers regularly and thoroughly, and to make, or have made, any necessary alterations or repairs before the safety factor of the boiler dropped to any extent, there would be no need for government inspection to insure the safety of the public, nor of boiler insurance to indemnify the owners against loss in case of boiler explosion, because there would be little chance of explosion.

It seems, however, that humans are much more thorough in inspecting someone else's work, or a plant with which they are not over-familiar, than in the inspection of their own work or plant, no matter how conscientious they may be. Thus, it is apparent that boiler inspection must continue.

In Ontario, the Factory, Shop and Office Building Act stipulates that no boiler, except private house heating boilers and those used purely for agricultural purposes, shall be operated or used unless it is insured with one of the companies licensed to insure boilers in Ontario, or has been inspected within one year by a boiler inspector appointed by the Department of Labor for this purpose.

Up to the present time there have been no inspectors appointed under the above regulations, but an order-in-council is effective whereby persons holding Ontario stationary and hoisting engineers' certificates are permitted to inspect boilers under the above regulation.

The author will not here give his opinion as to the value of inspection by any person holding the Ontario certificate, suffice it to say that even in the examination for first-class stationary engineers' certificates the candidate is not examined on his ability as a boiler inspector.

A boiler inspector must be able to accurately determine safe working pressures for boilers in all sorts of conditions, and it is likely that most holders of stationary or hoisting certificates would not have the least idea of how to commence such a determination, let alone knowing how or where to look for weakening in the boiler parts.

Insured Boilers Safe

It is quite safe for the Department of Labor to depend on insured boilers being in safe working condition, because the insurance companies are not going to take any more chances than they can help, and will make sure through their inspectors of the condition of any boiler, and will not insure it unless it is safe at the pressure at which it is to be operated.

A boiler inspector should never condemn a boiler. The most he should do is to calculate a safe working pressure after he knows thoroughly the condition of the boiler and specify that the safety valve must not be set to blow off at a higher pressure.

If this specified pressure turns out to be too low for the purpose for which the boiler is used, the owner will do his own condemning, or else will have repairs made or the boiler rebuilt so the inspector will allow the necessary pressure. Any factory inspector appointed under the Ontario Act has, however, the power to order the discontinuance of the use of any boiler which he considers unsafe, until it is inspected by a boiler inspector who must issue a certificate showing at what pressure the boiler may be safely operated.

Makes Inspection Easy

If the engineer in charge of the plant makes the inspector's work as clean and easy as possible and co-operates with him and anticipates his requirements, it is quite natural that the inspector should give a better report on the condition of the plant and allow more latitude to such an engineer than would be the case if he were inspecting a boiler where the engineer had made little preparation for the inspection and obstructed rather than helped the inspector in his work.

It is quite right that such should be the case, for if an inspector finds that the engineer in charge of the plant is on the lookout for trouble, and knows where to look for it and how to remedy it, he is fairly well assured that the plant is in good hands and will be perfectly safe.

On the other, if the engineer rubs the inspector the wrong way, gives him dirty furnaces and boilers to crawl through, tries to hide or keep him from finding some fault or defect which may reduce the safety of the boiler, or otherwise fails to co-operate with him, it is likely that the inspector will not give a good report, or may even require a further reduction in allowable pressure as an added safeguard.

Cover Up Defects

There are some engineers who feel it their duty to their employers to try to cover up defects from the eye of the inspector and thus prevent him obtaining a thorough knowledge of the condition of the boiler, thinking that in this way they can prevent the reducing of the working pressure by the inspector.

In such instances the inspector usually plays safe and cuts the allowable working pressure low enough to make sure of taking care of possible hidden defects, which pressure is probably lower than he would allow if he knew the complete condition of the boiler; thus the engineer would really be defeating his own object. It must be remembered that the owner, in the case of insured boilers, is paying out money to have his boilers inspected and thus assure himself that they are in good shape, but if his engineer reduces the effectiveness of these inspections he is really disloyal to his employer and is wasting that money. Also, if defects should be hidden from the inspector and an accident happen in respect thereof, it would be more difficult for the owner to get any further boiler insurance, and more difficult still for the engineer to get another job if he survived to look for one.

Find Co-operation Best

On consideration of the above points it would seem that the most complete co-operation with the inspectors is the best for all concerned. On the other hand, there are people in the world who are naturally suspicious of everybody. The writer has met boiler inspectors of this type, and the more one tries to cooperate and help such an inspector the more suspicious the inspector becomes that the engineer is trying to "put something over" him.

The writer once tried to help an inspector in every way possible, helped him scrape the shell, held his candle for him and did everything possible to assist. The inspector in question gave that boiler such a thorough inspection as the writer never saw before or since, many parts twice or three times. Finally, the writer was quite taken back when the inspector said: "Whatever it is you are trying to hide by sticking so close to me, I cannot find it so you might as well tell me what it is."

Luckily such inspectors are few and far between, but one should be careful not to force unwelcome attentions on an inspector for fear he might begin to suspect one of duplicity.

The object of this lesson is, therefore, to impress on engineers the advisability of co-operating with the boiler inspectors, and to tell how this may best be done without antagonizing the inspector.

Washed Clean Inside

Before a boiler can be inspected it must be cooled down, emptied, and washed clean inside, and the outside of the shell and the whole setting should be brushed and cleaned of all soot and ashes.

A worth-while preliminary step in the cleaning of the boiler is to blow down a couple of gauges of water while the boiler is still making steam. While in this condition much of the dirt in the boiler is being agitated and moved about slightly by the formation of the steam and in this condition it is more likely to be washed out with the current of water toward the blow-off pipe than after the dirt has had a chance to settle close to the bottom of the boiler.

In endeavoring to cool a hot boiler some engineers make the mistake of opening the cleanout and smoke-front doors, thus bringing cold air in direct contact with the tube ends. They then wonder why they are troubled with leaking tubes and tube sheets when they are operating next time.

The proper procedure is to keep the furnace doors closed after the fire is drawn, open the damper and allow cold air to enter through the ash pit in the usual way.

Thus, all the air used to cool the boiler passes through the hot furnace before it reaches the boiler, and is partly warmed up, causing less strain on the various joints, etc. After the setting is cooled down to such an extent that it no longer warms up the air appreciably the boiler will be cool enough to be unaffected by cold air.

Pressure Drops to Zero

As soon as the steam pressure has dropped to zero, let the water run out of the boiler through the blow-off, opening the safety valve or the try-cocks to allow air to enter the boiler. As soon as possible break in the manhole cover, and remove it as soon as the cloud of vapor which arises has subsided sufficiently to allow of it being done.

Remove the other manhole and handhole covers and allow air to circulate through the boiler to both cool and dry it. By this time the fire doors and back clean-out doors may be left open, but the smoke-front doors should be kept closed, except while the manhole or handhole is being opened.

Much of the cleaning of the outside of the boiler cannot be attempted until the furnace and combustion chamber are cooled sufficiently for one to work therein. This necessary cooling will be hastened considerably if the ashes and dust are removed as much as possible by means of a long-handled shovel, and the bottom and heads of the boiler are swept off with a broom.

As soon as the smoke-front doors can be left open the tubes should be thoroughly cleaned.

Do not "blow out" the tubes with steam from another boiler after they are cool, because this steam will heat up the boiler again, at the same time condensing in the tubes and forming a gummy mixture with the soot and dust. Compressed air is good for this purpose, if available. The tubes must finally be "punched" or scraped and brushed out.

Remove All Dirt

All dirt should be removed from the furnace, combustion chamber, smoke-front, etc., the sides of the setting and all parts of the shell of the boiler should be scraped and brushed clean. A sawed-off broom will be found very convenient for cleaning the bottom of the shell and side walls.

The whole setting should be made as nearly perfectly clean as possible in order that the inspector may not be bothered wading through dirt and soot nor have to waste time cleaning the plates in order to examine them closely.

In cases where it is impossible to wait long enough to cool down a boiler, as detailed above, it may be hastened by letting down the steam pressure by easing off the safety valve.

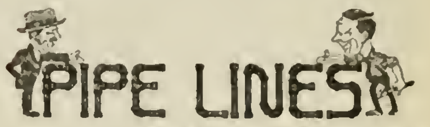
In this way much of the heat contained in the boiler is used up in forming low pressure steam, in which form it escapes. It may also be found necessary to allow a free circulation of air as soon as the fire is drawn, but this is not advisable if it can be helped in any way.

It must be remembered that air entering the fire doors or the clean-out doors will cool the boiler far more than air allowed in the smoke-front doors, which merely rubs against the head of the boiler and kills any draft as far as the tubes are concerned.

After pressure has been brought to zero by allowing the steam to escape, the boiler can be emptied through the blow-off, and the manholes and handholes can be opened at once to allow circulation of air in the boiler. If emptied by the quick method, hot water should be used for flushing out. This may be obtained from another boiler below the water line, or from a separate heater, or part of the steam wasted in lowering the pressure may be led into a large water tank to heat the water for washing out. This latter is the most economical method if one has the tank available. If the boiler has been allowed to cool thoroughly, cold water may be used for flushing out.

This should be done with a hose under as high pressure as possible in order to remove the greatest amount of dirt possible. In washing out, a note should be

(Continued on page 45)



UNCOVERED IN ANY OLD SPOT

They had to carry Carl to the carriage;
The carriage carried Carl to the door;
The reason they had to carry Carl to the carriage,
Was because Carl couldn't carry any more.

* * *

When installing an oil engine have a foundation of sufficient size. Many engines are damaged from severe vibrations which would be eliminated by using more foundation material.

* * *

The man who once most wisely said,
"Be sure you're right, then go ahead,"
Might well have added this, to wit:
"Be sure you're wrong before you quit."

* * *

Unlike the steam engine or steam turbine which show a large increase in fuel per brake-horsepower as the load drops, the Diesel has an excellent low load efficiency. For this reason the Diesel is economical on changing loads.

* * *

The man who gives in when he is wrong, is wise. The man who gives in when he is right is generally married.

* * *

If a semi-Diesel is operated with a low temperature cooling water discharge it usually smokes badly and will not carry its load. The engineer should experiment until he secures the temperature for best results.

* * *

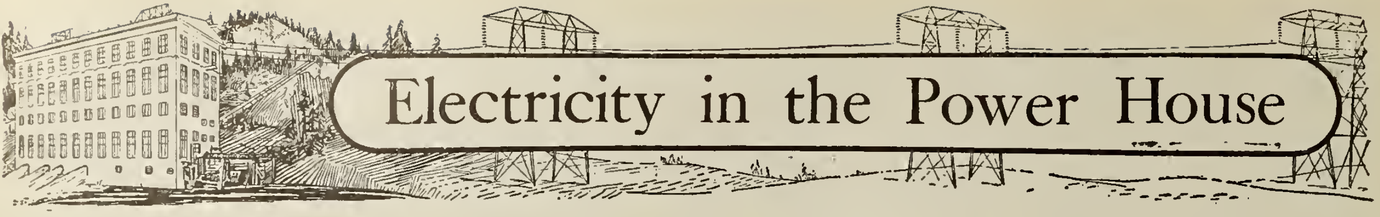
Her name was Irene
And she wore crepe de chine—
You could see more Irene
Than you could crepe de chine.

* * *

The fuel consumption of the usual semi-Diesel of over 100 hp. is approximately 0.6 lb. of fuel per horsepower-hour. Large semi-Deisels have shown a fuel consumption as low as 0.50 lb. per horsepower-hour. Small engines deliver a brake-horsepower on about 0.8 lb. per hour at full load.

* * *

Some folks argue that advertisin' is an expense which must be charged agin' th' consumer. It's a two-to-one shot that these folks try to sell last year's goods this Christmas.



Electricity in the Power House

By J. A. BURNETT, M.E.I.C., Consulting Engineer, 205 St. James St., Montreal

RUNAWAY ENGINE

A CASE of trouble with an engine recently came to the attention of the author. This particular engine was a small, high-speed piston valve type, directly connected to a 75-k.w. lighting machine, normal speed 270 r.p.m.

When this outfit was started and the engine given full steam pressure, the first speed would probably be 276 and as quickly as another reading of the speed could be taken 281, then 287, 293, 297, 301, 310, continuing to creep up slowly.

With any load from 10 k.w. up, the speed regulation was very good, but whenever the load was thrown off the speed would begin to creep up. It was run throtttled until all of the parts had reached an even temperature, but with no better results. The engineer then took out the valve to look for steam leaks but it seemed to be in good condition. A trial showed that the condition had not been improved.

An improvised device showed that the governor did its work so that it looked reasonable to believe, despite the indicator cards, that there must be some error in the valve setting.

This was checked over, the piston being taken out and examined. Cards were taken until there was no more paper to fit the indicator. The trouble continued for three or four days, until a theoretical curve, such as engine builders send out, was found.

In comparing the card with one of the no load curves the trouble was as apparent as though it had been printed in words across the paper.

The valve leaked steam. The valve was taken out for the second time and the inside of the rings peened to spread them out thereby increasing the pressure against the walls of the steam chest. The problem was solved, for no engine could run better than this one does now.

VICIOUS COMMUTATION

It is no uncommon thing to nurse a piece of apparatus through the rush hours and then spend the rest of the day in tearing it to pieces and hustling to get it together for the heavy loads of the morrow.

In large cities where the street cars must be kept moving and the lights kept burning as long as machinery will deliver power, chances are taken that fairly startle one in the calmer moments of reflection.

An instance of this sort once happened when an engineer wandered aimlessly into a station where he had started a small rotary converter for street car work some ten or twelve days previously.

He was very much surprised to find that with any load the brushes would spark viciously. Shifting them either way to find a better point of commutation made no difference.

The commutator was in bad shape, but even this failed to explain why the machine should behave in this manner when it had satisfactorily handled a much heavier load only a week before. A few hours finished the days' run and a careful examination revealed the fact that only seven out of the twenty-four brushes were touching the commutator. For some reason the brush tension had been increased to such an extent that the brushes had been ground away until the nuts which fasten the carbon to the copper shunts would not let the brush slide farther down in the holder.

The cause of the sparking on the heavy loads was clearly due to the lack of sufficient brush area for carrying the current.

Since no extra brushes were at hand it took the best part of the night to smooth off the commutator and put the machine in a workable condition.

LOOSE BRUSH HOLDER

Elevator work is more or less troublesome, because these motors are not, as a rule, installed by the makers and if anything goes wrong, it is usually attributed to a supposed defect in the machine.

A short time ago the writer was asked what could be done with a small direct current motor in elevator service which was unsatisfactory.

On reaching the place all hands were awaiting his coming. They claimed that the motor seemed to run away and that the brushes threw off sparks like a blast furnace.

The control outfit was of a complicated design, the wires being so concealed that it looked to be a three or four-hour puzzle to find out where they went.

Before an actual demonstration was made a happy thought prompted an investigation of the brushes and there they were, just half way between the neutral points, so that running the motor in either direction produced a furious sparking. It did not take long to remedy the defects.

Speedy Elevator

Another similar case occurred where the man in charge of the installation insisted that the motor was wired according to the diagram and since the elevator ran about four times its proper speed, there was undoubtedly something wrong with the motor.

Like the experience just cited there was litttle difference in the speed whether the car was going up or down.

A drop across the shunt field revealed the trouble at once. The connections were such that less than 25 per cent. of the line voltage reached this part of the motor, and when the foreman stated that he did not see how this could make any difference, it was necessary to make the changes in the wiring to demonstrate to him that there was nothing wrong with the machine.

Convention Notes

THAT there has been no decline of interest upon the part of members in the work being carried on by the National Association of Ice Industries was evident by the large attendance at the sixth annual convention of the association, at the Hotel Winton, Cleveland, Nov. 13-16. It is probable the record attendance at Chicago last year was broken, 680 delegates being recorded as present. Every state in the union was represented and there was a strong delegation from Canada.

There was an overflow at every general session and the group meetings were also well attended. Throughout the entire convention the deepest interest was manifested in the questions of nation-wide importance to the industry covered by the reports of officers and standing committees.

The outstanding features of the convention were the adoption of a new constitution, and the action taken through a resolution passed by the convention and put into effect at a meeting of the board of directors to proceed with research work and to make arrangements for the testing of materials used in the manufacture of ice.

A pleasant incident connected with the meeting was the presentation to President Black of a token of the esteem in which he is held by the whole membership of the association.

Great satisfaction was felt by all members that the board saw fit to elect Mr. Black to the presidency for the third time and that it was possible for him to again accept the arduous duties of presiding officer.

Treasurer A. W. Broecker and Secretary Smith were also re-elected as were Vice-President Robbins and most of the regional vice-presidents.

Practical Ideas From Practical Men

REPAIRS DRAFT GAUGE

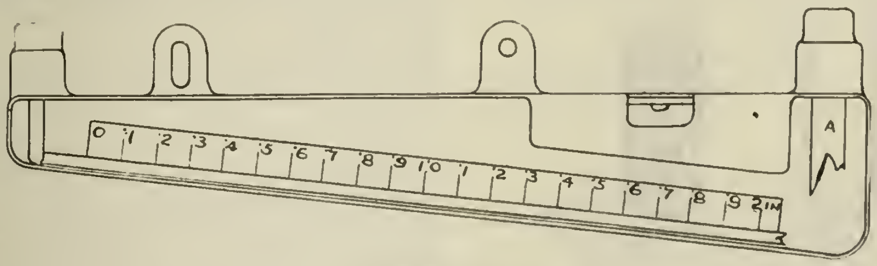
Some time ago we had the misfortune to break the glass tube of a differential draft gauge in our plant, through a careless fireman striking it with his rake. It looked a rather hopeless repair job with the facilities at hand, and getting a new tube meant a long delay and all kinds of bother.

'Tis said, however, that "necessity is the mother of invention" and the illustrations show how the problem was solved rather neatly.

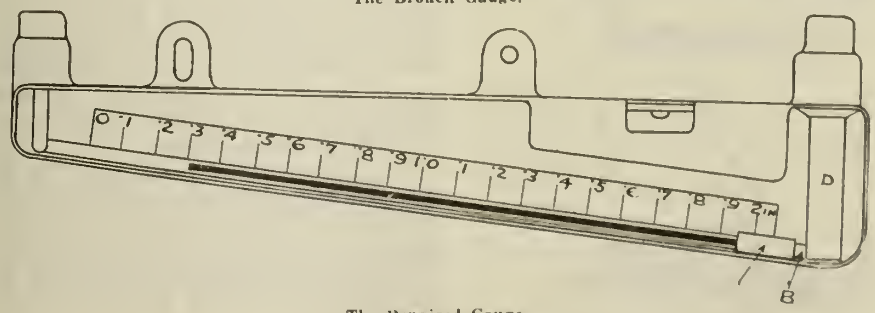
The internal diameter of the vertical part of the tube A was measured accurately, and a piece of thin sheet brass cut and bent into a tube of the same diameter, the joint being soldered and a bottom being soldered in.

A small piece of brass tube B of the same size as the inclined glass tube was then soldered in near the bottom as shown in the illustration. A piece of rubber tube C about ¾ in. long was then acquired from the Orsat apparatus and slipped on the end of the inclined glass. The glass tube A was then dug out and the brass one D slipped into place and secured at the top with ordinary putty. After the putty had hardened, a little thin shellac varnish was poured in and emptied out again, this operation being repeated three times, allowing an interval for the shellac to harden between each pouring, the object being to coat the rubber tube internally with shellac and protect it from the action of the oil used in the gauge, oil having been found very injurious to the rubber.

The repair has proved entirely satisfactory, though of course, it has reduced the capacity of the instrument slightly. This, however, does not trouble us, as we only use natural draft which is generally around .3 of an inch—THOMAS C. PORTEOUS, Michel, B. C.



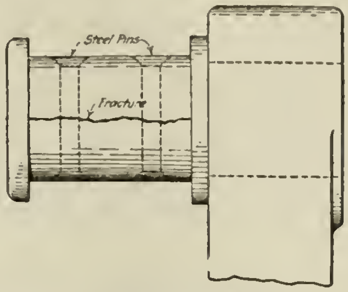
The Broken Gauge.



The Repaired Gauge.

REPAIRING A CRANKPIN

The crankpin of an engine for a long time had been giving trouble on account of heating. Often it had been necessary to turn a hose on the pin to prevent a shutdown before the close of the day. The engineer could discover nothing wrong with the pin; it was square with the crank and was round and smooth. Finally, the troublesome pin was removed and a new one put in.



Crankpin Repair.

But the engineer was not entirely satisfied that the new one was needed. As a last resort he examined the pin with a magnifying glass and found a fracture extending lengthwise of the pin almost from one collar to the other. The line of the fracture was so faint as to be almost undiscernible.

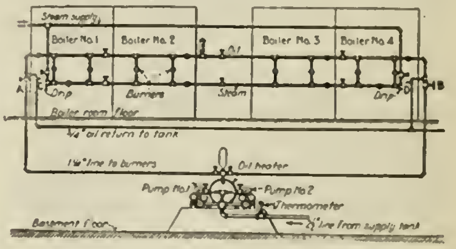
That explained the difficulty. The expansion of the pin as it warmed up to a running heat would cause it to spread out on each side of the fracture, thus making it bind in the boxes and cause excessive heating.

The pin was repaired as shown. Two ⅝-in. holes were drilled through it perpendicular to the fracture. The holes were countersunk and filled with close-fitting steel pins, heated to redness and riveted over at the ends. The riveted ends were then filed down to the curvature of the pin.—WALTER G. HUDSON, Montreal.

OIL BURNING LAYOUT

In our plant a complete oil burning system for four boilers has now been installed.

A storage tank of 100,000-gal. capacity is located a short distance from the plant, from which the oil flows by gravity to an underground tank of 6,000 gal. capacity. This tank is fitted with a heating coil, and the temperature of the oil is raised to 120 deg., live and exhaust steam being used for heating.



Layout of Pump and Piping.

Then the oil is handled by a 5¼ x 3½ x 5-in. duplex pump, which discharges through a heater to the burners. A duplicate pump is installed for stand-by service.

The heater is located between the pumps, and the temperature of the oil is raised to 200 deg. while passing through it.

Both the oil and steam piping are installed on the loop system. A return line is connected off each end of the loop between the discharge valve and first burner connection. In normal operation the valve A is open and the oil drains back to the suction tank through valve D, or the oil may be fed in the opposite direction by opening valves B and C and closing valves A and D.

There is a valve and union on both steam and oil line between each set of burners, for convenience in isolating or removing sections of the piping.

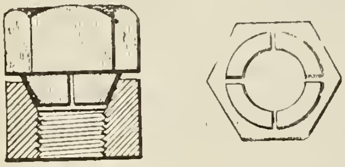
The burners are fitted with a valve and union on each connection and any burner can be removed and replaced in a few minutes, a spare being kept in readiness. A pressure of 100 lb. is carried on the discharge line from the pump, and a quantity of the oil is by-passed continuously to insure the proper temperature being maintained in the oil line. —A. W., Montreal.

LOCKING NUT

In some makes of steam hammer where the piston head and the hammer-block end are integral with the rod it is not unusual to form the gland casting in halves.

The intense vibration set up when the hammer is in operation renders difficult the permanent fixing of the gland nuts, these tending to work loose.

The writer tried double nutting, spring washering, and other familiar methods to check this tendency, but without avail.



Ultimately satisfactory results were secured by designing the form of check nut illustrated herewith.

A pair of ordinary ⅝ in. nuts were machined down to a conical male and female, the faces not quite abutting when set one upon the other. A double saw-cut slot was made across the conical portion of the male nut, which upon being locked by the female tended to close in a tapered portion of the male nut upon the threads of the gland stud, thus opposing any tendency for the nuts to work loose.

Two pairs of these nuts have been holding up a gland on a two ton steam hammer for the past two years without once slackening back.—GEO. SMITH.

PACKING HYDRAULIC RAMS

Herewith is a sketch of the lower parts of a hydraulic accumulator. Packing gland A is of the usual type packed with "cup leathers," but owing to the working surface of ram being slightly rough, the average life of each set of "leathers" was two months. I tried the following method with great success and can recommend it to anyone.

Take a piece of copper tubing long enough to make one turn of packing and flatten it out as shown in Fig. 2, then, carefully bend the flattened tube round ram allowing ends which should be cut at an angle (see Figs. 3), almost to "butt." Next cut the ring thus formed as shown in sketch, leaving the copper in the form of a U-piece sufficiently deep to fill packing box.

Fig. 4 shows U-piece filled with packing, which in my case was "Tuck's" with rubber core. This lasted for years. When setting up gland, see that the copper ring has been properly softened, also that packing is a tight fit in U-piece. The top turn should project for about two-thirds its diameter in order to allow for compression.

The best method to adopt in flattening copper tube is to fill it with lead, then pass it through rollers until the required dimensions are reached. This procedure tends to leave a more uniform surface than when the flattening is done with a mallet.

A. SMYTH.

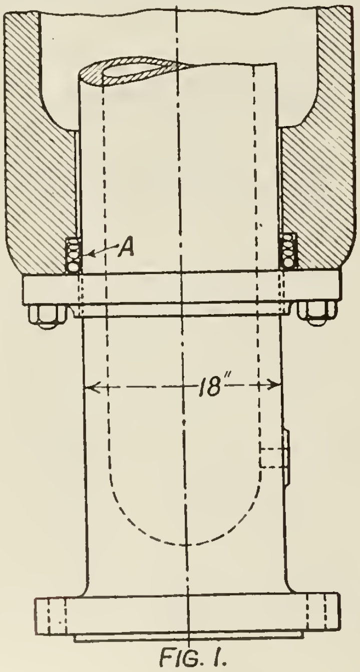


FIG. 1.

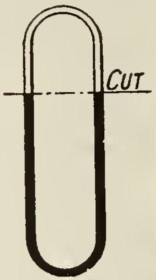


FIG 2

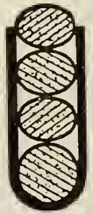


FIG. 4.

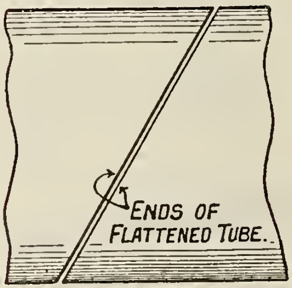


FIG. 3.

"Movies" Feature Power Show

Educational Exhibits Increase Interest of Engineers in Mammoth New York Exposition

INTEREST in the Exposition of Power & Mechanical Engineering at the Grand Central Palace, New York, Dec. 3 to 8, was increased by a series of educational exhibits and an extensive program of motion pictures. The subjects of the exhibits were fuels, steam locomotives, and modern high pressure boilers.

The exhibits of fuels were made up of specimens of the various kinds of fuels, solid, semi-solid and liquid with complete statement as to origin, and analysis. The solid fuels included a types of anthracite, semi-anthracite, semi-bituminous, and bituminous coal. The section of solid fuels contained samples of splint and cannel coal, dried peat, wood logs, faggots, wood mill waste, and various forms of briquetted coals. Prepared fuels, such as charcoal and coke, were shown as well as powdered fuels.

The exhibit of modern steam locomotives consisted of pictures and drawings, showing the development of the locomotive from its earliest stages down to the large machines of to-day. Various locomotive companies and railroad organizations co-operated in making this exhibit complete.

Showing of high pressure boilers consisted mainly of drawings of foreign and American designs, which have been in use or are at present being installed. The exhibit proved very instructive to all those who are following the rapid advances in steam power plant practice.

The manner in which valve manufacturers have solved the problem of valves and fittings for the high temperature steam plants, which modern economy demand was clearly displayed.

To Withstand Pressure

The features of this equipment to withstand extreme temperatures and pressures included sectionalized valves of steel and monel metal. One exhibitor showed a monel mounted globe valve for operating conditions of 400 lb. working steam pressure and 800 deg. Fahr., total temperature. Several manufacturers displayed large valves equipped with the Dean system of electrical control in operation at the show.

There were a large group of manufacturers showing steam traps, damper regulators, steam and water regulators, air regulators, injectors and ejectors, inspirators, oil separators, and grease extractors. One particularly interesting exhibit of steam traps was a glass model of a trap working under steam pressure. The outfit consisted of an electrically heated boiler with pump so arranged that water can be supplied to the reservoir which the trap drains.

The importance of high-grade packings and gaskets for high pressure steam as well as for the great variety of liquids and gases used in industrial and chemical plants attracted attention to the section of the show devoted to these materials.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

LEAKING TRAPS

A large public building is equipped with two separate heating systems. One is located under the windows with 6,562 square feet of direct radiation. Steam is supplied to the system through a pressure reducing valve at 3 lb. per sq. in. The other is a hot air system using motor driven fans. The air is heated by eight stacks of heating coils with a total heating surface of 2,712 square feet. Air is drawn from the outside through gratings in the sidewalk.

Steam is supplied to the coils at 4-5 lb. per sq. in. pressure after passing through a reducing valve. The 4 inch steam line is 260 feet long and carries steam at 70 lb. per sq. in. The average temperature of the air entering the fans is 48 deg. and a temperature of 68 to 70 deg. is maintained on the floors.

Both systems are connected by common returns to vacuum pumps in the boiler room, but when the indirect system is operating a proper vacuum can not be held unless a jet of cold water is fed into the suction line of the pump, due to the high temperature of the returns.

What is the cause of this trouble and could we save fuel by having the pressure reducing valve located at the boiler instead of close to the coils?—A. V. BUCHNAM, Victoria, B. C.

Answer:—The trouble is due to steam leaking from the coils to the returns, in this way tending to keep the return water too hot. Water boils at 212 deg. F., at atmospheric pressure, but as soon as a partial vacuum is produced the boiling point is around 193 deg. F. What is occurring in your returns is probably as follows:

Steam from some source or other is finding its way to the returns and destroying the vacuum. This leakage is no doubt due to defective steam traps on the heating coils. Look to the drip traps on the risers. Repair the present traps if they are defective or replace with a trap that will close tight against steam loss after discharging the condensation.

If, on examination of all the traps, they appear in good shape, it might be advisable, if the trouble still persists, to make an inspection of the pipe lines and look for some by-pass or steam connection that might be allowing steam to short-circuit through to the returns. By-passes are sometimes put on for draining lines or for starting up in a hurry and, as the valves are sometimes not tightly closed, steam keeps leaking back to the returns.

One thing is certain, steam escaping to the returns is the cause of the trouble.

There would be for all practical purposes no difference in the quantity of steam used on the building, whether you carried the 260 feet line at high or low pressure.

The velocity of steam through pipes is confined to certain velocities, which experience has proven to be the most economical both from the point of view of the cost of installation and loss in heat from the steam.

With the low pressure steam of 3 lbs. the temperature is about 222 deg., and with steam at 70 lbs. the temperature is about 316 deg., indicating that with the low pressure steam, due to the lower temperature, the radiation loss would be less; on the other hand the volume of steam with the low pressure (3 lbs.) is about 22 cu. ft. per pound, with 70 lbs. the volume is about 5 cu. ft. per lb. or with the low pressure steam the pipe volume would have to be 4 times that used for the 70 lb. line. This would necessitate a pipe of double the diameter and double the radiating surface.

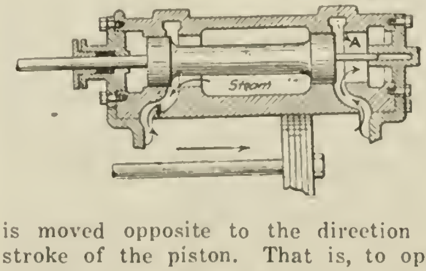
With the low pressure then, the radiation losses, in spite of the lower temperature of the steam, would be greater, to say nothing of the expense of erecting an 8 inch line in place of the present 4 inch line.

INDIRECT PISTON VALVES

What is an indirect piston valve for an engine and why is it so called?

—A. WYLIE

Answer.—An indirect valve is so designated because, for admission of steam at the beginning of a stroke, the valve is moved opposite to the direction of stroke of the piston. That is, to open the steam port the eccentric follows instead of leading the crank.



The figure illustrates an indirect piston valve in which steam is taken beneath the valve while exhaust is taking place at the end A of the valve, thus reversing the method of steam distribution of the ordinary D-slide valve.

SETTING VALVES

In setting a D-slide valve, is it of greater importance to obtain good leads or to equalize the cutoffs of opposite ends?

—W. H.

Answer.—The economy of the engine is not materially affected by a considerable variation of the point of cutoff, but it is desirable to have sufficient lead to fill the steam passages with steam by the time the piston is ready to start out on its stroke, and sometimes also for smoother running to cushion the piston over the centre on engines where there is little compression of the exhaust.

There is a considerable lowering of the pressure when the steam enters the cylinder and comes in contact with surfaces that have previously been cooled by the exhaust of lower temperature, and, if admission at full pressure is delayed, the re-heating of the cylinder with reduction of pressure is extended to the period of admission.

FREEZING TRAPS

I am in a power plant where it is necessary to close off a section of the heating system during the winter, sometimes for a number of days, sometimes for only a night at a time. The traps nearly always freeze up and give no end of trouble, even when the return lines are drained.

Can you suggest a radiating system with a style of trap that can be used for the work that will not freeze up?

The present one is similar to the coil system shown in the September 20 issue of Power House. The returns run horizontally with very little fall.—J. H. STACEY, Winnipeg.

Ans.—You are up against a real problem unless you change present methods of heating the building. The real source of the trouble is caused by the water of condensation from the steam when starting up, not as might be supposed by some water remaining in the traps and freezing as soon as the temperature falls below the freezing point.

Assume the whole system is properly installed with good traps and proper returns. When the steam is turned off with the system hot, enough heat is retained in the metal to dry out any water in the radiators or the traps. The traps then can not freeze up because there is no water to freeze them.

When the heat has been turned off the system, the temperature drops and may be considerably below the freezing point of water (32 deg.).

When the steam is turned on with the

radiators and traps cold, some of it is condensed at once and is cooled by the metal, so that when it reaches the traps its temperature is about at the freezing point.

The result is that the small outlet through the trap immediately becomes frosted over or frozen up, forming a dead end. As there is then no circulation in the pipe leading to the trap and in the trap itself, the only practical method of opening the trap is by applying heat externally.

I do not know of any make of trap which would overcome the troubles when used in a building in which the temperature is allowed to drop below the freezing point; however the following pointers by a prominent heating engineer may be of value to you.

The use of a check valve instead of a steam trap may be of assistance, because of the larger passage for the steam to pass through, a slight amount of frosting will not be so apt to plug the outlet.

Check valves are not as efficient as traps because of the steam which is allowed to pass to the returns with them.

If there is a warm basement under the building, locating the traps in it will prevent freezing.

If possible locate the supply line close to the trap so that the heat given off from the steam in the supply will heat up the trap and thaw it out if it is frozen. In some places where the piping is installed it is probably impossible to change the piping except at considerable expense, in others it may be possible to run the supply next the trap at a trifling expense.

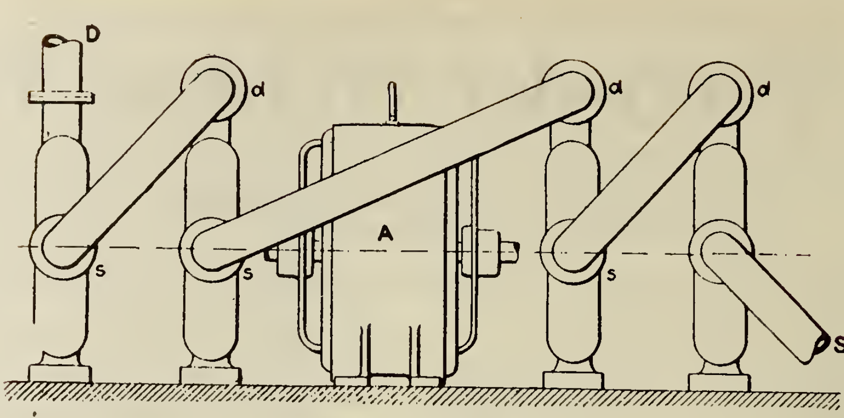
It is best to keep a small amount of steam passing through the system, not necessarily enough to heat the building, but merely sufficient to prevent the returns and the traps from freezing. This last suggestion would apply especially when the heat is turned off at frequent intervals for short periods.

CENTRIFUGALS IN SERIES

For raising water with centrifugal pumps, where a single pump cannot raise the water to a sufficient height, cannot several centrifugals be employed in series? —A. HENDERSON.

Answer:—The required energy may be imparted to the water by means of two or more moderately sized pumps arranged in series of place of a single pump of large diameter running at a high velocity. High lifts frequently have been accomplished in this manner, using a pair of centrifugals driven direct by a double-cylinder steam engine or other motor. The figure is a sketch diagram representing an arrangement of four centrifugals as coupled by a European maker to an electric motor A with all mounted on the same bedplate.

Water received at the main suction S of the first centrifugal is successively delivered by the delivery outlets d and suctions s to the fourth centrifugal with the discharge D. It is understood that a plant of this kind was employed to raise water through a height of more than 150 feet.



Centrifugal Pumps in Series.

SUCTION LIFT

What is the rule for height of suction head or suction lift for pumping water of a given temperature?—C. A. S. E.

Answer:—With a velocity of from 3 to 4 feet per second and a short suction pipe with one bend, water under atmospheric pressure and as warm as about 160 deg. Fahr. will require no suction head, and at 212 deg. Fahr. will require a suction head of 12 ft. For each deg. Fahr. from 160 deg. Fahr. to 212 deg. Fahr. there should be a suction head of 2¾ in.

At 60 deg. Fahr. the suction lift may be as much as 22 ft., and from 160 deg. Fahr. down to 60 deg. Fahr. there may be a suction lift of about 26⅝ in. for each deg. Fahr. of the water below 160 deg. Fahr. If the suction pipe is long, the velocity high, or there are many bends or other obstructions, such as a foot valve, strainer or surface condenser, the losses must be estimated and deducted from the available lift computed by this rule.

WATER IN FUEL OIL

I use fuel oil for firing and have a condition that is giving us trouble. We have underground storage tanks, and there is a percentage of water that will not separate from the oil, but hangs in solution and when agitated by pumping the oil becomes emulsified. How can the condition be overcome?

— A. HEINRICK

Answer.—When water cannot be separated by allowing the oil to stand a reasonable length of time to allow the water to settle to the bottom of the tank, it can be removed by passing the oil through a centrifugal separator on its way to the furnaces.

This method is commonly used for improvement of fuel oils for removal of dirt and water without depending on quiet storage for settling the impurities.

CHECK VALVE LEAKAGE

How can it be determined whether a boiler-feed check valve leaks?—S. M., Toronto.

Answer:—When pump valves and water pistons are not perfectly tight and the feed-stop valve is left open when the pump is not running, the hot boiler water will be forced back to the pump and check valve leakage will be revealed by a higher temperature of the feed pipe near the boiler than when the pump is feeding the boiler.

A surer test of the check-valve leakage is to tightly close all direct supply connections to the check valve. Then with boiler pressure on the discharge side, test for leakage by bleeding any direct supply connection between its stop valve and the inlet side of the check valve.

The Hydro Electric Power Commission, of Ontario, is conducting negotiations for purchasing the plant of the insolvent Georgian Bay Power & Milling Co., Meaford, Ont. This is a result of the January vote of Meaford to adopt the Hydro.

Get That
Certificate!

WHEN that next good job is open for a Certified Engineer be fully qualified! Fit yourself for a better position — by law and by your knowledge. Study in your spare time by mail through Shaw's Course in Stationary Engineering. Personal Instruction by T. H. Fenner, former editor of "Power House." Industry needs qualified engineers. There's a course for you—to help you get just the Certificate you require. Write for full facts, syllabus, etc., to

Shaw Schools Limited
Dept. 100
46 Bloor St., W. Toronto

Comments in the Power Plant Field

ELECTRICAL KNOWLEDGE

It is necessary for most stationary engineers to have a certain amount of electrical knowledge, and where one should start to learn this subject seems to be a much-mooted question. Naturally, the information that one desires to obtain is that which concerns the equipment under his charge whether it be generators or motors.

To all, but especially those who are not familiar with electrical apparatus, a study of "Ohm's Law" and its practical application to various problems is interesting and instructive.

Ohm's Law was discovered by and named after the German electrician George Simon Ohm, and is: "The strength of the current varies directly as the electro-motive force and inversely as the resistance." It can be more simply expressed thus:

$E = I \times R$ where
E = Electromotive force or volts.
I = Current or amperes.
R = Resistance or ohms.

Named After Italian

A volt, named after the Italian, Alessandro Volta, is the amount of pressure (electro motive force, E. M. F.) required to force a current of one ampere through a circuit having a resistance of one ohm.

An ampere, named after the Frenchman, Andre Marie Ampere, is the amount of current that an E.M.F. of one volt will send through a circuit having a resistance of one ohm.

The ohm is the unit of electrical resistance. Then if $E = I \times R$, it is apparent that we can change the formula around, also knowing any two factors we can easily find the unknown for $E = I R$, then $I = \frac{E}{R}$ and $R = \frac{E}{I}$.

Finding Electromotive Force

For instance, if we have a circuit with a resistance of 5 ohms, and we desired to send a current of 10 amperes through it, what E. M. F. would be required? $E = I \times R \therefore 10 \times 5 = 50$ volts. If we knew the volts and current and wanted to know the R, i.e., through what R will 110 volts send 11 amperes, $R = \frac{E}{I}$ $\therefore \frac{110}{11} = 10$ ohms.

If we wish to find the I from the following, an electric heater is attached to a circuit of 110 volts, the R of heater is 22 ohms, then $I = \frac{E}{R} \therefore \frac{110}{22} = 5$ amperes.

These are some simple illustrations of Ohm's Law, and it would be worth while for anyone interested to work out several such problems and thereby become familiar with its application.—E. GOLIGHTLY.

SMALL PIPE LINES

There is such a thing as making steam pipe lines too large in spite of the advantages of accompanying low steam velocity and slight pressure loss. The trick is to select pipes of the right size—neither too large nor too small.

The size of a steam pipe is usually based on steam velocity. For saturated steam 6,000 to 8,000 ft. per min. is common practice, while for superheated steam 8,000 to 12,000 ft. is often used. Before going above 8,000 ft. per min., however, one should be certain that the piping and valves are of sufficient size and design so that the pressure drop will not be excessive, so that there will be no wire drawing through valves, and no loud whistling noises. By exercising judgment velocities can sometimes be brought up to 14,000 ft. per min. for large reciprocating engines or steam turbines.

The advantages of small piping are

1—Lower first cost. The pipe weighs less per foot. Thinner pipe can be used to withstand the same pressure. Consequently the initial investment is less.
2—Correspondingly smaller and less expensive fittings.
3—Less surface is exposed to the atmosphere, hence the radiation losses are lower.
4—Less insulation is required because of small surface—sometimes a very important item.
5—The greater friction loss through the small pipe tends to superheat the steam. As a result the steam may reach the engine or turbine, after a long run, in a perfectly dry state. The pressure loss is thus converted over into useful heat energy.

It has been suggested by an engineer and the suggestion seems to have some merit—that in long straight runs of steam pipe large valves be used, with smaller intermediate pipe. In this way the steam velocity through the valves would be low, or "just right," and through the smooth pipe the velocity would be high, or, again, "just right." If any of the readers of Power House have had experience with pipe lines designed in this way the writer would like very much to know whether or not they were successful. —W. F. SCHAPHORST, M.E.

M.D.E.A. Notes

The regular meeting of the Montreal and District Engineers' Association was held on Nov. 23, when, in spite of the inclement weather, there was a large attendance of members.

J. Thompson, of the Dearborn Chemical Co., Toronto, was heartily welcomed as a visitor to the lodge, by President W. Forbes.

An election for the vacancy of treasurer took place and by unanimous vote, W. J. Carmichael, of the Mount Royal Hotel, was chosen for this responsible position.

Mr. Carmichael's elevation to the treasurership is a fitting tribute to his faithful attention to duty whilst holding the office of financial secretary of the C. A. S. E. for a considerable period.

Book Reviews

Hydro-Electric Power Stations. By David B. Rushmore and Eric A. Lof. Published by John Wiley & Sons, Inc., New York, 1923. Cloth 6x9 in.; 830 pages; 437 illustrations; 66 tables. Price, $7.50.

This is the second edition of this book, which has been revised and brought up to date so as to set forth recent practices in hydro-electric power developments. The rapid advances made in recent years in water-power development have led to radical changes in both the hydraulic and electrical parts of the station.

The book is divided into ten chapters and an appendix. Chapter I is a general introduction dealing with the history of water power and electrical development, water powers of the world, classification of developments, etc. Hydrology is the subject of Chapter II and treats of properties of water, rainfall, disposal of rainfall, stream flow and energy of flowing water. In Chapter III the various practices in dam and headworks construction are set forth, with numerous examples of the different types of construction. Water conductors, surge tanks, gates and valves are treated in Chapter IV and in Chapter V storage reservoirs have been given attention. In Chapter VI numerous examples of modern hydro-electric power-house construction are given as well as a discussion on the feature of design and putting the station into service. In Chapter VII hydraulic equipment, turbines, draft tubes, governor pressure regulation and flow meter are the chief subjects considered.

In Chapter VIII there are 400 pages devoted to electrical equipment in the plant, such as generators, exciters, relay protection, switching equipment, transformers, synchronous condensers, automatic regulation, etc.

Tell Economy of Powdered Fuel

H. D. Savage, of Combustion Engineering Corporation, and F. A. Scheffler, of Fuller Engineering Company, Address Metropolitan Section A.S.M.E.

THE drawing power of the subject of powdered coal was demonstrated on Nov. 20, when approximately 500 members of the Metropolitan section of the A.S.M.E. assembled to hear lectures on the subject by H. D. Savage, of the Combustion Engineering Corp., and F. A. Scheffler, of the Fuller Engineering Company.

Mr. Scheffler, who was the first to speak, told of the great activities in the pulverized-coal fields. During the year 1922, fifteen million tons of coal was pulverized in the United States and Canada. The figures for 1923 will be about seventeen and a half million tons.

Mr. Scheffler said that powdered-fuel furnaces were now designed on the basis of 7 to 10 ft. per sec. gas velocity. He understood that a special high-temperature firebrick was soon to be placed on the market at a moderate price. The use of such a brick would permit reducing furnace volume 25 to 35 per cent. The use of powdered coal is as safe as stoker firing, he claimed, if the equipment is properly designed. The distributing systems had been so far perfected that powdered coal could be forced through a pipe line one mile long. He pointed out that in making cost comparisons between stokers and powdered coal, the method of figuring often made the cost differential appear much higher than it really was. For example, there are preparation and handling costs with stokers as well as with pulverized-fuel apparatus.

Shows Operating Costs

He gave figures showing that the operating costs with pulverized coal ranged from 57c per ton for small stations to 43c for those of medium size. The corresponding figures for stoker-fired plants were 38 and 36c, leaving the extra cost of pulverizing 19 to 7c per ton. These figures do not apply to large central stations. The gain in efficiency due to pulverized coal was given as 10 per cent. for large plants and 15 per cent. for small.

In his paper on the same subject Mr. Savage stated that powdered fuel was much better established than many other innovations, such as high pressure, air heaters, bleeder heating etc. Since January, 1923, powdered-coal installations for 1,300,000 sq. ft. of boiler-heating surface had been contracted for. These were for all kinds of coal under all kinds of conditions.

Among advantages claimed for powdered coal were the ability to change the proportion instantly to meet changes in the heating value of the coal; complete oxidation of the sulphur, thus using its heat and preventing clinkers; ability to burn high-ash fuel with efficiency; ability to burn coal otherwise unavailable, thus saving on first cost and on freight.

Unfair Comparisons

As to the first cost of the plant, it was pointed out that it was unfair to make the comparison on the same total boiler-heating surface. The use of powdered coal permitted a considerable reduction in the boiler-heating surface for the same plant capacity. If proper consideration was given to such factors and comparison made between two plants, one independently designed for stokers and the other for powdered coal, the latter would show little, if any, greater first cost.

The operating costs, according to Mr. Savage, were no higher for pulverized coal. A slide was shown giving the operating costs at Lakeside station for the first nine months of 1923. Mr. Savage said the importance of the ash question had been greatly exaggerated. There were never any complaints, he said, from the neighbors. If the ash was there, it was too small to see.

Personals

Fraser S. Keith, M.E.I.C., secretary of the Engineering Institute of Canada, was the speaker at a meeting of the Montreal branch of the Institute Nov. 22. The engineering profession is too crowded to-day, Mr. Keith said. There are some 2,383 engineering students in the engineering school of this country, with 585 graduating this year, and there is not sufficient work going on to employ half of the qualified engineers looking for jobs. To relieve the situation and offset the unfavorable position in the engineering field, Mr. Keith suggested dividing the science course into two groups—one to be a four-year course leading to B.Sc., for industrial and other purposes, and the other a six-year course leading to the degree of Bachelor of Engineering.

O. O. Lefebvre, M.E.I.C., chief engineer of the Quebec Streams Commission, addressed the members of the Ottawa Branch of the Engineering Institute in the Victoria Memorial Museum, Nov. 15. Mr. Lefebvre outlined the construction and operation of storage reservoirs for power development, the financing of such undertakings, and the rates determined. Indicating the value of regulating the flow of rivers especially in their relation to industrial development, he stated that many industries during the low water period in the province could not operate but that those industries served by the storage dams the St. Maurice and St. Francis rivers were not so affected, operating for the full twelve months. Lack of water power thus curtailed production and it was the work of the commission to remedy this situation. Mr. Lefebvre announced that the Quebec Streams Commission were now investigating storage possibilities in the Gatineau river, with a view to the development of two power projects.

Dr. Charles Camsell, chairman of the Canadian Fuel Board, has just arrived in Ottawa after two and a half months in England and other parts of Europe. Dr. Camsell attended the economic conference as a delegate from Canada and devoted considerable time to investigating the advance made in Europe in the scientific utilization of coal.

W. T. BRICKENDEN, B A., Sc., A S M.E.

The Under-Feed Stoker Company of Canada, announce the following change in their personnel: W. T. Brickenden, B.A. Sc. (Honors) A.S.M.E., has been appointed chief engineer for the company; vice, D. F. Grahame, who has been transferrerd to the head office of the Sanford Riley Stoker Company of Worcester, Mass.

Mr. Brickenden, a graduate of Toronto University, Faculty of Applied Science-Mechanical Engineering, has been with the company as assistant to chief engineer since 1920 and has been engaged in research and installation work during the ensuing period.

Trade Catalogs

The R. H. Beaumont Co. of Philadelphia have published a 250-page catalog describing coal and ash handling systems for boiler houses.

The catalog is divided into four sections, the first dealing with central coal and ash handling systems, the skip hoist for coal and the skip hoist for ashes; the second section describes the coal weight lorry; section 3, the cable drag scraper and the last section, steel suspension bunkers, steel circular bunkers, double roll coal crushers, coal and ash gates and general engineering data.

The booklet is well illustrated and contains many useful suggestions and valuable data for the engineer on the handling and storage of coal and ashes. The Combustion Engineering Corporation of Toronto are the Canadian agents for The Beaumont Co.

The new 28-page Catalogue No. 1,400, just received from the American Schaeffer & Budenberg Corp. of Brooklyn, N.Y., is a complete treatise on pop, safety and relief valves and every engineer interested in the subject should procure a copy.

Of particular interest is the Model "J" high capacity pop safety valve, which is a new achievement of the company. It is a well-designed valve and, while universal in its application, is particularly suited for water tube boiler service where saturated steam not exceeding 250 lbs. pressure is encountered. Its exterior design is compact and well rounded, insuring maximum strength at all points.

The De Laval flexible coupling is described in a 12-page pamphlet issued by the De Laval Steam Turbine Company, of Trenton, N. J. This coupling, which has been developed for turbines or other motors geared or direct coupled to pumps, generators, and similar machinery, consists of two opposed flanges mounted on the driving and driven shafts respectively.

One flange carries bolts or pins which enter holes bored in the opposing flange, but not coming into metallic contact with the latter, as the driving force is transmitted through steel-lined molded rubber bushings slipped over the pins. The rubber supplies the flexibility required to take care of inevitable slight misalignment, does not require lubrication, absorbs shocks and is long lived and reliable.

There is no constraint upon independent endwise motion of the shafts, and one shaft can be removed without disturbing the other. The peripheries of the flanges are ground to true cylinders and the faces to true planes to facilitate lining up. All parts are made to limit gages and all similar parts are interchangeable.

A little booklet on modern steam pipe insulation has been issued by the Armstrong Cork and Insulating Company in which attention is directed to the development of a new material for insulating purposes.

The new covering is termed by the makers Nonpareil High Pressure Covering, and has for its basic material diatomaceous earth, (kieselguhr), for which the producers claim greatly improved efficiency over the materials generally in use for this purpose.

Diatomaceous earth is a marine deposit composed entirely of the minute shells of aquatic organisms called diatoms. These shells are practically pure silica, from which all organic matter has been dissolved, and they are hollow and so small as to be visible only when highly magnified.

This earth is found in beds often hundreds of feet thick, where age-long deposits of myriads of these tiny shells has created a firm chalk-like white substance. Its microscopic shells are hollow and form a mass of tiny air pockets so small that the air cannot circulate either within or between them, and this it is stated is such a cellular structure as will contain entrapped non-circulating air particles in the manner regarded as most efficient in heat insulation.

Other advantages claimed for this material are that it is almost pure silica, and is, therefore, insoluble in water, and its structure and composition is such that it is capable of withstanding a high degree of heat without breaking down.

Steam turbine plants will be interested in the new Uehling bulletin No. 150. It describes the combined barometer and vacuum recorder, which instrument is, in effect, an automatic log of steam turbine and condenser performance, because it records the absolute back pressure of the turbine continuously, thus showing up instantly any air leakage or other cause of reduced efficiency. This is accomplished by tracing the records of both barometric and vacuum changes on the same chart. The absolute back pressure is read directly from the vacuum record by using the barometric record as the base line.

When the vacuum fluctuations parallel the barometric fluctuations on the chart, conditions are normal, but a divergence of the two records warns the operator that immediate attention is required. The working range of the chart is expanded and hence remarkably legible. The instrument operates on the mercury column principle, consequently stays in calibration permanently, because there are no moving parts to get out of adjustment.

Copies of this bulletin may be obtained from the Uehling Instrument Co., 473 Getty Ave., Paterson, N. J.

The Republic Draft Indicator and Recorder, for which the Dominion Flow Meter Co., of Toronto, is the Canadian agent, employs a more or less novel principle in securing accuracy, according to new literature just published this week.

The operation of the indicator involves a combination of the bell float, the balance, and the plumb weight so designed as to indicate on a dial an absolute pressure independent of the level of the liquid medium. Heretofore, the bell float, sealed with liquid to form a gas holder, has been commonly used for the purpose of indicating low negative pressures or furnace drafts, and a balance must be obtained at a given level of the liquid to correspond with the zero reading of the pointer on the dial of the instrument, which level must be maintained at all times for true draft indications to be shown.

In the construction of the Republic draft indicator, the acting force of the pressure difference is resisted by a positive weight acting on a balance and not dependent on the buoyancy of the material comprising the bell.

The relationship of the angles and weights and the gear ratio is such that the hand moves one-tenth of an inch for each 1-100 of an inch of draft. The scale can consequently be read accurately to a fraction of 1-100 of an inch of water throughout its entire range of zero to minus two inches of water.

Attention is also directed in a new pamphlet to the Republic R.B. boiler meter, handled by the same company. These meters are made for two classes of plants, one using single boilers of less than 100 horsepower and the other plants employing a large number of smaller units, gradually being replaced by larger ones. To these plants it is essential that the fireman be provided with a record that will enable him to obtain the maximum efficiency from the small boilers, and the Republic R. B. meter, as its chief function, indicates to the fireman the load carried on each boiler.

The Wright-Austin Co., Detroit, have issued a booklet on boiler trimmings describing safety alarm water columns for high and low water, water gauges and try cocks, automatic pump governors and automatic boiler feed water regulators.

In the automatic alarm for high and low water, a round copper float idles on the water, two baskets are fitted inside the column, operating a valve which allows steam to blow a small whistle.

When the water in the boiler lowers sufficiently, the weight of the float on the bottom basket opens the whistle for the low water alarm. Should the boiler become too full of water the float is raised up against the top basket, its buoyancy operating the same whistle valve as for the high water alarm.

The advantages claimed for the alarm are: Prevents burning of boiler parts from low water, eliminates danger of water being carried over with the steam in case of high water, and the maintaining of the proper water level at all times, resulting in a saving of fuel.

Progress in New Power Equipment

AMMONIA COMPRESSORS

A NEW line of Canadian-built ammonia compressors in sizes of 2.5 to 42 tons has been placed on the market by the Canadian Ingersoll-Rand Co., 260 St. James St., Montreal.

These small ammonia compressors embody all of the features responsible for the success of Ingersoll-Rand air and gas compressors which have been on the market for over fifty years.

These features, including Ingersoll-Rand plate valves for ammonia inlet and discharge, exceptionally large valve and port areas, enclosed frame construction, with automatic lubrication, etc., enable the users of small ammonia compressors to obtain efficiencies only heretofore attained by large plants.

The light, high speed, automatic action of the valves, improved cylinder construction, and the well protected, properly lubricated driving ends, permit higher speeds with resultant increase in tonnage per horsepower, and per foot of floor space occupied.

An Advance in Design

These new machines are of the enclosed, horizontal, straight-line, centre-crank type, with single-stage, double-acting ammonia cylinders. The design of the frame, crank-shaft, crosshead, and other running parts, is identical with that of the small air and gas compressors and vacuum pumps manufactured by the Canadian Ingersoll-Rand Company. The construction and valving of the ammonia cylinders represent a noteworthy advance in ammonia compressor design, which is of particular interest to users of machines of up to twenty-five tons of ice, or up to forty tons of refrigeration capacity.

The Class "ERA-1" ammonia compressors are arranged for long belt or short belt drive. The smaller sizes can also be equipped with tight and loose pulleys when desired.

The Class "FRA-1" steam-driven units are equipped with a simple piston valve steam cylinder placed between the ammonia cylinder and frame. The piston valve is of the Ingersoll-Rand balanced type, similar to those used on modern locomotives, and together with the wide-range automatic cut-off governor provides for better steam economy than has hitherto been obtainable from small steam-driven machines. With this valve the valve chest gland is subject to exhaust pressure only. It also permits the use of high pressure superheated steam as well as the low pressures common in the past.

Easy to Operate

Both types of compressors are simple and self-contained, easy to operate, economical and thoroughly reliable.

A few outstanding features of design are:

The heavy one-piece enclosed dust and dirt proof main frame lends rigidity to the compressor and simplifies the foundation and installation. It also prevents waste of oil, insures cleanliness and long lived running parts.

The double-acting ammonia cylinder is of cast-iron sufficiently heavy for reboring. The cylinder barrel and heads are thoroughly water-jacketed, insuring efficient lubrication and reducing heat of compression.

The plate valves used for both intake and discharge are placed in the cylinder tangent to the bore, so as to obtain minimum clearance. Discharge valves are at the bottom of the cylinder, thus preventing any liquid ammonia from being trapped in the cylinder barrel. All sizes are equipped with a foot-piece supporting the ammonia cylinder. This foot-piece is an integral part of the cylinder and contains the discharge connection. A small cast-iron soleplate under the foot-piece facilitates removal of cylinder when desired.

Ingersoll-Rand plate valves are used on both intake and discharge. These valves are durable, light in weight, automatic and extremely quiet in operation. Large free port and lift openings offer the least possible resistance to intake or discharge of ammonia gas.

The machines are equipped with a special water-jacketed stuffing box, fitted with a special packing made up of a set of high and low pressure France metallic rings separated by a dry gas vent. An oil gland is also provided with this packing, which acts as a seal, while additional soft packing, adjustable by means of a screwed gland, prevents gas and oil leakage. The France metallic packing is of very high quality and has been particularly successful for ammonia work.

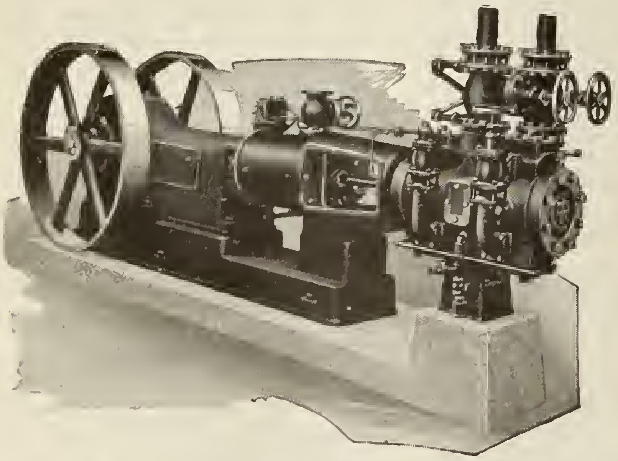
The running parts in all class "ERA" and "FRA" compressors are of very rugged construction. Crankshafts and connecting rods are one-piece drop forgings of special steel. The connecting rods are of the solid-end type with adjustable and renewable boxes. Crossheads are of the bored-guide type with adjustable bored and turned boxes.

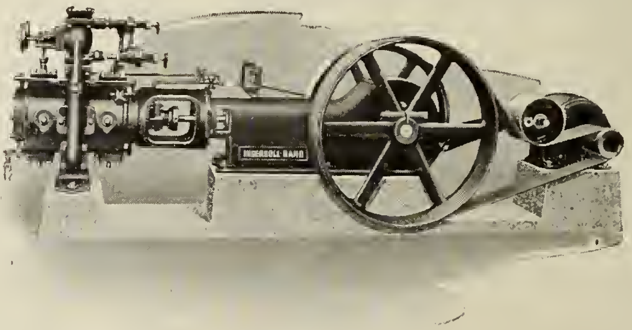
The adjustable, die-cast, removable bearing shells of genuine babbitt metal, insure smooth running and long life, and are easily and cheaply replaced when necessary.

Proportions Lubrication

Main bearings, crank and crosshead pins and crosshead guides have adjustable flood lubrication. Force feed lubrication is used for oiling ammonia cylinder, ammonia stuffing box and steam cylinders. Lubrication is automatically proportioned to the speed of the compressor at all times.

Main ammonia stop valves for both intake and discharge are furnished complete with companion flanges of regular tongue and groove construction. These valves are located next to each other





The photo on the left shows an Ingersoll-Rand Class "ERA-1" straight-line, belt-driven, single stage, double-acting ammonia compressor. On the right is shown an Ingersoll-Rand, class "FRA" ammonia compressor, with short belt motor-drive attachment.

De Laval Oil Purifiers

Insure your Diesels or turbines against damage resulting from keeping inefficient oil in service. They maintain the original characteristics of the oil so that it may be used indefinitely.

No matter whether De Laval Purifiers are considered as a means of saving oil or as a means of protecting engines, they are certain to show greater savings than any other method of purification. The reason is that they effect the removal of impurities by a centrifugal force which is several thousand times greater than the force of gravity—until recently the only moderately successful and economical method of purifying oil.

Write for Bulletin No. 105 which tells how De Laval Oil Purifiers save enough money to pay for themselves.

The De Laval Company,
Limited
Peterborough, Ont.

Montreal Edmonton
Winnipeg Vancouver

Safety Plastic METALLIC PACKING

Self-Lubricating
Practically Frictionless

In Cotton Tubes.

Made of an alloy of the finest anti-friction metals, and the best lubricating materials which always remain in the packing; we have records to show that it has been in constant use in many engines, pumps, compressors, expansion joints, valves, etc., for over 12 years, giving consistent satisfaction.

Packing in bulk.

GUARANTED TO LAST THREE YEARS WITHOUT RENEWAL

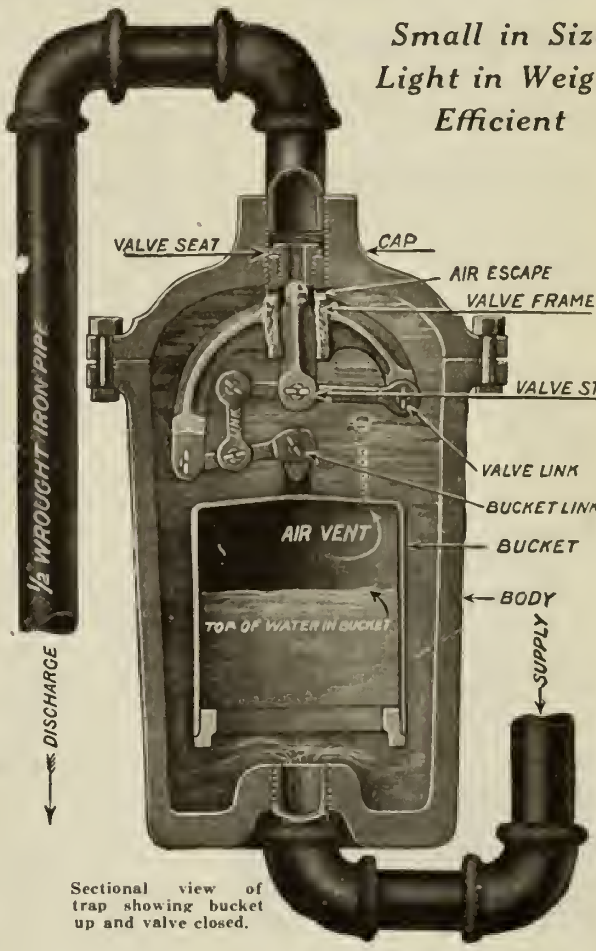
Let us send you further interesting details also about our "Safety" Superheat Sheet Packing.

Steel Mill Packing Co.
Windsor Ontario

Established 1899 *Agents wanted*

ARMSTRONG STEAM TRAP

Small in Size
Light in Weight
Efficient



Sectional view of trap showing bucket up and valve closed.

Advantages of the Armstrong

Greater Capacity	Than any trap of equal size. Powerful leverage insures full opening of valves.
Self-Scrubbing	Discharge is at the top, so accumulation of oil, sediment, etc., is washed out by high velocity discharge.
Cannot Pass Steam	Closure is positive; steam is trapped in bucket which floats and closes valve.
Action Quick and Positive	Both in closing and opening valve, due to quick passing of point of balance of the bucket.
Non Air-Binding	Port permits positive discharge of air and incondensible gases.
Small Size	Easily supported by any line.
Low Cost	Without sacrificing high quality, because of simplicity.

Write for Catalogue

THE ARTHUR S. LEITCH CO.
LIMITED
1001-2 Kent Building, Toronto, Ont.

M. BARRY WATSON
B.A. Sc., C.E., M.E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W

J. A. BURNETT,
M.E.I.C., P.E.Q.
CONSULTING
AND APPRAISAL
ENGINEER
Room 301—205 St. James St.
Telephone Main 6737. Montreal.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.
It will help you with your daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.
AUDEL'S ENGINEERS & MECHANICS GUIDES
4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE
These Guides tell you all about—
Theory, Practice and **Operation** of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines --the Indicator --Lubrication --PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE. STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-C02 Recorders-Construction of all types of Boilers,--Mechanica Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught --HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers --Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.
SHIPPED TO YOU FREE
Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.
SEND NO MONEY
THEO. AUDEL & CO.,
72 Fifth Ave., N. Y.
Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you , 1 monthly until $12 is paid.
Signature ____________
Occupation ____________
Employed by ____________
Residence ____________
Reference ____________

above the cylinder where they can be conveniently handled.

A special large by-pass valve is provided for complete unloading when starting, so as to prevent excessive current inrush and overloading of the motor.

A spring loaded safety or relief valve is connected to the discharge passage of the cylinder, and the blow-off of this valve is piped back to the cylinder intake.

Pump-out piping is furnished complete with necessary valves and fittings.

Thermometer wells, thermometers and indicator connections are also provided.

The Canadian Ingersoll-Rand Company also announce the publication of bulletin K-214, describing these units. Copies of this bulletin will be sent to any reader on request.

The company also builds at its Sherbrooke plant a complete line of duplex ammonia compressors for steam, belt, oil engine or direct-connected electric motor drive, suitable for larger plants.

A CONDENSATION PUMP

About three to five years ago various makes of electric automatic centrifugal pumps with the usual type of horizontal receiver, elevated six to ten inches above the pump, were placed on the market and found to fill requirements of low first cost, inexpensive operation and dependability.

The difficulty with the original design of these outfits, however, was that the vertical height was such that to flow all condensation by gravity into the receiver it was necessary to place the outfit in a pit, an undesirable location on account of dirt, heat and moisture affecting the electrical equipment. This has now been overcome and eliminated in a new design offered by the Canadian Buffalo Forge Co., Kitchener.

This vertical condensation pump is of the vertical shaft type, submerged in a 40-gallon oblong receiving tank which may be sunk in concrete and given no further thought as the motor is elevated above the floor level as is also the float switch.

All parts of the pump itself are carried or suspended from the cover plate which is conveniently removable, is of comparatively small weight and may be easily lifted off for cleaning or inspection of pump, pit, or float. The float is spherical, seamless copper, ten inches in diameter, carrying a tobin bronze rod passing through gland and stuffing box and actuating the float switch.

Leakage of steam cannot occur around the pump shaft which is fully enclosed between pump casing and cover plate in tight pipe casing. Weight of moving parts are carried on a high grade self-aligning ball bearing, the pump shaft being connected to the motor shaft through a flexible coupling.

The Ever Tyte Piston Ring Division of the Walter A. Zelnicker Supply Co., St. Louis, have issued a pamphlet describing Ever-Tyte and Zelco piston rings.

The rings are of special three-piece construction, and are covered on face with a coating of metal, usually zinc, except when the rings work in ammonia, lead is then used.

The advantages claimed for the ring are: expansion from three points assuring a correct fit in the cylinder, a right-angle interlock which keeps the three members of the ring from spreading and wearing, independent seats in the groove, and the zinc or lead coating on the face wears quickly to a good seat, the metal filling up the pores of the cylinder wall and giving a glazed surface.

Belliss & Morcom, Birmingham, Eng., have issued two pamphlets; one, No. X, describing gas compressors and air pumps, the other, No. 1, emphasizing full economy or the production of cheap power in conjunction with heating and drying by exhaust steam.

The gas compressors are built in various sizes and types with as many as five stages. The pressures for which the compressors are built vary from low to as high as the 3,000 lb. per sq. in. required for compressing air for torpedoes and for compressing gases such as oxygen and acetylene for shipment in steel containers.

The vacuum pumps are made in either the wet or the dry types. In the wet vacuum pump all parts are made of gunmetal with the exception of the valves and the piston rod, which is of stainless steel.

Pamphlet No. 1 contains interesting information on the possibilities of saving in fuel by the utilization of exhaust steam from engines for heating buildings and for process work. Numerous examples are given of actual savings made by manufacturing concerns, which either allowed their exhaust steam to go to waste or used steam solely for heating and purchased their power from a central station.

The pamphlet contains information and tables of interest to engineers on: h.p. from engines per 10,000 lb. of dry steam per hour under various inlet and exhaust pressures, typical lay-out of combined power and heating installation, pass-out engines and turbines, steam pipes, receivers, the flow of saturated steam in pipes, cylinder lubrication, removing oil, heating the feed water, etc.

Announcements

The National Association of Practical & Refrigerating Engineers has sent out the tentative program for its Fourteenth Annual Convention and Exhibition which is to be held in Memphis, Tenn., Dec. 12-15.

Papers of interest to Power House readers are as follows: "Open Brine Refrigerating Systems," by S. C. Bloom; "High-Speed Compressor Valves," by J. H. H. Voss; "Internal-Combustion Engines in Ice and Refrigerating Plants," by A. E. Park; "Evaporating Systems for Refrigerants," by W. F. Davis; "Railway Refrigerator Car Icing Systems," by A. L. Blatti; "Amount of Ammonia Required for Initial Charges," by J. Laichinger; "Cooling Water for Ice Making and Refrigerating Plants," by J. P. Lawlor; "Control of Electrical Equipment in Ice Making and Refrigerating Plants," by H. P. Hill.

"Some Causes and Remedies for

(Continued on page 46)

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—with house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

POWER PLANT FOR VILLAGE OF TIGNISH About 18 kil. hour capacity 110 to 220 volting alternating current. Apply to John A. Hackett, Box 67, Tignish, P. E. I.

EQUIPMENT FOR SALE

FOR SALE—ONE CANADIAN GENERAL belt driven, direct current generator, 115 to 125 volts, capacity 360 amperes, speed 975 R.P.M's.; also a quantity of used shafting and pulleys. Apply to Box 114, Power House.

SAW MILL MACHINERY FOR PORTABLE medium and heavy mills, band or circular; we build everything for the saw mill from haul-up to sorting table. The Waterous Engine Works, Ltd., Brantford.

TAYLOR SAFE FOR SALE—INSIDE DIMENsions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110, Power House

For Quick Sale

Self-oiling high speed engine, single cylinder 17 in. bore x 16 in. stroke. Engine develops 200 H.P. when running at 235 R.P.M. with 100 lbs. steam pressure. There are two heavy leather belts 18 in. wide. The engine has two fly-wheels, each 78 in. diameter x 18 in. face. Apply **Box 112, Power House.**

PISTON RINGS

EVER-TYTE and ZELCO Piston Rings with Patented Zelco Process Save Gasoline, Oil, Increase Capacity, Prevent Cylinder from Wearing Out of Round, Lessen Carbon; after using, make arrangement with us to sell them; made up to 80-inch; used in Locomotives, Boats, Engines, Compressors, Ice Machines, Autos, Trucks, Tractors, etc.; are looking for distributors with mechanical knowledge; all or part time; real opportunity. Ever-Tyte, St. Louis, Mo.

BOILER LAW

(Continued from page 31)

All agreed with section 9: "No person shall act as an inspector of boilers unless he has passed a satisfactory written examination before a board . . . ."

This section would cancel inspection of boilers by a stationary engineer unless he had passed the examination, and would require all inspectors, whether government or insurance companies, to pass the test.

A penalty is provided for failure to answer pertinent questions of the inspector.

The matter of uniform inspection fee was thoroughly discussed but no action was taken, as it was considered a problem for the department to work out. It is understood that the department is considering a flat inspection fee for the whole province.

The penalty for tampering with safety valves brought forth comment, Mr. Roberts contending that a minimum penalty of $200 was justifiable.

"The penalty for such conduct on the part of the engineer or fireman can not be made too severe."

ENGINEERING LESSONS

(Continued from page 33)

made of the amount of hard scale and soft mud in the boiler, also a sample of each should be saved for the inspector, as these may help him in determining the cause of certain weakening, etc., in the boiler, and he may be able to suggest remedies, such as feed water treatment.

Removing Hard Scale

Hard scale in a boiler may have to be removed by means of a hammer and chisel. In doing this work great care must be taken not to cut or scratch the boiler plate, because corrosion always takes place in a cut or scratch faster than on a flat surface, the deeper the cut the faster the corrosion takes place. Special care should be taken in working around the joints in order not to disturb the condition of the caulking or the rivet heads. At the same time, particular attention must be paid to getting these points thoroughly clean so the inspector can see at a glance the condition of the plates and rivets. Most corrosion and weakening of the plates takes place at the joints. This is probably on account of the original working on the plates; punching, drilling and caulking at these points, which has made these parts more susceptible to corrosion, as pointed out above.

As a rule it is better to remove as much of the scale and dirt as possible by means of scrapers before resorting to the hammer and chisel, which should only be used in the most obstinate cases. The scale can be removed from the tubes by any of the tools on the market for this purpose.

Naturally, all the dirt should be removed from the inside of the boiler, and the inside left as nearly dry as possible for the inspector.

Extraordinary BARGAINS

Steam Engines

1 Goldie & McCulloch heavy duty, cross compound, latest type Corliss condensing engine with rope drive, line shaft pulley and idlers complete, equipped with Dean condenser. Cylinders are 20"x40"x42" stroke. Water heater included.

1 Robb-Armstrong 11"x14" high speed automatic engine, direct connected to a Westinghouse 70 k.w., 3 phase, 60 cycle, 220 volt generator, complete with exciter and marble control panel.

Also several smaller automatic engines and some air hoists from 4" to 10½".

Chain Blocks

2 15-ton Herbert Morris chain blocks with trolleys.

1 10-ton Herbert Morris chain block with trolley.

Water Tube Boilers

2 250 h.p., 175 lbs. working pressure, government certificate. Everything complete and in first-class condition.

SPECIAL

One Jenny Electric Co. push button control complete, in first-class condition, capacity up to a double width sextuple press. This is a rare bargain. For quick sale.

Get full particulars and remarkably low prices from

Wm. Coates
Mail Building
Toronto, Ont.

ANNOUNCEMENTS

(Continued from page 44)

Cracked and Checked Ice," by Erle Ormsby; "Improvements of Ice Plants," by R. C. Doremus; "The Operation of the Absorption of Refrigerating Plants," by G. A. Pardee; "Cold Storage Refrigeration," by Charles W. Chapman; "Raw-Water Ice Making Systems," by Van Rensselaer H. Greene; "Safety Movements and Devices in the Refrigerating Industry," by M. F. Nicholson; "Relation of Education and Engineering," by Harry Sloan; "Latest Data on Some Common Refrigerants," by William H. Motz; "Burning of Oil Under Power Boilers," by R. F. Burke; "New and Suggested Forms of Ammonia Condensers," by Thomas Shipley.

The B. F. Sturtevant Co. of Boston announce the opening of a new plant at Camden, N.J., for the manufacture of sheet-metal work for the installation of sheet metal fan systems including heating, ventilating, drying, exhaust, and conveying work, as well as guards for machines, pulleys and gears.

In addition a stock of standard equipment such as propeller, monogram and planing mill fans, steel pressure blowers, turbo undergrate blowers, blast gates, etc., will be carried.

WORLD POWER CONFERENCE

In connection with the British Empire Exhibition at Wembley, London, next summer, there will be held during July a World Power Conference, which is being arranged by the British Electrical and Allied Manufacturers' Association.

The object of the conference will be to consider how the industrial and scientific sources of power may be adjusted nationally and internationally.

In response to the invitation for Canadian participation, the Hon. Charles Stewart, Minister of the Interior, sent J. B. Challies, his director of water power, to London to confer with the British authorities with a view to having the Dominion's co-operation made both adequate to Canada's unique achievements in hydro-electric matters, and acceptable to the plans of the British committee.

Miscellaneous

Town council, Brockville, Ont., are receiving prices on gas engines for a hydro-electric station.

Price Bros. & Co., 56 St. Pierre St., Quebec, are in the market for equipment for a hydro-electric power house on the Chicoutimi River.

The Empire State Ice Co., Michigan Central Yards, Windsor, contemplate the installation of three ice making machines, electric motors, special refrigeration equipment and brine pumps for an ice plant to supply refrigerator cars. Estimated cost, $100,000.

The Sisters of Jesus and Mary, Outremont, contemplate removing their mother house to Outremont from Hochelaga.

The International Electric Co., Stewart, B. C., contemplate the construction of a hydro-electric plant. Estimated cost $50,000.

Kerry & Chase, Ltd., Toronto, are preparing plans for the construction of a $50,000 electric sub-station for the Hollinger Consolidated Gold Mines, Timmins, Ont.

Dr. L. W. McKeehan, of the research laboratory of the Western Electric Co., N. Y., spoke Nov. 27, in the Physics building, University of Toronto, on "the electrical and other properties of metals as related to the arrangement of their atoms." The lecture was given under the auspices of the Royal Canadian Institute.

H. D. Savage, of the Combustion Engineering Co., in an address on the subject of fuel before the Toronto branch of the Engineering Institute Nov. 20, declared that if Canada would use "pulverized coal," which increased fuel efficiency 25 per cent., it would be unnecessary to import anthracite from the United States.

In This Issue

Editorial Point of View 21
By Campbell Bradshaw
Combustion Problems of Canada ... 22
By Thomas H. Marsh
Operating the Steam Engine 25
By Charles L. Hubbard
U. C. C. of E. Banquet 29
Hamilton Members Entertained at Toronto
Boiler Law Revision Looms 30
Power House Stand Endorsed at Ontario Conference
Easy Engineering Lessons 32
Continuation of Series by M. Barry Watson, B.A., Sc., M.E.
Pipe Lines 33
Electricity in the Power House 34
By J. A. Burnett, M.E.I.C., Consulting Engineer.
Convention Notes 34
Practical Ideas 35
Repairs Draft Gage
Repairing a Crankpin
Oil Burning Layout
Locking Nut
Packing Hydraulic Rams
Movies Feature Power Show 36
Everyday Problems With Answers .. 37
Leaking Traps
Indirect Piston Valves
Setting Valves
Water in Fuel Oil
Freezing Traps
Centrifugals in Series
Check Valve-Leakage
Suction Lift
Comments in the Power Plant Field. 39
Tell Economy of Powdered Fuel ... 40
H. D. Savage and F. A. Scheffler Address A.S.M.E.
Trade Catalogs 41
New Power Plant Equipment .42
Ammonia Compressors
Announcements 44

Hugh Marriott, of the Institute of Mining and Metallurgy, London, Eng., gave an address Nov. 26, to students of all branches of engineering at McGill University.

The Essex Border Utilities Commission, Windsor, is receiving bids for the construction of a pump house, pipe lines and filtration equipment. Estimated cost $150,000. Engineer, J. C. Smith.

The West Kootenay Power & Light Co., a subsidiary of the Consolidated Mining & Smelting Co., is practically doubling the capacity of its plant at Bonnington Falls, near Nelson, B. C.

The Quebec Provincial Government contemplate the construction of a dam at Calumet on the north branch of the Ottawa River. The work will be supervised by the Running Streams Commission.

The Town Council, Oshawa, is in the market for a 1000 g.p.m., 3 stage centrifugal pump to work against a head of 340 ft., direct connected to a 60 cycle, 550 volt squirrel cage induction motor. W. C. Smith, engineer.

Robert S. Whipple, M.I.E.E.F., Inst. P., managing director of the Cambridge and Paul Instrument Co., of England, was the speaker at a luncheon of the Ottawa branch of the Engineering Institute of Canada, at the Chateau Laurier, Nov. 13. Mr. Whipple, who is an international authority on scientific instruments, emphasized the importance of scientific instruments in all lines of endeavor.

"Inductive co-operation as a practical problem," was the subject of an interesting paper delivered before the Montreal branch of the Engineering Institute of Canada by J. L. Clarke, B. Sc., A.M.E.I.C., at its meeting Nov. 15. Election of officers resulted in the choice of O. O. Lefebvre, M.E.I.C., as chairman for the ensuing year and other officers elected were: Vice-chairman, Lt.-Col. Robert Bickerdike, Jr., D.S.O., M.E.I.C., and J. L. Bushfield, M.E.I.C.; executive committee: Messrs. Wm. C. Adams. M. E. I. C., J. Chambers, M.E.I.C., Prof. C. V. Christie, A.M.E.I.C., Aime Cousineau, A.M.E.I.C., P. S. Gregory, A.M.E. I.C., and F.C. Laberge, A.M.E.I.C.

Forty Members of the sales staff of Nesbitt, Thompson & Co., Montreal, the firm who recently purchased the Ottawa and Hull Power Co. and allied interests, inspected the power plant at the Chaudiere Nov. 19. The Ottawa and Hull Co. are planning another addition to its power plant, but as this power has been contracted for in advance, it will not add anything to the available power for the district. The company has a power plant at Calumet Falls, 50 miles up the river, which is now being developed. Plans provide for three installations which will allow a total of 67,500 horse power. Contract for the initial unit has already been let to Fraser, Brace and Co., and the work is well under way.

PRATT & CADY VALVES

P. & C. Swing Checks are made in the regrinding type and with renewable asbestos, rubber or leather discs. They have a full port opening and may be used in either the vertical or horizontal position.

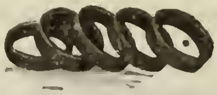
The Swing Type of check valve was first patented by Pratt & Cady in 1878.

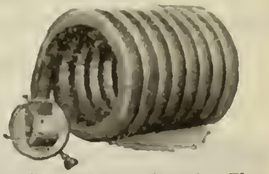
Reading Steel Casting Co., Inc.
Pratt & Cady Division
General Sales Office: Bridgeport, Conn.
929 Connecticut Avenue
CANADIAN REPRESENTATIVES—CANADIAN FAIRBANKS-MORSE CO., Montreal, Canada.

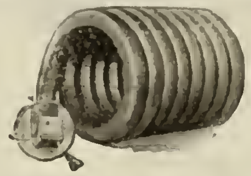
A COMPLETE SERVICE IN
"John Crane"
FLEXIBLE METALLIC PACKING
"MADE IN CANADA"

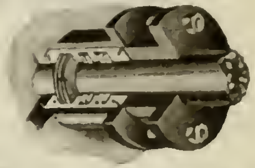
Style 100: Babbitt foil, impregnated with purest graphite and wrapped spirally. Flexible, uniform, compressible.

Style 104: Special Ammonia Sets Alternate rings Styles 100 and 400 Speeds to 450 f.p.m.

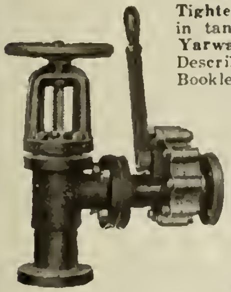

Style 601: Condenser tube packing. Patented. Keeps condensers tight. Will not crush or deform tubes.


Style 300: Asbestos channel. Flexible metallic wearing face. For steam, air, gas under high pressure.


Style 400: Duck channel. Flexible metallic wearing face. For plunger pumps, etc., hot and cold water.


Style 801: Floating type inside split case. For use on rising and falling rods. Max. steam pressure 300 lbs.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordeva Street, Vancouver, B. C.


Yarway Double-Tightening Valve in tandem with Yarway Seatless. Described in Booklet B-410.

YARWAY SEATLESS BLOW-OFF VALVES are giving unusual service in the plant of the New Castle Leather Manufacturing Company, of Wilmington, Delaware.

Not One Cent for Repairs Nor a Moment's Trouble

A good record is the usual thing for a Yarway Seatless Blow-Off Valve.

A letter of August 31, 1922, signed by Howard C. Kilmon, Chief Engineer of New Castle Leather Manufacturing Co., of Wilmington, Delaware, states: "We have been using Yarway Seatless Blow-Off Valves on four of our five boilers for more than a year. They have not cost us one cent for repairs nor given us a moment's trouble in any way, and we have never known one of them to leak. We are installing at the present time larger boilers of a different type and Yarway Blow-Off Valves will be used on all of our new boilers."

The average good service—often with no repairs—of from eight to ten years of the Yarway Seatless Blow-Off Valve is made possible by its construction. It withstands the destructive action of mud, grit and sediment under high pressure.

Yarway Seatless Blow-Off Valve (formerly the Simplex). Described in Booklet B-410.

The Yarway Seatless and the Yarway Double-Tightening Valve are fully described in Booklet B-410. We would like to send you a copy.

YARWAY

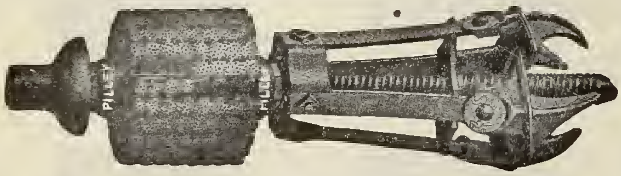
Yarnall-Waring Co.
Mermaid Lane & Ardleigh St., Philadelphia
207 St. James St., MONTREAL. 400 Penobscott Bldg., DETROIT.

POWER PLANT DEVICES *to save fuel*

YARWAY BLOW-OFF VALVES—YARWAY SPRAY NOZZLES—YARWAY-LEA V-NOTCH METERS

HINTS TO BUYERS

The Simplest and best cleaner on the market is

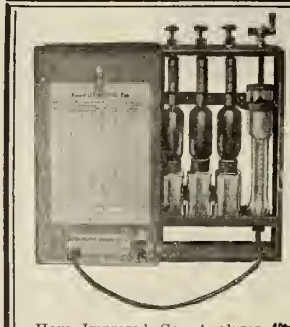


PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For Sale by Leading Canadian Jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG CO.
623 South Third Street. St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.



Hays Improved Gas Analyzer

compact — rugged — accurate, employs the Hays patented steel wool method of breaking up the gas and presenting a large absorption surface—the most accurate and rapid known. CO2 analysis can be made in 30 seconds, complete analysis for CO2 O2 and CO in 4 minutes.

No troublesome pinch clamps and rubber connections, no glass cocks to stick. We use a special needle valve with renewable seat.

Neat leather carrying cases for Consulting and service engineers.

Better send for Literature.

Hays Improved Gas Analyzer

AGENTS: P. A. Goepel, Vancouver, B.C.; Wm. A. Goold, Winnipeg, Man.; H. N. Brown, New Glasgow, N.S.; General Engineering Co., Reg'd., Montreal, Que.; The Arthur S. Leitch Co., Ltd., Toronto, Ont.

The Jos. W. Hays Corporation
Combustion Efficiency
Appliances
1034 E. Eighth Street
MICHIGAN CITY, INDIANA

BOICO BOILER COMPOUND

routs the most stubborn cases of boiler formations, quickly, thoroughly and economically. Hurts nothing but scale.

ANTI-CLINKER SHELL BAR GRATE

Ample air space gives perfect combustion ensuring maximum heat. without waste, from the last bit of fuel.

ONE-PIECE JOINTLESS FURNACE LINING

"Plibrico" gives your furnace greater resistance. Lasts longer and installed quicker than brick.

TIP-IT PATENT WELDING PROCESS

Tools with shanks of carbon and high-speed steel tips save time and money.

SHELL-BAR BOICO
Supply, Limited
1-15 Saunders Ave., Toronto

Sales Agents: Mill Supply Dept., Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

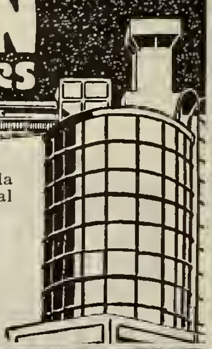
Make Good With
Your Product
and Then
Advertising Can
Make Good for You

LADD WATER TUBE BOILER

LADD
WATER TUBE BOILER
COMBINES PERMANENT ECONOMY OF OPERATION WITH UNUSUAL ADAPTABILITY TO ANY INSTALLATION REQUIREMENTS.
DESCRIPTIVE CATALOGUE ON REQUEST.

GEORGE T. LADD COMPANY
First National Bank Bldg. PITTSBURGH, PA.
CHICAGO OFFICE: 529 MC CORMICK BLDG. CHICAGO, ILL.

AMERICAN STEAM ASH CONVEYORS



75% of all steam jet ash conveyors in Canada are American. Satisfactory and economical performance guaranteed. Ask for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Edmonton, Calgary.
WM. A. GOOLD, Winnipeg.
T. M. GRINDLEY Co., Vancouver.

CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

HEPBURN CRANES

Electric Hoist or Chain Block

These easily manipulated, well-built cranes will prove a decided saving in the Power House. Hand cranes can be supplied for a moderate outlay. And while you are at it—What about pumps?
We make all kinds Centrifugal—Steam Simplex and Duplex, and Power Pumps.

JOHN T. HEPBURN, LIMITED
Engineers and Iron Founders
18-60 VAN HORNE STREET - TORONTO, CANADA

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is **economical.** British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

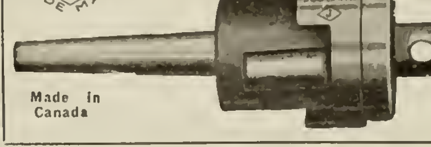
JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

NORTHERN CRANES

NORTHERN CRANE WORKS, LTD.
Walkerville, Ont.

REGISTERED J TRADE MARK

Jardine's Self-feeding Tube Expanders



All have properly case-hardened bodies and are self-feeding and self releasing. By reversing position of mandrel it is withdrawn without danger of breaking mandrel or straining expander

Made in Canada

A. B. Jardine & Co., Ltd.
Hespeler, Ont.

EDWARD VALVES

Valves for high pressures and superheated steam.
Write for catalogue.
THE EDWARD VALVE & MFG. CO.
Main Office and Works: East Chicago, Indiana.
CANADIAN AGENTS: Lytle Engineering Co., Ltd., Montreal.
Valve Engineering Co., Toronto.

BOILER SETTINGS

SPECIALISTS IN
FIREBRICK AND ARCHWORK
FOR EVERY TYPE OF STEAM BOILER

A. E. RULE COY.
122 Garden Ave. TORONTO Lakeside 1274

INVESTIGATE THE
ADVERTISEMENTS
APPEARING IN EVERY ISSUE OF
POWER HOUSE

SIL-O-CEL PREVENTS HEAT PENETRATION **INSULATION**

SAVES FUEL—Maintains Uniform Temperature. In world wide service on all types of high temperature equipment. Write for Bulletin W-6C

CELITE PRODUCTS LIMITED
New Birks Bldg., MONTREAL, QUE.

SUPERHEATERS ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES, EXHAUST STEAM INJECTORS.

MADE IN CANADA THE SUPERHEATER CO. LIMITED, Transportation Bldg., Montreal WORKS AT SHERBROOKE, QUE.

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you.

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
H. Mueller Mfg. Co., Ltd., Sarnia, Ont.

AIR COMPRESSORS
Laurier & Lamb Co., Montreal.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Teronto.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal,
American Steam Pump Co., Battle Creek, Michigan.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto.

AIR FILTERS
Midwest Canada, Ltd., Montreal.

ALARMS (LOW WATER)
Bristol Co., Waterbury, Conn.
James Morrison Brass Mfg. Co., Ltd., Toronto.

AMMETERS
Bristol Co., Waterbury, Conn.

AMMONIA COMPRESSORS
The Vitter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

ASH CONVEYORS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal, Que.
Heat Automatic Damper Control.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BEARINGS
Can. Fairbanks-Morse Co., Ltd., Montreal
Beveridge Supply Co., Montreal, Que.

BELT LACING
Bristol Co., Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
D. K. McLaren Ltd., Montreal.
Dominion Belting Co., Hamilton.
L. F. Smidth & Co., New York.

BELTING LINK
Can. Fairbanks-Morse Co., Ltd., Montreal.
Link-Belt Ltd., Toronto, Ont.

BELTING, ROLLER
Hans Renold of Canada, Ltd., Montreal and Toronto.

BELTING, RUBBER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Dunlop Tire & Rubber Co., Ltd., Toronto.
Gutta Percha & Rubber Co., Ltd., Toronto.

BLOWERS, TURBINE
Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BLOWERS, FAN
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
De Laval Steam Turbine Co., Trenton, New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
Canadian Blower & Forge Co., Kitchener, Ont.
De Laval Steam Turbine Co., Trenton New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BOILER TUBE CLEANERS
Pilley Packing & Flue Brush Co., St. Louis, Mo.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd. Toronto.

BOILER COMPOUNDS
G. F. Sterne & Sons, Ltd., Brantford.
H. P. Stephens, Toronto.
Shell Bar Boico Co., Toronto.
Refinite Co. of Can., Ltd., Toronto.
Kirby & Co., Toronto.

BOILER TUBES
Babcock & Wilcox, Ltd., Montreal.

BOILER SETTINGS
A. E. Rule Co., Toronto.
Beveridge Supply Co., Montreal, Que.
Gates Engineering Co., Ltd., Montreal.
Celite Prodcuts, Ltd., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto, Ont.
Shell Bar Boico Co., Ltd., Toronto.
Sterne & Sons, G. F., Brantford, Ont.
W. R. Sexton Boiler Setting Co., Toronto.

BOILERS, HEATING
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Waterous Engine Works, Brantford.

BOILERS, RETURN TUBULAR
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOILERS, VERTICAL WATER TUBE
Geo. T. Ladd Co., Pittsburgh, Pa.

BOILERS, WATER TUBE
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOXES, STEEL, FOR ELECTRIC SERVICE
Canadian Drill & Electric Box Co., Ltd., Toronto.

BREECHINGS
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Engineering & Machine Works of Canada, St. Catharines, Ont.

BRICK, FIRE
Goldie & McCulloch Co., Ltd., Galt, Ont.
Elk Firebrick Co., Ltd., Hamilton, Ont.
Sexton Boiler Setting Co., W. R., Toronto, Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.

BRICK, INSULATING
Celite Products, Ltd., Chicago, Ill.

CABINETS, LIGHTING
Canadian Drill & Electric Box Co., Ltd., Toronto.

CALORIMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

CASTINGS, BRASS & IRON
Canadian Steam Boiler & Equipment Co., Ltd., Toronto.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Kerr Engine Co., Ltd., Walkerville, Ont.
Gollie & McCulloch Co., Ltd., Galt, Ont.

CASTINGS, GREY IRON
Velter Mfg. Co., Milwaukee, Wis.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CEMENT, ASBESTOS
Sterne & Sons, G. F., Brantford, Ont.

CEMENT, IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

CEMENT, FIRE BRICK
Sterne & Sons, G. F., Brantford, Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.

CHAINS (See sprockets and chains)
Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, DRIVING
Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, ROLLER
Hans Renold of Canada, Ltd., Montreal and Toronto.

CIRCUIT BREAKERS
Dominion Engineering Agency, Ltd., Toronto.

COAL AND ASH HANDLING MACHINERY
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COAL CRUSHERS
Babcock & Wilcox, Ltd., Montreal.
Canada Stoker Company, Ltd., Toronto and Galt.
The Canadian-Fairbanks Morse Co., Ltd., Montreal.

COAL PULVERIZING EQUIPMENT
Combustion Engineering Corp., Ltd., Toronto.

COCKS, BRASS & IRON
Homestead Valve Mfg. Co., Homestead, Pa.
James Morrison Brass Mfg. Co., Ltd., Toronto.

COCKS, GAGE
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COCKS, STEAM
James Morrison Brass Mfg. Co., Ltd., Toronto.

CO2 RECORDERS AND FLUE GAS ANALYSIS INSTRUMENTS
Sarco Co., Inc., N. Y.
Foxboro Co., Inc., Foxboro, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal.

CONDENSERS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine, Toronto.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

CONDENSERS (JET)
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Galt, Ont.

CONDENSERS (SURFACE)
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CONVEYORS (SEE COAL AND ASH HANDLING MACHINERY)
Babcock & Wilcox, Ltd., Montreal.

COUPLINGS, FLEXIBLE SHAFT
De Laval Steam Turbine Co., Trentnn, New Jersey.

COUPLINGS, SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

CRANES
Babcock & Wilcox, Ltd., Montreal.
John T. Hepburn, Ltd., Toronto.

DEALERS (MACHINERY)
Can. Fairbanks-Morse Co., Ltd., Montreal.

DISTILLING APPARATUS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.

DISTRIBUTING BOARDS
Can. Drill and Electric Box Co., Ldt,. Toronto.

DRILLS
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

EJECTORS
Laurie & Lamb Co., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ELECTRIC GENERATING SETS (STEAM ENGINE)
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton, Ont.
Laurie & Lamb Co., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC GEN. SETS—(Steam Turbine)
Can. General Elec. Co., Ltd., Toronto.
Can. Westinghouse Co., Ltd., Hamilton.
Laurie & Lamb Co., Montreal.
E. Laurie & Co., Montreal.
De Laval Steam Turbine Co., Trenton,
Turbine Euipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC MOTORS
Can. General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

ENGINES, DIESEL
Laurie & Lamb Co., Montreal.

ENGINES, CORLISS
Laurie & Lamb Co., Montreal.
Frick Co., Wanesboro, Pa.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, GAS & OIL
Laurie & Lamb Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, PUMPING
Laurie & Lamb Co., Montreal.

ENGINES, STEAM
Can. Sirocco Co., Ltd., Windsor, Ont.
Laurie & Lamb Co., Montreal.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ENGINES, UNA-FLOW
Vilter Mfg. Co., Milwaukee, Wis.
Frick Co., Wanesboro, Pa.

ENGINE REPAIRS
Goldie & McCulloch Co., Ltd., Galt, Ont

EXPANSION JOINTS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FANS (SEE BLOWERS, FAN)
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

FEED WATER HEATERS
Arthur S. Leitch, Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont
Sims Company, Erie, Pa.

FEED WATER PURIFIERS
Sterne & Sons, G. F., Brautford, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

FILTERS, FEED WATER
Babcock & Wilcox, Ltd., Montreal.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

FILTERS, OIL
Babcock & Wilcox, Ltd., Montreal.
Turbine Equipment Co., Ltd., Toronto.

FILTERS, WATER
Laurie & Lamb Co., Montreal.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

FIRE BRICK ARCHES
Combustion Engineering Corp., Ltd., Toronto.

FITTINGS, AMMONIA
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

FITTINGS, PIPE
International Malleable Co., Guelph, Ont.

FITTINGS, STEEL
Reading Steel Casting Co., Bridgeport, Conn

FITTINGS, CAST IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

FLOATS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FUEL OIL SYSTEMS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
T. J. Cunerty Co., Toronto.

FURNACES
Can. Sirocco Co., Ltd., Windsor, Ont.

FURNACE ARCHES, FLAT SUSPENDED
Canada Stoker Co., Ltd., Toronto and Galt.
Bell Fire Brick Co., Toronto.
Shell Bar Boico Co., Ltd., Toronto.
Gates Engineering Co., Ltd., Montreal.

FURNACE LININGS
Shell Bar Boico Supply Ltd., Toronto, Ont.
G. F. Sterne & Sons, Ltd., Brantford, Ont.

GAGE COCKS (SEE COCKS GAGE)
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASS GUARDS
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASSES
Durabla Mfg. Co., New York City.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, DIFFERENTIAL
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

GAGES, DRAFT
Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd. Toronto.

Use

PLIBRICO

for Repairs, During the Christmas Shut-down.

Power costs show a large increase in fuel consumption, at this season, due to short-circuiting of hot gases, where PLIBRICO is not used as a furnace lining.

Minimize this loss by installing a monolithic jointless furnace lining.

Start the new year right.

YOUR POWER PLANT IS THE HEART OF YOUR BUSINESS

Beveridge Supply Co.
LIMITED
628-630 St. Paul St., West
MONTREAL

Stocked also in Toronto, Winnipeg and Vancouver

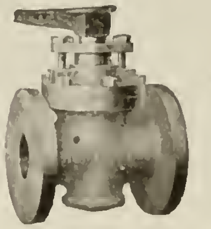
HOMESTEAD

Quarter-Turn Valves

Economy!

A valve to be economical must give dependable, lasting service.

Homesteads open and close easily. The patent balancing parts insure it against sticking. When the Homestead is fully opened, the two surfaces which are depended upon for tightness are in no way affected by the material passing through. The plug cock provides a straight-way opening which is desirable in all sorts of work but particularly so in high pressure service—also in the handling of thick heavy liquids.



Elimination of waste time and leakages quickly pays for all Homestead valves. You would do well to adopt them without delay.

Homestead Valve Mfg. Company
Homestead, Pa.

AIR **The Profit Builder**

In every public building or industrial plant, the installation of modern air handling equipment will increase its profit possibilities. *Your* profits can be increased if you take advantage of American Blower equipment and engineering service along the following lines:

Mechanical Draft
Heating and Ventilating
Generator Cooling
Air Washing
Fans and Blowers
Steam Engines

Bulletins on any of these subjects, embodying the knowledge acquired through forty successful years, will be sent upon request.

CANADIAN SIROCCO CO., LTD., WINDSOR, ONT.
BRANCH OFFICES IN ALL PRINCIPAL CITIES

(338)

"Sirocco" Products

BLOWERS EXHAUSTERS VENTILATING FANS AIR WASHERS ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

This
ANDERSON
Steam Trap

Positively
Prevents
Wasted
Steam

Use it on any Line

WHEREVER there is condensation the Anderson Model "D" Trap will give you economical service. Because it absolutely prevents loss of steam some odd thousands of users are "strong" for this trap. It is the most effective trap because it automatically adjusts itself to any pressure within its capacity. Valves are built of wear-proof, rust-resisting materials. Equipped with a removable strainer which prevents scale, packing, etc., from entering the valve.

Write for Catalogue

THE V. D. ANDERSON CO.
1935 West 96th St., Cleveland, Ohio.

GAGES, PRESSURE

Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, RECORDING

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

GAGES, STEAM

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
Babcock & Wilcox, Limited, Montreal, Que.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, VACUUM

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, WATER

The Bristol Co., Waterbury, Conn.
The James Morrisson Brass Mfg. Co., Limited, Toronto, Ont.

GAS EXHAUSTERS

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

GASKETS

Jenkins Bros., Limited, Montreal, Que.
Shell Bar Boico Supply Ltd., Toronto, Ont.

GEARS

E. Laurie & Co., Montreal, Que.
Turbine Equipment Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Limited, Montreal, Que.

GEARS, CUT

Hans Renold, of Canada, Ltd., Montreal and Toronto.

GEARS, ROLLER CHAIN

Hans Renold of Canada, Ltd., Montreal and Toronto.

GEARS, SILENT CHAIN

Hans Renold of Canada, Ltd., Montreal and Toronto.

GENERATORS, ELECTRIC

Laurie & Lamb Co., Montreal, Que.

GENERATORS, HOT WATER

The Sims Co., Erie, Pa.
Arthur S. Leitch Co., Toronto.

GOVERNORS, PUMP

Canada Stoker Co., Ltd., Toronto and Galt.
Northern Equipment Co., Erie, Pa.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

GRATES

Beveridge Supply Co., Montreal, Que.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Can. Steam Boiler Equipment Co., Ltd., Toronto, Ont.

GRATE BARS

Canadian Steam Boiler Equipment Co., Toronto, Ont.
Engineering & Machine Works of Canada, Limited, St. Catharine, Ont.
Babcock & Wilcox, Limited, Montreal, Que.
John T. Hephurn Ltd., Toronto, Ont.
Goldie McCulloch Co., Ltd., Galt, Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.

GREASE EXTRACTORS

Babcock & Wilcox, Limited, Montreal, Que.

HEATERS, FEED WATER

Goldie & McCulloch Co., Ltd., Galt, Ont.

HEATING SYSTEMS

Can. Sirocco Co., Ltd., Windsor, Ont.

HOISTS, ELECTRIC

Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

HOPPERS, COAL & ASH

Combustion Engineering Corp., Ltd., Toronto, Ont.

HOSE, AIR

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

HOSE, RUBBER

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Babcock & Wilcox, Limited, Montreal, Que.

HOSE, STEAM

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

HOSE, WATER

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

ICE AND REFRIGERATING MACHINERY (SEE REFRIGERATING MACHINERY)

Jamieson Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
Can. Ice Machine Co., Toronto, Ont.
York Mfg. Co., York, Pa.
Frick Co., Waynesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.

INDICATORS, SPEED

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INDICATORS, STEAM ENGINE

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INJECTORS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

LUBRICATORS, CYLINDER

The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, FORCE FEED

The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, SIGHT FLOW

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

MACHINE WORK, SPECIAL

Engineering & Machine Works of Canada, Limited, St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

METERS, BOILER

Laurie & Lamb Co., Montreal, Que.

METERS, FLOW

Canada Stoker Co., Ltd., Galt and Toronto.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

OILING DEVICES

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PACKING, ASBESTOS

Durabla Mfg. Co., New York City.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC

Laurie & Lamb Co., Montreal, Que.

PACKING, SHEET

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Durabla Mfg. Co., New York City.
The James Morrison Brass Mfg. Co., Ltd., Toronto Ont.

PACKING, VALVE STEM PIPE

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

PIPE, BRASS & COPPER

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE BENDING

Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE COILS

Can Ice Machine Co., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke Que.
Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE CUTTERS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PUMPS, BOILER FEED

Albany Pump Co., Toronto.
American Steam Pump Co., Battle Creek, Mich.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CENTRIFUGAL

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
E. Laurie & Co., Montreal, Que.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Co., Toronto, Ont.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CONDENSER

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Micb.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

PUMPS, FORCE FEED

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb, Montreal, Que.

PUMPS, OIL

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Euipment Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Westco Mfg. Co., Toronto.

PUMPS, POWER

American Steam Pump Co., Battle Creek, Mich.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Euqipment Co., Ltd., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, ROTARY

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont. Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Westco Mfg. Co., Toronto.

PUMPS, STEAM

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
John T. Hepburn, Ltd., Toronto, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
F. L. Smidth & Co., New York.
Turbine Euqipment Co., Ltd., Toronto, Ont.

"PUMPS-SUMP"

Albany Pump Co., Toronto.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.

PUMPS, TURBINE

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto, Ont.

PUMPS, VACUUM

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Young Pump Company, of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairhanks-Morse Co., Ltd., Montreal, Que.
Arthur S. Leitch Co., Toronto.
Nash Engineering Co., (Hytor) South Norwalk, Conn.

PYROMETERS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

REFRACTORY MATERIAL

G. F. Sterne & Sons, Ltd., Brantford.

REFRIGERATING MACHINERY

Jamison Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.
Frick Co., Wanesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

REGULATORS, DAMPER, DRAFT & FAN

Laurie & Lamb, Montreal, Que.
Julian D'Este Company, Boston, Mass.

REGULATORS, FEED WATER

Canada Stoker Co., Ltd., Galt and Toronto.
Northern Equipment Co., Erie, Pa.

REGULATORS, TEMPERATURE

Sarco Co., Inc., New York.
The Bristol Co., Waterbury, Conn.
Julian D'Este Company, Boston, Mass.
The Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

REGULATORS, PRESSURE

The Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, AIR

Can. Sirocco Co., Ltd., Windsor, Ont.

SEPARATORS, AMMONIA

York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.

SEPARATORS, OIL

Anderson Co., V. D., Cleveland, Ohio.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, STEAM

Anderson Co., V. D., Cleveland, Ohio.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SMELTING LININGS

G. F. Sterne & Sons, Ltd., Brantford.

SODA ASH

G. F. Sterne & Sons, Ltd., Brantford, Ont.

SODA SILICATE

Diamond Specialty Mfg. Co., Windsor.

SOOT BLOWERS

Diamond Specialty Mfg. Co., Windsor.
Pilley Packing & Flue Brush Co., St. Louis, Mo.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SPRAY NOZZLES

Can. Sirocco Co., Ltd., Windsor, Ont.

SPROCKETS AND CHAINS

Hans Renold of Canada, Ltd., Montreal and Toronto.

STACKS, METAL

Engineering & Machine Works of Canada Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STACKS, RADIAL BRICK

Combustion Engineering Corp., Ltd., Toronto, Ont.

STEEL PLATE WORK

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STOKERS, CHAIN & TRAVELING GRATE

Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que. Que.

STOKERS, OVERFEED

Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.
Detroit Stoker Co., Detroit, Micbigan.

STOKERS, UNDERFEED

Detroit Stoker Co., Detroit, Mich.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.

STOKERS, HAND OPERATED

Combustion Engineering Corp., Toronto, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

STRAINERS, WATER

Sarco Co., Inc., New York.

SUPERHEATERS

Babcock & Wilcox Ltd., Montreal, Que.
Goldie & McCulloch Co., Ltd., Galt, Ont.

SWITCHES, ELECTRIC

Canadian Drill & Electric Box Co., Ltd., Toronto.
Canadian General Electric Co., Ltd., Toronto.

TACHOMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Laurie & Lamb, Montreal, Que.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TANKS

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

THERMOMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

THERMOMETERS, FLUE GAS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

THERMOMETERS, RECORDING

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.

TRANSFORMERS

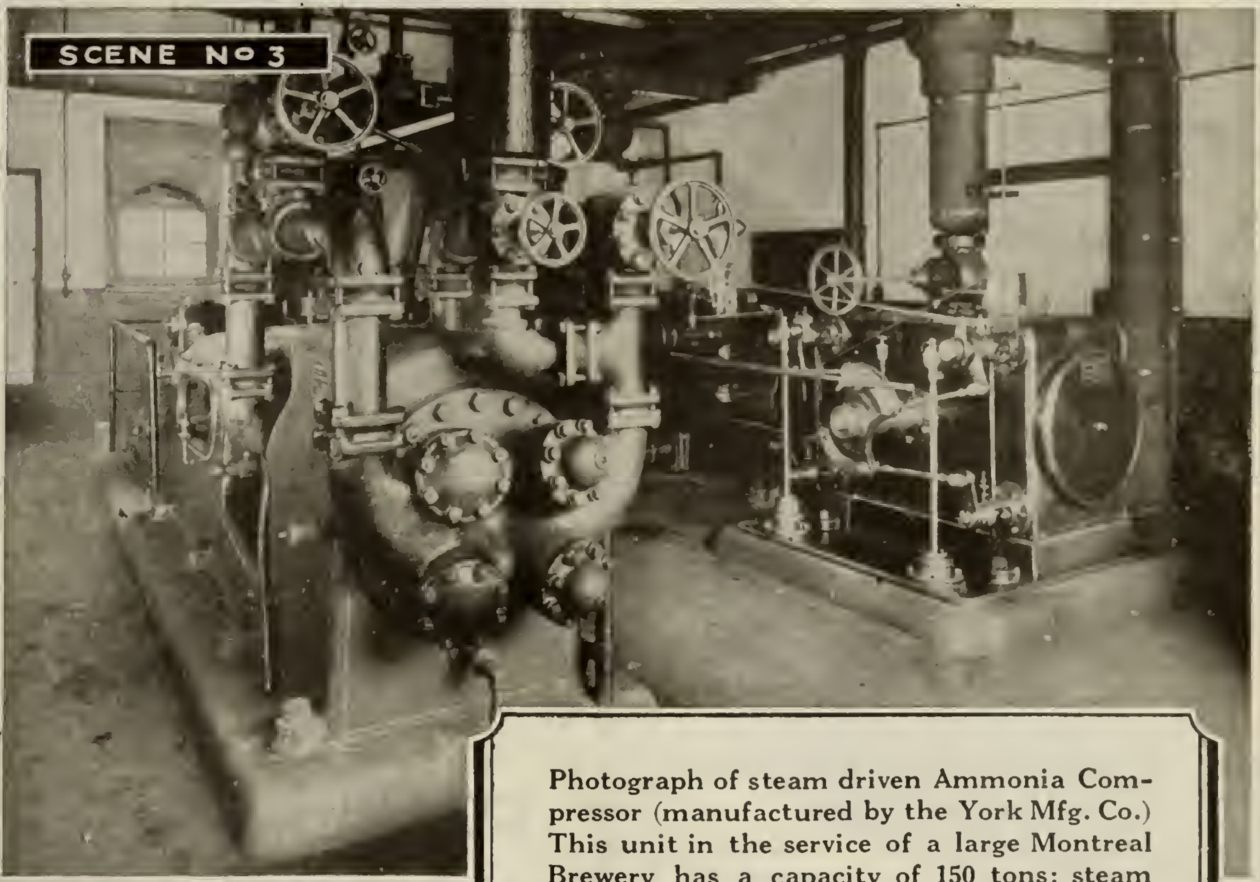
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

TRAPS, NON-RETURN

Anderson Co., Inc., V. D., Cleveland, Ohio
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Sarco Co., Inc., New York.

TRAPS, RADIATOR

Sarco Co., Inc., New York.



Photograph of steam driven Ammonia Compressor (manufactured by the York Mfg. Co.) This unit in the service of a large Montreal Brewery has a capacity of 150 tons; steam pressure 150 lbs.; speed 65 R.P.M.

Imperial Lubricants in use:—

Imperial Cylinder Oil.
Imperial Atlantic Red Oil.
Imperial Polar Machine Oil.

IMPERIAL
LUBRICANTS

FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

Expensive machinery warrants the protection which Imperial Lubricants assure through correct lubrication of every bearing, journal and other moving part. Plant operation is made more profitable by the standardized use of the right grades of Imperial Lubricants on your different units. When you are confronted with a difficult lubrication job write our nearest branch office for the expert advice and service of our lubrication engineers.

IMPERIAL OIL LIMITED

Boiler Brand

The Simplest and Most Effective

FEED WATER TREATMENT

Silicate of Soda is the base of the majority of Boiler Compounds on the market—often made up under special names.

Boiler Brand is but one of our many grades of Silicate of Soda. It does the work of the most expensive compounds but as the engineer knows just what it is he can adapt it to varying conditions. Why bother with complicated treatments for the removal of boiler scale when the solution is so simple?

"Let a Technical Firm do a Technical Job."

G. F. Sterne & Sons, Limited

Chemical Manufacturers.
Consulting Chemical Engineers.
Brantford - - Ontario

Power House

Solves the Problem

It is a dominating factor in maintaining power plant efficiency in equipment and service.

Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge.

Two Issues per Month
Twenty-four per Year

$2.00 PER YEAR — Every Power Plant employee should read Power House

TRAPS, STEAM
Can. Sirocco Co., Ltd., Windsor, Ont.
Farrfhern Steam Services, Ltd., Toronto.
Laurie & Lamb, Montreal, Que.
Sarco Co., Inc., New York.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TRAPS, VACUUM
Anderson Co., Inc., V. D., Cleveland, Ohio.

TUBE CLEANERS, BOILER
Pilley Packing & Flue Brush Co., St. Louis, Mo.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal, Que.

TURBINE BLAOING
De Laval Steam Turbine Co., Trenton, New Jersey.

TURBINES, STEAM
Coppus Engineering Corp., Worcester, Mass.
Laurie & Lamb Co., Montreal, Que.
E. Laurie & Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Arthur S. Leitch Co., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt. Ont.

TURBINES, WATER
De Laval Steam Turbine Co., Trenton, New Jersey.

UNIONS & UNION FITTINGS
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVE DISK
Kerr Engine Co., Ltd., Walkerville, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, AIR
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BACK PRESSURE
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Jenkins Bros. Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BALANCEO
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto.

VALVES, BLOW-OFF
Arthur S. Leitch Co., Toronto.
Babcock & Wilcox, Ltd., Montreal, Que.
Homestead Valve Co., Homestead, Pa.
Jenkins Bros., Ltd., Montreal, Que.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BRASS & IRON BOOY
Reading Steel Casting Co., Bridgeport, Conn.
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BYPASS
Kerr Engine Co., Ltl., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co,. Ltd., Toronto, Ont.

VALVES, CHECK
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, EXHAUST RELIEF
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES FLOAT
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, GATE
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, GLOBE
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, HYORAULIC
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, NON-RETURN STOP
Babcock & Wilcox, Ltd., Montreal, Que.

VALVES, SAFETY POP
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, PUMP
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, RAOIATOR
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.

VALVES, REOUCING
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd.. Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, REGRINOING
Jenkins Bros., Ltd., Montreal, Que.

VALVES, REGULATING
Northern Equipment Co., Erie, Pa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, RELIEF
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, SAFETY
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, STOP
Babcock & Wilcox, Limited, Montreal, Que.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, SUPER-HEATEO STEAM
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Reading Steel Casting Co., Bridgeport, Conn.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.,

VALVES, THROTTLE
The James Morrison Brass Mfg. Co., Ltd., Toronto. Ont.

VALVES, VACUUM
The James Morrison Brass Mfg. Co., Ltd., Toronto. Ont.

VENTILATION
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor. Ont.

WASHERS, AIR
Canadian Blower & Forge Co., Limited. Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

WATER COLUMNS
The James Morrison Brass Mfg. Co., Toronto, Ont.

WATER SOFTENING APPARATUS
Laurie & Lamb Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Babcock & Wilcox, Ltd., Montreal, Que.
W. J. Westaway Co., Ltd., Hamilton, Ont.

WHISTLES
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

WRENCHES
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

Building a one-piece furnace lining without special forms.

BETSON'S
TRADE MARK
PLASTIC FIRE BRICK

Makes practicable, solid, one-piece furnace linings, including front and back arches, side walls and baffles. It costs but little to install in any make or type of boiler. It saves fuel, annoying shut-downs, costly repairs, and increases the amount of power from the fuel used. It's the ideal material for baffles.

The many uses, methods of installing, how to order, measurement blanks, etc., are given in a booklet which we will gladly send you.

BETSON PLASTIC FIRE BRICK CO., Inc.
Post Office Box 386-6, Rome, N.Y.
Canadian Distributors:
INTERNATIONAL CHEMICAL CO.
26-6 Adelaide St., Toronto, Ont., Canada.

Specify *Tycos* for

Atmospheric Relief Valve
Barometric Pressure
Blow Off Lines
Boiler Room Temperature
Calorimeter Test
Coal Pile
Condensers
Drafts
Economizers
Feedwater Pressure
Flue Gas Temperature
Furnace Fires
Heating Systems
Hot Water Tanks
Humidity of Boiler Room
Outside Temperature
Recording Boiler Pressure Gauges
Saturated Steam Line
Superheated Steam Lines

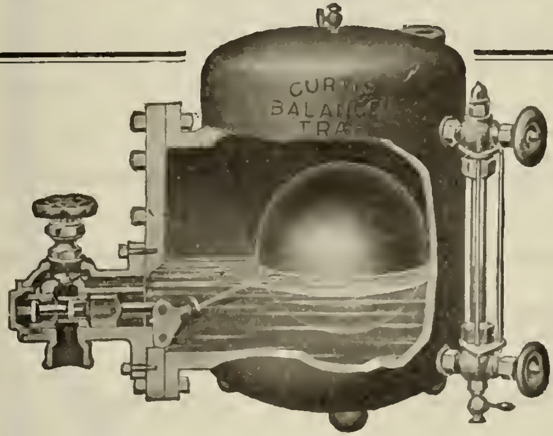
Write for Catalog Part One. A handy reference for Power Plants.

Tycos
Temperature Instruments
INDICATING-RECORDING-CONTROLLING
Taylor Instrument Companies
110-112 Church St.,
Tycos Building, Toronto.
There's a *Tycos* or *Taylor* Instrument for Every Purpose

REG'D TRADE MARK *Tycos* CANADA

C912

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

Send for descriptive circular of this trap.

Sole Distributors for Canada:
DARLING BROS., 120 Prince Street, Montreal, P. Q.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14, Mass.

Emergencies Prove Its Superiority

It may not be often that the oil film fails in any of your bearings, but the possibility is always present. It is emergencies such as this that test the value of your bearing metals. Magnolia Anti-Friction Metal protects your shafts and bearings from damage in such temporary contingencies. With the lowest frictional coefficient of any known bearing metal—proven by U.S. and foreign government tests—it runs cool with less lubricant and is a safeguard against hot boxes and melting out where lubrication is neglected or may fail for any reason.

Try out a sample Magnolia-lined bearing and test its many advantages for yourself.

Magnolia Metal Company
37-39 Shannon St., Montreal, P.Q.
Magnolia Factories also at London, New York, Chicago, San Francisco.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK

Established 1907

POWER HOUSE

Member A.B.C.

B. G. NEWTON, Manager

S. S. MOORE, Advertising Manager

CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740
Montreal: L. C. Hazelton, 128 Bleury St., Tel. Plateau 946. Winnipeg:
810 Confederation Life Bldg., Tel. Main 3449.

UNITED STATES—New York: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. Chicago: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. Boston: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—London: The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

SUBSCRIPTION RATE:—Canada, $2.00; United States $2.50; Great Britain and other countries in Postal Union, 14s. per year. Australia and other countries not in Postal Union, 19s. per year.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A
Anderson Co., V. D. 51
Armstrong Cork and Insulation Co., Ltd. 13
Audel Co., Theo. 44
American Steam Pump Co. 8
American Schaeffer & Budenburg Corp. 4

B
Betson Plastic Fire Brick Co. 55
Bristol Co., The 8
Buyers' Directory 50, 52, 54
Bird-Archer Co., The 6
Burnett, J. A. 44
Boiler Repair & Grate Bar Co. 19
Beveridge Supply Co. 51

C
Can. Fairbanks-Morse Co. 5
Can. Ingersoll-Rand Co. 11
Celite Products 49
Classified Adv. Section 45
Conveyors Corp. of America 48
Can. Sirocco Co. 51
Crane, Ltd. 7
Crane Packing Co. 48
Coates, Wm. 45
Canada Stoker Co. .....Front Cover

D
DeLaval Steam Turbine Co. 16
DeLaval Co., Ltd., The 43
Dart Union Co., Ltd., The 56
D'Este Co., Julian 55
Diamond Specialty, Ltd. 16
Durabla Mfg. Co. 5

E
Elk Fire Brick Co. 18
Engineering & Machine Works of Canada 14
Edward Valve Mfg. Co. 4

F
Foxboro Co. 15
Flexible Metallic Packing Co. 48
Frick Company 12

G
Garlock Packing Co. ....Inside Front Cover
Garth Co., The 12
Goldie & McCulloch Co. 20
Greene, Tweed & Co. 2
Gutta Percha & Rubber, Ltd. 3
Gates Engineering Co. 18

H
Hints to Buyers 48
Hepburn, John T., Co. 49
Hays Co., Jas. W. 48
Homestead Valve & Mfg. Co. 51

I
Imperial Oil Co. 53

J
Jardine, A. B. 49
Jenkins Bros. 17
Jointless Firebrick Co. 18

K
Kerr Engine Co. 4

L
Ladd, Geo. T. 48
Laurie & Lamb 6
Linde Can. Refrigeration Co. 10
Leitch, Arthur S. 43

M
McLaren, D. K., Co. ....Inside Back Cover
Magnolia Metal Co. 55
Moncrieff, Ltd., John 49
Morrison Brass Mfg. Co., Jas. Outside Back Cover

N
Northern Crane Works 49

P
Pilley Packing & Flue Brush Mfg. 48
Pratt & Cady Co. 47

R
Reading Steel Casting Co. 47
Refrigeration Dept. 10
Refrigerating Engineers 12
Rule, A. E. 49

S
Smooth-On Mfg. Co. 12
Superheater Co. 49
Shell Bar Boico Co. 48
Sterne & Sons, G. F. 54
Stephen Chemical Co. 49
Steel Mill Packing Co. .... 4[illegible]

T
Taylor Instrument Co. 55

U
Underfeed Stoker Co. of Canada, The 9

V
Vilter Mfg. Co. 10

W
Wall, W. J. 49
Waterous Engine Works Co. 1
Watson, M. Barry 44
Watson & McDaniel Co. 12
Wilson & Sons, J. L. 12

Y
Yarnall-Waring Co. 47
York Mfg. Co. 13

Bronze to Bronze

DART

At the Joints

UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

It's All In the Tanning!

Even the tough back portions of the choicest hides, specially selected by experts, such as used exclusively for **D. K. McLaren's Leather Belting,** would make only **ordinary** belting were it not that every inch is subjected to the **Genuine British Oak Tanning Process**—for many years a closely-guarded secret of British tanners.

The wonderful toughness and flexibility of **D. K. McLaren's Belting** is due, principally, to this tanning process. It gives it greater strength, greater durability and makes it as stretch-proof as it is possible for belting to be. It is this which has made **D. K. McLaren's Leather Belting** an important factor in the reduction of transmission costs.

Every length is stamped with the Oak Leaf — it's worth looking for.

D. K. McLaren
LIMITED

Head Office and Factory:
351 St. James Street
Montreal, Que.

BRANCHES:

Toronto, Ont., 194 King St., W.;
St. John, N.B., 90 Germain St.

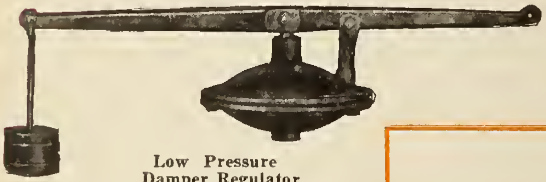
STOCK DEPOTS

Calgary, Alta., Gorman's Limited;
Edmonton, Alta., Gorman's Limited;
Vancouver, B.C., T. M. Grindley Company, 1158 Homer Street.

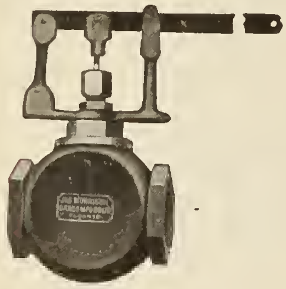
MORRISON'S

Steam Goods and Specialties

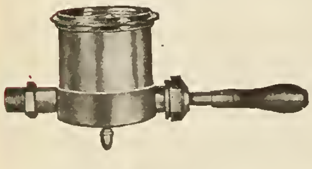
TRADE MARK
J.M.T.
REGISTERED
A GUARANTEE OF QUALITY



Low Pressure Damper Regulator.



Balanced Valve.



Hand Cylinder Oil Pump.

A reputation for dependable quality extending over half a century makes exacting demands.

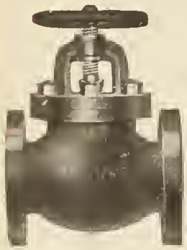
The reliable service to which Morrison Steam Specialties have accustomed their users would cause even the slightest variation of quality to become as noticeable as a bulge on a boiler.

Thus does the tyranny of prestige become a guarantee of quality maintained.

Gem Ejector.

Model "C" Safety Valve.

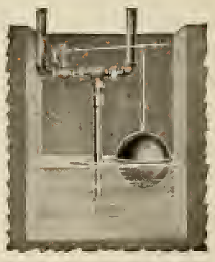
Water Gauge.



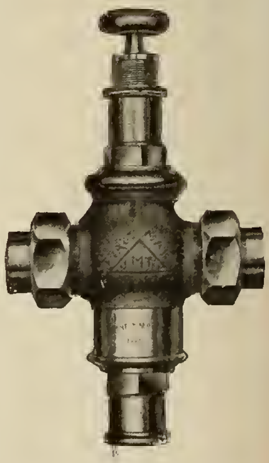
Globe Valve.

Morrison Injector.

Non-Return Stop and Equalizing "Y" Valve.



Morrison Automatic Drainer. Operates on Water pressure. Keeps cellars, wheel pits, etc., free from water.



J. M. T. Reducing Valve.

"Every Installation is a Demonstration of Merit."

The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. W., Toronto, Ont.

POWER HOUSE

Fostering Economy in Steam, Oil and Hydro-Electric Power Development

Vol. XVI—No. 24

Published Semi-Monthly by
The MacLean Publishing Company, Limited, Toronto, Ont.

December 20, 1923

Architect:
M. E. COLLINS,
61 Old Broad St.,
London.

Consulting Engineer:
ADRIAN COLLINS,
61 Old Broad St.,
London

Power House of Furness House

Leadenhall St., London, E.C., Eng.
equipped throughout with

Genuine
JENKINS VALVES

The valves in this installation were selected on the principle of merit and reputation and the men responsible for the installation in selecting Genuine Jenkins Valves have assured a maximum of service with a minimum of care and attention.

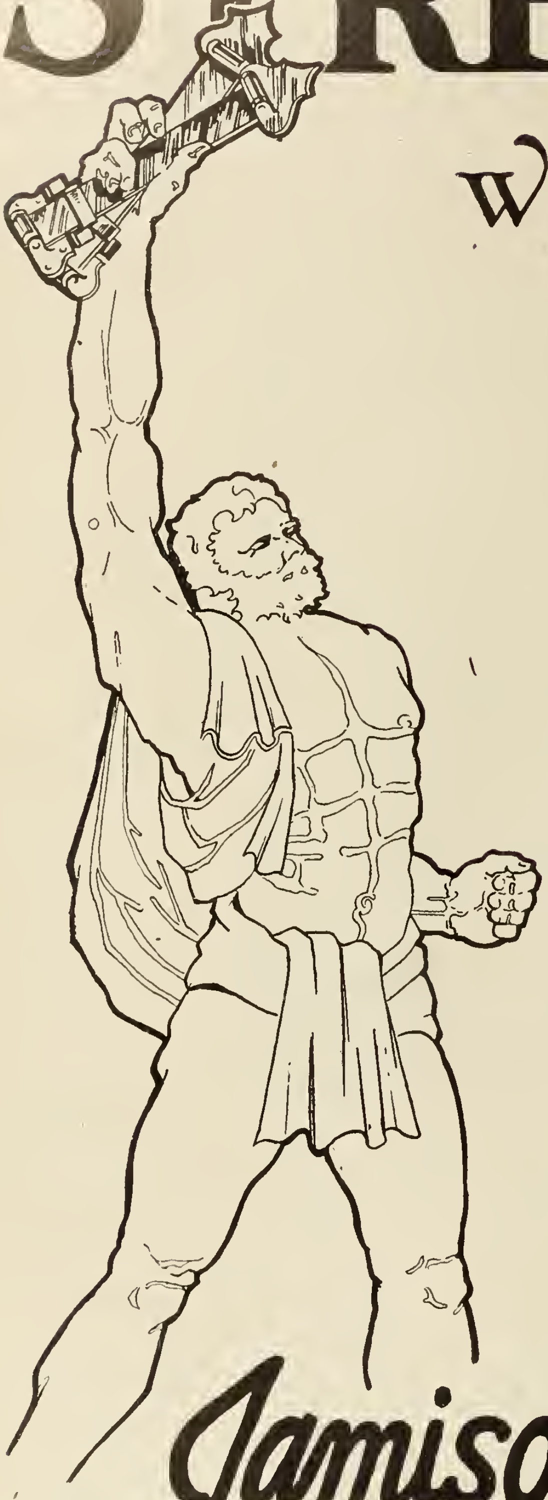
Wherever equipment is installed and maintained on a quality basis—wherever quality equipment is rightfully regarded as a permanently paying investment—due attention is paid to dependable valve equipment and genuine "Jenkins" are invariably selected by the men who know. Write for Jenkins Catalog No. 9.

JENKINS BROS., LIMITED

Head Office and Works—103 St. Remi St., Montreal.
Sales Offices - - - - Toronto, Vancouver.
European Branch - - - London, W.C. 2, Eng
Factories - - Montreal, Bridgeport, Elizabeth

Always marked with the "Diamond"
Jenkins Valves
SINCE 1864

STRENGTH



Where there's weight there's strength

Time tells! Much as the constant drip, drip, drip of water on stone will eventually wear away the surface—so will every-day hard usage make inroads into the efficiency of your cold storage doors.

Ever stop to consider the number of people that pass through your doors each day—going in and out? Ever stop to consider the countless slams, bangs, bumps, and crashes each door has to withstand in every day's work—365 days a year—year in and year out?

The doors of your plant are **important—vitally important!** They must stay "in commission" and serve their purpose without flinching—without taking any trips to the "shop" for repair. For their absence from the line of duty handicaps the efficiency of the plant!

We realize the **importance** that the cold storage door takes in cold storage **plant efficiency**—have realized it for seventeen years, since our very beginning.

By test, Jamison Doors weigh considerably more than other doors. By test, the hardware on Jamison Doors weighs **three times** as **much** as the hardware on **other** doors. The weight PLUS the construction gives the needed strength. Jamison Products are **truly** heavy duty products. And **that's** what you want!

If you care to make a comparative test of these weights, we shall be glad to have you do so—at our expense.

Write for our catalogue—Address Desk No. 11

JAMISON COLD STORAGE DOOR CO.
Hagerstown, Md., U.S.A.

Jamison Doors

for better refrigeration

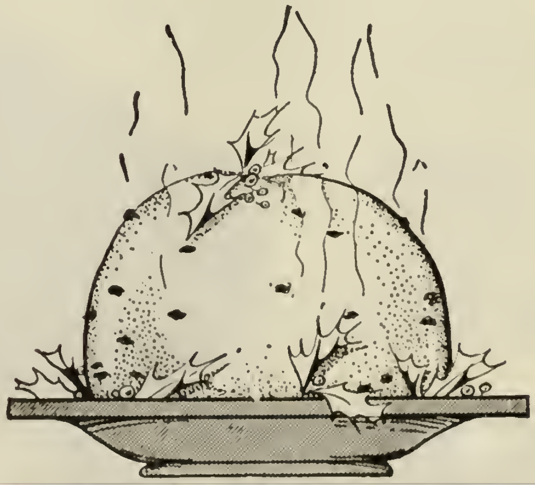
Friendship—

A friend is a present we make to ourselves.

We are grateful for the gift of new friends and for the long association with our old ones.

To both new and old and to the friends to be, we extend our heartiest Greetings.

The Waterous Engine Works
Brantford, Ontario



BOILER CHEMICALS

Made in Canada for You

Do it Now

Not a hit-and-miss ready-made compound, but made for you on scientific principles.

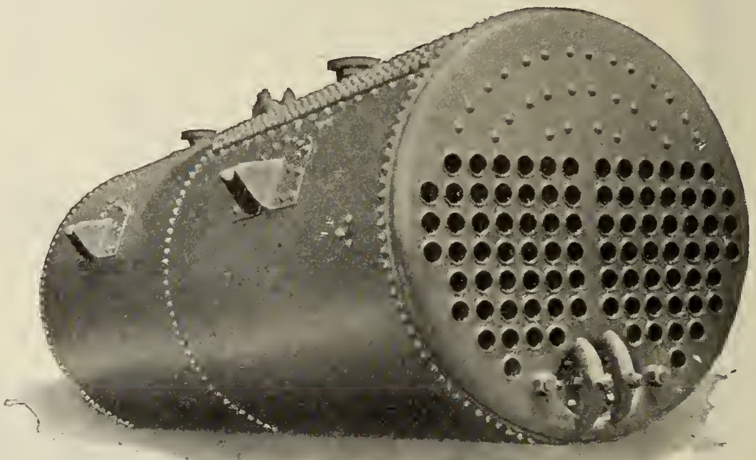
Send us ½ gallon sample of the water used in your boiler, together with a description of your boiler plant, for analysis, and be convinced.

THE BIRD-ARCHER CO.

Office: McGill Bldg., Montreal

Factory: Cobourg

How much Life is there in a Second Hand Boiler?



Nobody knows.

Like a second-hand car, its principal recommendation is its low price.

We build Boilers of all types to suit Interprovincial Boiler Code—at moderate prices. The quality of our workmanship and materials makes a Boiler from us a definite money saving, power or heat delivering factor that you measure and feel assured will be a real money making factor in your business for many years to come.

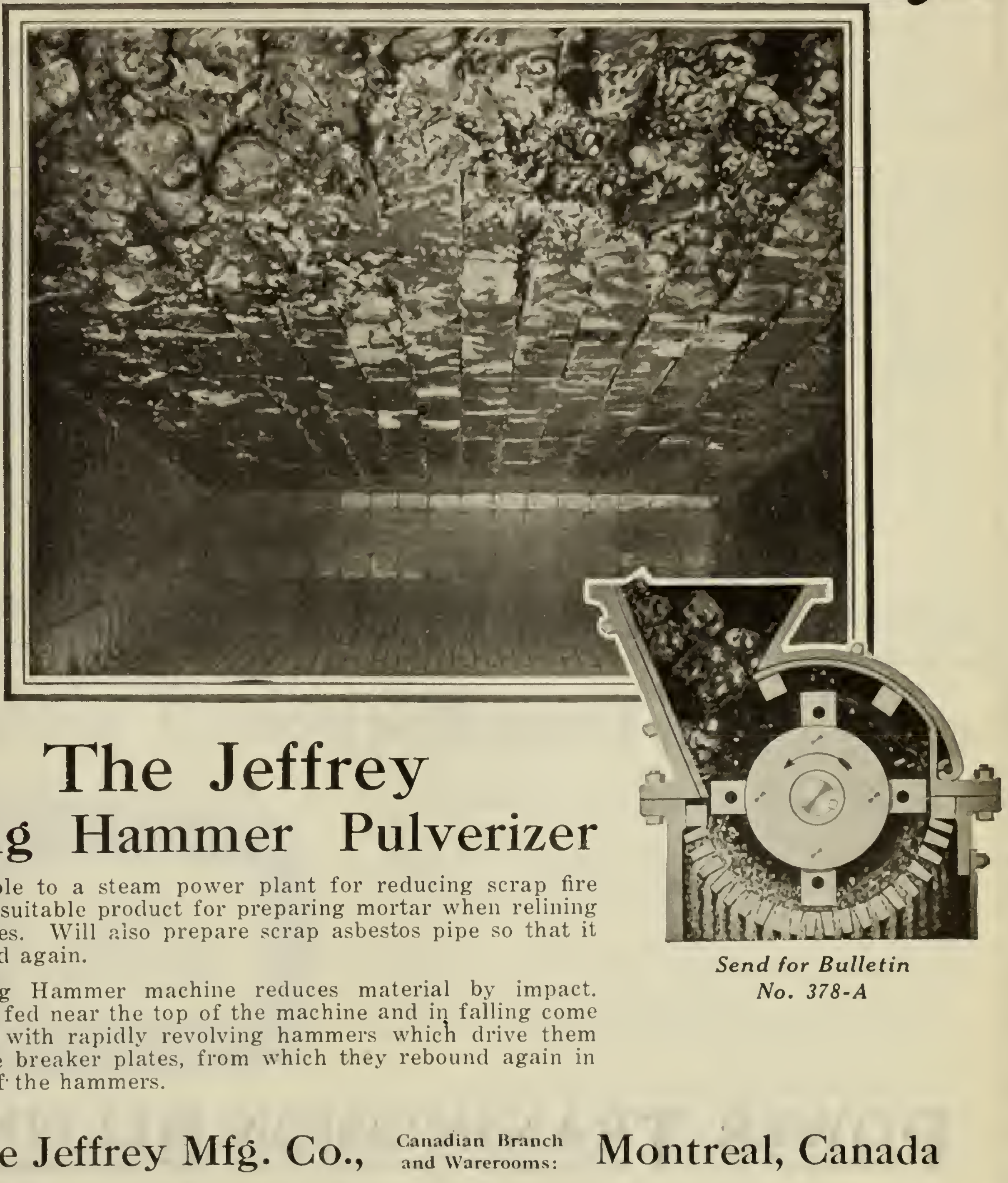
Let us quote you.

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: HALL MACHINERY CO., Sherbrooke, Que., and Birks Bldg., Montreal

Make Use of Your Old Linings



The Jeffrey
Swing Hammer Pulverizer

is invaluable to a steam power plant for reducing scrap fire brick to a suitable product for preparing mortar when relining the furnaces. Will also prepare scrap asbestos pipe so that it can be used again.

This Swing Hammer machine reduces material by impact. Bricks are fed near the top of the machine and in falling come in contact with rapidly revolving hammers which drive them against the breaker plates, from which they rebound again in the path of the hammers.

Send for Bulletin No. 378-A

The Jeffrey Mfg. Co., Canadian Branch and Warerooms: Montreal, Canada

JEFFREY
MATERIAL HANDLING EQUIPMENT

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

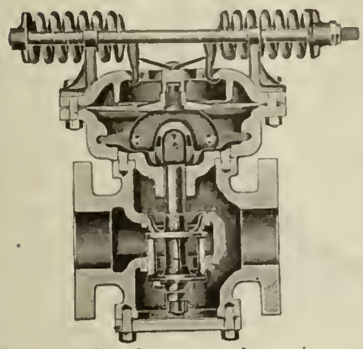
Unequalled!

Others have tried

POWER TRANSMISSION BELTING

GUTTA PERCHA & RUBBER, LIMITED
TORONTO - CANADA
Sales Offices - - Coast to Coast

Foster Class "W" Pressure Regulator



The leader for general service on steam, air (certain conditions), and hot water, where delivery pressure is practically constant. It is standard for working pressures of 125 to 250 lbs.

Made in two weights.

For these Reasons—

1. A compensating spring movement exerting a uniform power on the diaphragm, without regard to the opening of the valve.
2. Renewable Seat Rings.
3. Ample Steam Capacity.
4. Drop forged steel stem, levers, toggle levers (case hardened) insuring durability.
5. No small parts to clog.
6. Ease of adjustment and accessibility for repairs.
7. No friction of parts. No dash-pot required. Noiseless in operation.
8. Small movement of diaphragm insuring long life.
9. Absolutely automatic after adjustment is made.
10. Great simplicity of construction and operation.

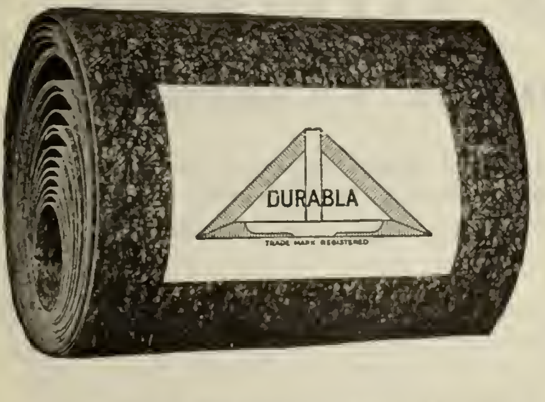
For prices and full Particulars, write

The Canadian
Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg,
Regina, Calgary, Vancouver, Victoria.

104

Durabla Gaskets Make Tight Joints



Withstanding all Temperatures and Pressures

Wherever a permanent Gasket is required, use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids.

Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla Trade Mark which guarantees strength and quality.

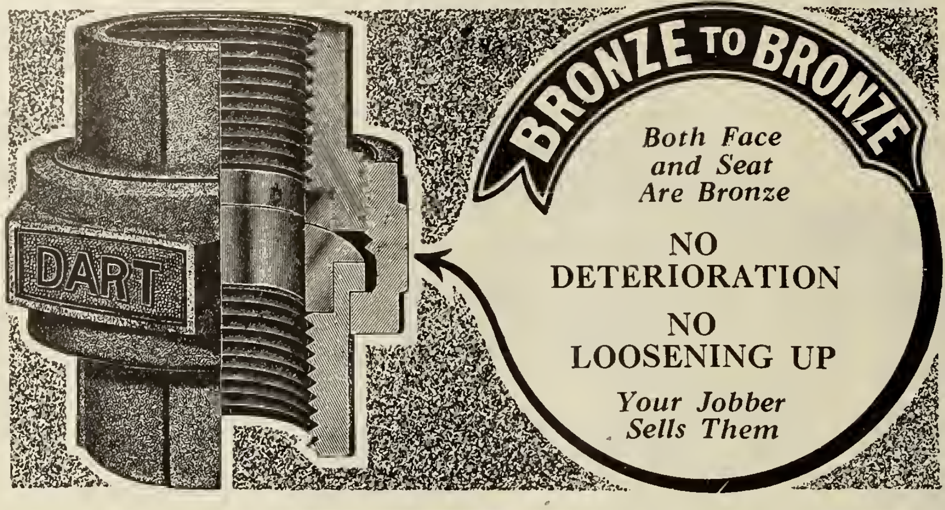
Made in Canada in Stock Sizes 36" wide x 150" long, in thicknesses of 1/64, 1/32, 1/16, 1/8".

Let us send you a trial shipment

CANADIAN DURABLA LIMITED, MONTREAL

Distributors: THE CANADIAN FAIRBANKS-MORSE CO., LTD.
St. John, Quebec, Montreal, Ottawa, Toronto, Windsor, Winnipeg, Regina, Calgary, Vancouver.

DURABLA



Manufactured by
Dart Union Co. Ltd.
Toronto

A. & P. Automatic Hydraulic Vacuum Producer

for creating and maintaining vacuum on steam heating systems in churches, schools, theatres, factories, flats, and residences.

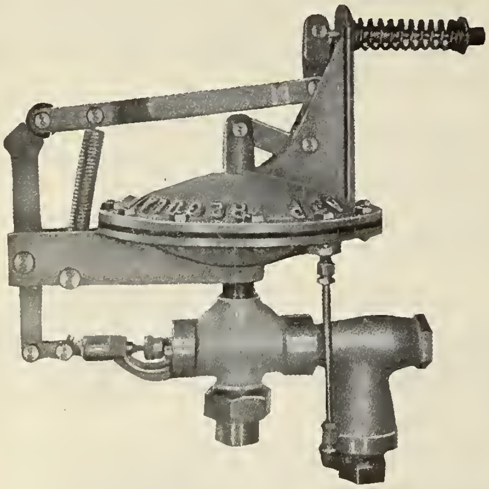
The A & P Vacuum Producer is for removing the air from the heating system and is operated by city water pressure. It is so designed that it completely shuts off the water supply when 3 to 5 inches of vacuum is established and operates again when low vacuum occurs. Maximum capacity with 20-lb. pressure is 2,500 sq. ft. of direct radiation.

Manufactured by

YOUNG PUMP COMPANY OF CANADA

96 Mary Street - - Hamilton, Ont.

Manufacturers of the Young Centrifugal Vacuum and Boiler Feed Outfit

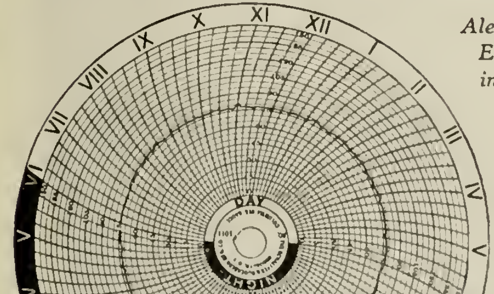


When Enlarging South High School, Youngstown, 60 per cent, they installed a Detroit Underfeed Stoker, and saved 100 Tons of Coal yearly over former practice ~ ~ ~ ~ ~ ~ ~

Naturally you would think that the addition of 42,000 square feet of floor space, to a modern school with its high ceilings and large window area, would inevitably increase very materially the coal consumption. This was not the case however at South High, because they put in a Detroit Underfeed Stoker at the same time that they enlarged the building, with the result that the fuel consumption was cut 100 tons a year.

There is nothing surprising in this record. Every user of Detroit Underfeed Stokers will testify that his savings in fuel have been very much larger than he actually anticipated. The reason—Detroit Underfeed Stokers set new and higher standards in stoker manufacture. Their flexibility, ease of control, and the completeness of combustion effected will surprise and delight you.

Alex S. Allen Engineer in charge



Note the steady, even steam pressure

Repeat orders for Detroit Underfeed Stokers from:

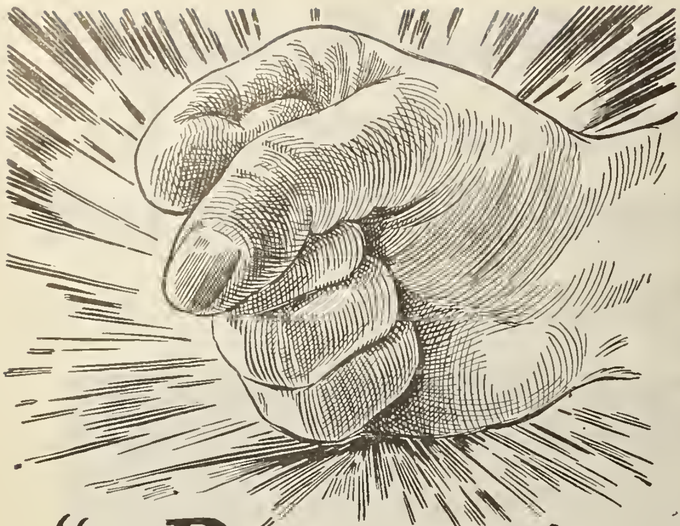
Youngstown Board of Education	God's Bible School, Cincinnati
Fifth Avenue Building, New York	Burroughs Adding Machine Co., Detroit
American Cotton Oil, Cincinnati and St. Louis	Saginaw Board of Education
Harvey Hubbell Inc., Bridgeport, Conn.	Krippendorf—Dittmann Co., Cincinnati
National Home, D. V. S., Johnson City, Tenn.	Chevrolet Motor Co., Tarrytown, New York
Durant Motors Corporation, Flint, Michigan	Fort Wayne City Lighting Plant.

Made in both single and multiple retort design capable of handling any boiler from the small HRT to the large water tube operated at high ratings. If you want to effect REAL savings in your plant install a REAL underfeed stoker—THE DETROIT.

Ask for Bulletin 238.

DETROIT STOKER COMPANY
Underfeed Forced Draft and Overfeed Natural Draft Stokers
238 GENERAL MOTORS BUILDING DETROIT, MICH.

DETROIT ASSURE CHEAPER **UNDERFEED TYPE U SINGLE RETORT** **STOKERS** STEAM PRODUCTION



"I Resolve"—

Thinking about the Sarco Temperature Regulator gets you nowhere. The savings effected by this Regulator in the elimination of spoiled goods due to too much or too little heat and by cutting steam consumption, its economy in first cost and maintenance—all these things are lost to you if you simply *read* about them and let it go at that.

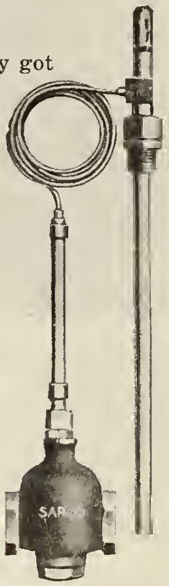
Thousands of Sarco Regulators were put into service by men of foresight and initiative who *acted*—men who said to themselves, "I will break away from old-fogy hand regulation and get hooked up with the dependable, money-saving Sarco."

They didn't wait. They didn't defer. They got busy. Judging by some of the letters of praise we receive, you would do well to follow the example of these men.

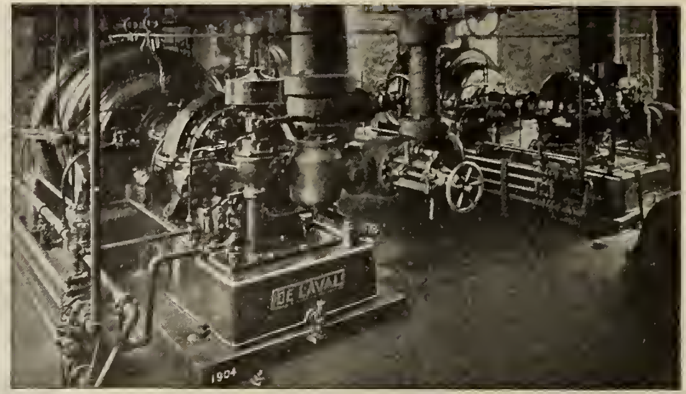
It is all right to read about the good points of the Sarco, but after you have read, *act!* Say to yourself, "I resolve to install the Sarco Temperature Regulator *now*—without further delay." And then *do* it.

The first step is to write for details of our 30-Day Free Trial Offer, also our interesting booklet J-82

SARCO CO., INC.
239 Broadway, New York City
Peacock Bros., Limited, Montreal



SARCO
TEMPERATURE
REGULATOR



The photograph shows two 14 in. three stage

De LAVAL CENTRIFUGAL COMPRESSORS

used in gas booster service. These compressors, handling 10,000 cu.ft. per min. of a gas of 0.6 specific gravity, raise its pressure to 5 lbs. gage when running at 3,600 r.p.m.

No matter what you wish to drive, you can to advantage use De Laval turbines, with or without gears. Ask for Catalog F-100.

DE LAVAL STEAM TURBINE CO. TRENTON, N.J.

De Laval Steam Turbine Co.

TURBINE EQUIPMENT CO., LTD.,
73 King St., West, Toronto.

THE E. LAURIE COMPANY,
243 Bleury St., Montreal, Que.

304

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE **METALLIC** PACKING

"MADE IN CANADA"

Here Is The Way To Stop Packing Troubles

Avoid packings that require frequent replacements, that score rods and add dead load to machine operation.

Your equipment deserves "JOHN CRANE" Packing. Costs far less in the end—avoids frequent shut downs; does not wear or score rods and runs practically without friction.

"Metallic Packing" and Chart

Keep abreast of packing science. Let us tell you of the greater economies and service you can enjoy through "JOHN CRANE" Packings. Why thousands of engineers are using them. Free upon request.

FLEXIBLE METALLIC PACKING CO.
WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS Packing and General Manufacturing Company, Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova Street, Vancouver, B. C.
Specify "John Crane" On All New Equipment.

Based on conservative estimates, SIL-O-CEL Heat Insulation saved One Million Four Hundred Thousand Tons of Coal for American Industry in 1923.

This saving continues and grows each year, for SIL-O-CEL lasts as long as the equipment with which it is used.

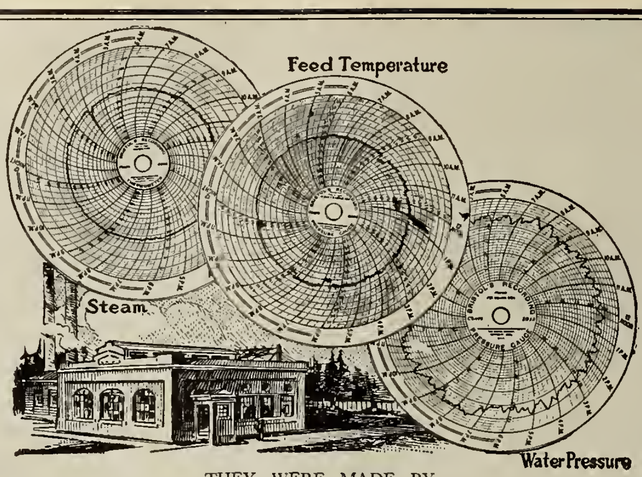
Whether you are repairing, rebuilding, or constructing —insulation is a profitable investment.

Ask for Bulletin W-6C. Free on request.

CELITE PRODUCTS LIMITED
New Birks Building
MONTREAL - QUEBEC

The History of One Day on these Three Charts

At the Winona Public Utility Company Plant.



THEY WERE MADE BY

TRADE MARK
BRISTOL'S
REG.U.S.PAT.OFFICE
RECORDING INSTRUMENTS

and analyzed by the plant owners, as follows:

"The steam chart gives us a record of the steam pressure 24 hours per day. The fireman knows that we have a record of the steam pressure and holds the steam where it should be at all times. He also knows that we have a record of the feed water temperature, and by a glance at the chart he knows if this temperature drops and goes after the trouble, which means a saving of fuel. The water pressure gauge shows the water pressure at all times, which is supplied by a motor driven centrifugal pump operating 24 hours per day. This chart makes a record of any excessive water consumption by a slight drop in the pressure. We have some 2 inch services, which when opened reduce the pressure about 10 lbs. You will also note at 12:30 noon a fire broke out and the fire pump was put on the lines for about 20 minutes which raised the pressure to about 115 lbs. From 9 o'clock at night to 4 o'clock in the morning you will note the chart to show an almost straight line as very little water is used this time of night."

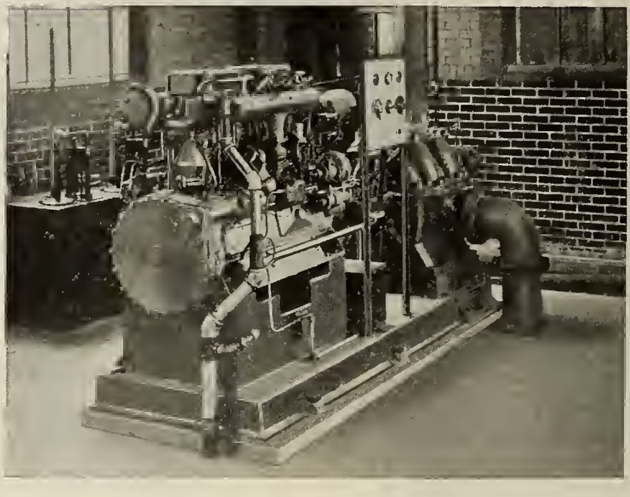
WRITE FOR CATALOG 1006-A.

THE BRISTOL COMPANY
Waterbury, Connecticut

Canadian Distributors:
EASTERN TERRITORY: Powerlite Devices, Ltd., Toronto and Montreal.
WESTERN TERRITORY: Gorman's, Ltd., Edmonton.

53 Cities and Towns in the Province of Ontario Insure Against Breakdowns

Sterling
THE ENGINE OF REFINEMENT

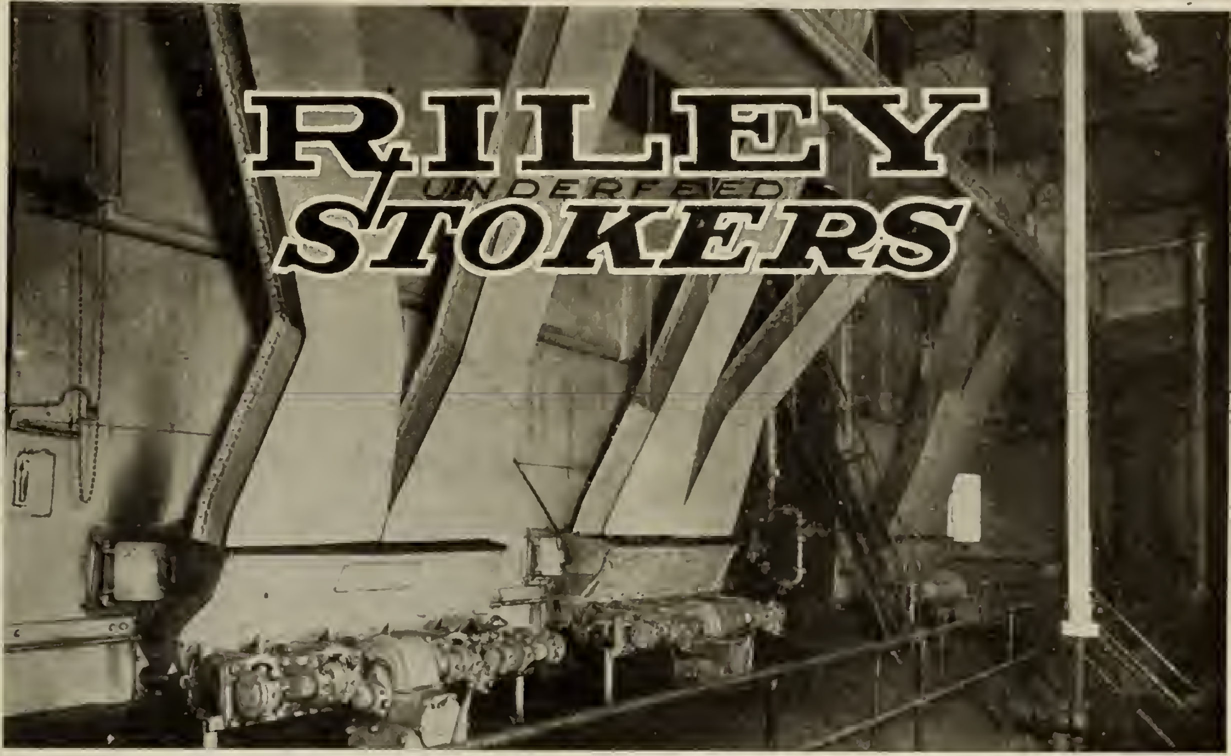


Kitchener, Ont., 4 cyl. 150 H.P. Sterling High Duty Internal combustion engine direct connected to Canadian Blower & Forge Co. centrifugal pump. An 8 cylinder Sterling is belted to an air compressor.

Low initial cost, no standby charge, usually pays for itself (comparing to steam standby) in about 2 years. Starts electrically.

Sterling Engine Co., (Dept. C4) **Buffalo, N.Y., U.S.A.**

Single Units up to 300 *H. P.*, 750, 900, 1150, 1200, 1450 *R.P.M. Can. Parallel.*



5 Retort RILEY STOKERS installed under 487 H. P., G. & McC. boilers.
Smith, Hinchman & Grylls, Consulting Engineers, Detroit.

More Steam at Lower Operating Cost

THE PROBLEM.

At the plant of Hiram Walker & Sons, Ltd., Walkerville, Ontario, more steam was required. Their boiler room contained 10—125 H.P. boilers. These boilers were economically fired but the plant layout in general was inefficient.

THE SOLUTION.

They replaced these *10* boilers with *3* of 487 H. P., fired by Riley Stokers which now gives them ample steam capacity. Although the normal boiler H.P. is increased but little the *actual* capacity is about three times greater because the Riley Stokers will operate the boilers up to 250% of rating or more. *When the above picture was taken two of the boilers were making 200% of rating.*

THE RESULT.

Greatly increased capacity with a *reduction in operating expenses.* The improved power plant layout with automatic coal and ash handling equipment and Riley stokered boilers has made possible a reduction in labor from 8 men to 2 men per shift. This saving in labor alone amounts to nearly $100 per day.

Find out what the Riley can do for you. Ask for the catalog.

The
UNDER-FEED
STOKER
COMPANY
OF CANADA
LTD.

The Under-Feed Stoker Co. of Canada, Ltd.
146 King Street, Toronto

"Jones" Stokers, "Riley" Stokers, "Murphy" Furnaces

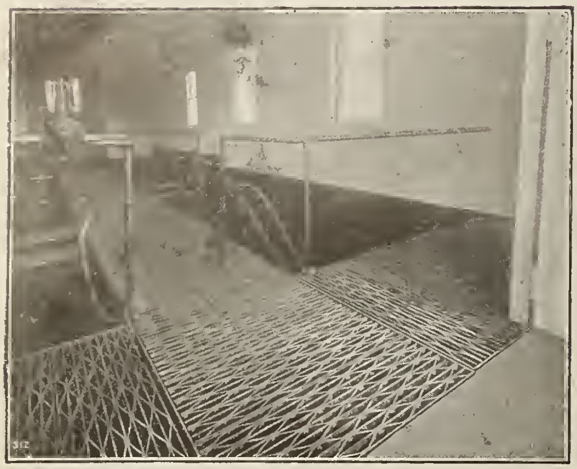
Alta. & West. Sask.:
Mr. J. Twomey,
Camrose, Alta.

Quebec:
The Cleaton Co., (Canada), Ltd.
Montreal, Que.

Man. and East. Sask.:
W. W. Hicks & Co.,
Winnipeg.

British Columbia:
B. C. Equip. Co.,
Vancouver, B.C.

IRVING SUBWAY
PATENTED TRADE MARK
THE FIREPROOF VENTILATING FLOORING



IRVING SUBWAY
TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

A floor of **Irving Subway** is not paid for on the installment plan. You buy it outright—your first payment is your only payment. There are no after costs—no maintenance and repair charges that are like irregular installment payments, steadily increasing the cost of the floor. The price you pay for **Irving Subway** is the total cost of the flooring. And—it buys extra value in permanent safety and comfort. Ask us for Catalog 4A50.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Canadian Agents:
Montreal, P.Q., 304 Coristine Bldg. Winnipeg, Man., 141 Bannatyne Ave. Welland, Ont., Standard Steel Cons. Co.

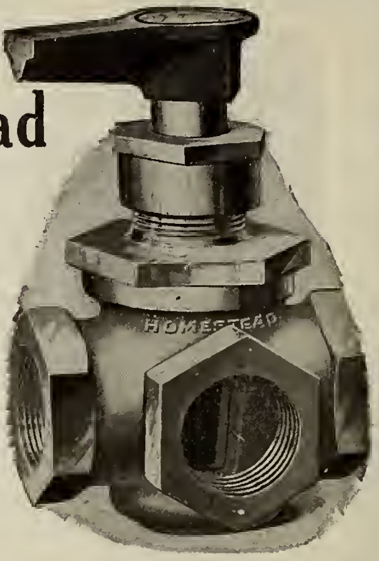
Manufacturers of

IRVING SAFSTEP
TRADE MARK
(PATENTED) REG. U.S. PAT. OFF.
ABSOLUTELY NON-SLIPPING ALWAYS

No. 11 W-143

Homestead

Quarter-Turn Valves
For Quick Opening and Quick Closing



Three-Way Valve.

You want a quick-opening valve, you want a quick-closing valve—then you should adopt Homestead Quarter Turn Valves. They are in addition always tight-closing, and provide an "unobstructed" flow. Homestead Valves are furnished in straightway, three-way, four-way and angle patterns. They are equally adapted for steam, water, air, gas, heavy, gritty fluids and any other power or industrial plant service. Used in thousands of plants in place of globe and gate valves. Order a few to-day.

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.
New York Office: 247 LAFAYETTE STREET

A Jointless Gastight Furnace Lining

The resistance of a furnace or firebox lining is weakest at the exposed edges of the brick, and may be remedied only in one of two ways: first, by setting the brick in Sternson No. 30 High Temperature Cement, or, secondly, by eliminating all edges and building a one-piece lining with

STERNSON NO. 40 MONOLITH

There can be no cracks where Sternson No. 40 Monolith is used. It withstands over 3,000 deg. F. and is not only more satisfactory and economical in operation, but is actually lower in cost than the old way of firebrick and mortar.

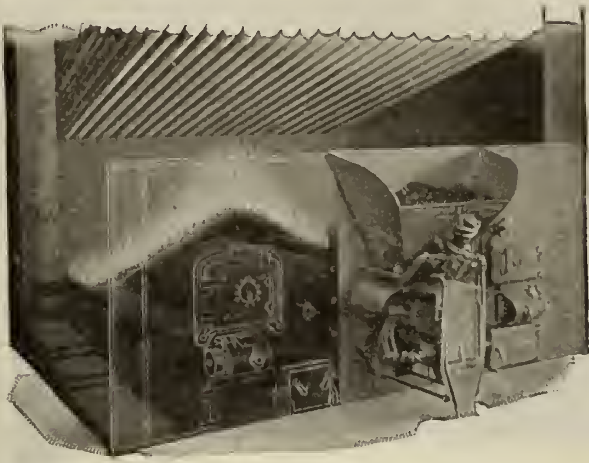
It is invaluable for repair work and is often used on the side wall without drawing the fire.

Write for Interesting Literature.
Let a Technical Firm Do a Technical Job.

G. F. Sterne & Sons, Limited
Chemical Manufacturers.
Consulting Chemical Engineers.
Brantford - Canada

Combustion Engineering Corporation,
Limited

Type E Stoker



THIS stoker is of the underfeed, single retort type, with ample front observation doors and side dumps always under observation and control. The ash dumps are operated from the front of the boiler, and the fact that deep ash pits are not required permits the installation of this stoker where excavation is impossible, as the refuse can be removed on the floor line at the front of the stoker. Grate bars are air-cooled and are alternately moving and fixed. The moving bars have a short upward and outward motion which may be regulated according to the requirements of the fuel. The active part of the fire is continuously self-cleaning:

A few special features of the Type E Stoker are:

The entire length of the retort bottom consists of a sliding member carrying the pusher block and the auxiliary pushers, insuring positive and proper feeding of the coal.

No separate drive required; the steam ram is an integral part of the stoker.

The action of the stoker is controlled by the operating valve mounted on the front of the hopper.

Air from the high pressure compartment passes through and cools the fire bars, and is thereafter discharged between the bars, entering the furnace at a temperature that will facilitate proper combustion.

This stoker is simple in design, may be quickly installed and insures high economy, large overload capacity, and continuous operation. It will burn a wide range of bituminous coals and is applicable to boilers from 150 H.P. up. It is the most widely installed stoker of its type in this country, which is possibly the best evidence of its efficiency and reliability.

REPRESENTATIVE USERS

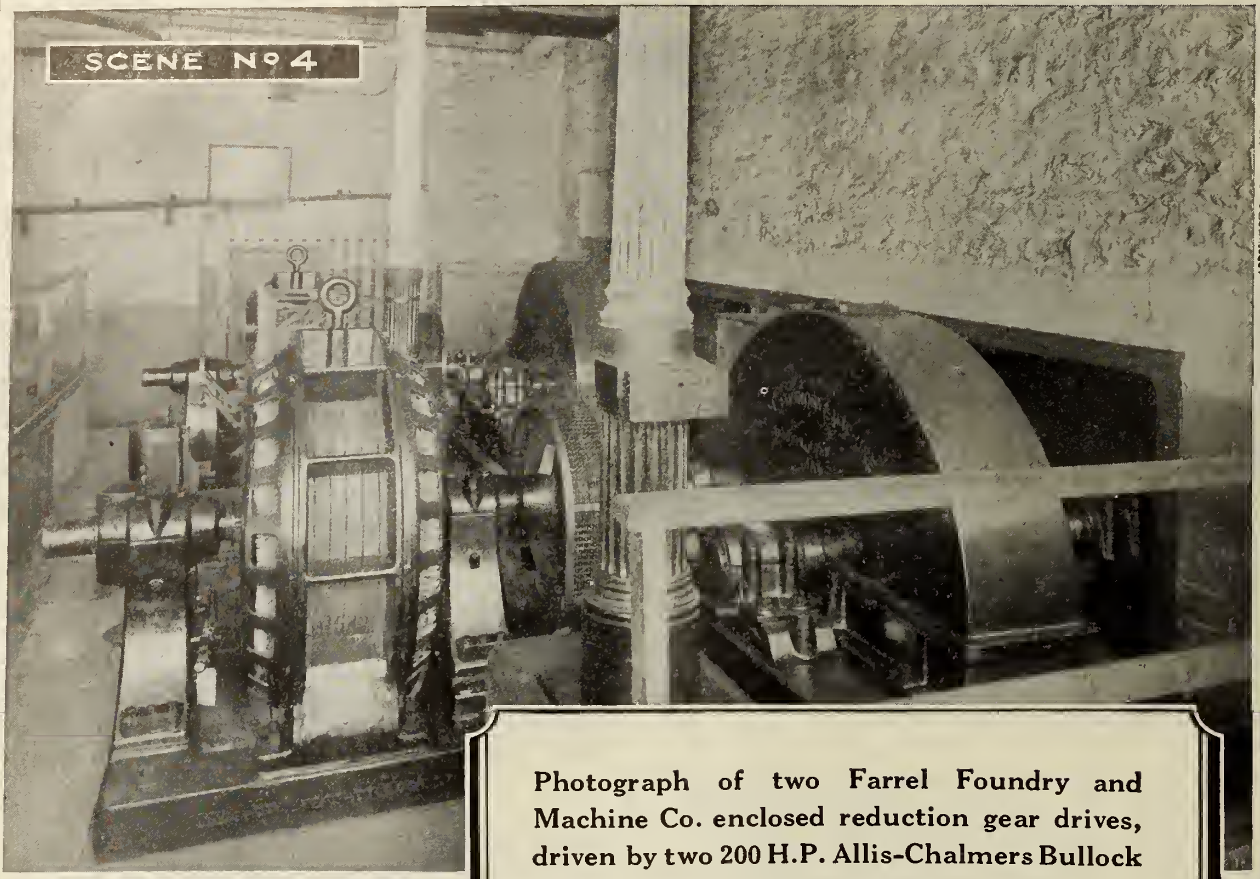
Pacific Mills, Ocean Falls, B.C.
Canada Paper Company, Windsor Mills, P.Q.
Canadian National Railways, Moncton, N.B.
J. R. Booth, Ottawa, Ont.
Spanish River Pulp and Paper Mills, Espanola, Ont.
Granby Coal Mines, Cassidy's, B.C.
Laurentide Paper Co., Grand Mere, P.Q.

Combustion Engineering Corporation, Limited
Head Office: Toronto

Type E Stokers
Type K Stokers
Coxe Stokers
Self Contained Stokers
New Frederick Stokers
Green Chain Grate Stokers
Green Cast Iron Hoppers
Quinn Oil Burning Equipment
Lopulco Pulverized Fuel Systems
Detrick Flat Suspended Arches
Combusco Water Seal Ash Conveyor
Elliot De-Aerators and Condensers
Custodis Chimneys
Uehling Co. Recorders
Beaumont Coal and Ash Handling Equipment

Howden Steam Turbines, High Speed Engines and Howden Ljungstrom Patent Air Preheaters.

Montreal **Winnipeg** **Vancouver**



Photograph of two Farrel Foundry and Machine Co. enclosed reduction gear drives, driven by two 200 H.P. Allis-Chalmers Bullock A.C. Motors. Motor Speed 290 R.P.M.

Imperial Lubricants in use:—

Imperial Renown Oil.
Imperial Polarine Transmission Oil.

IMPERIAL
LUBRICANTS
FOR MANUFACTURING, MINING AND MILLING

CYLINDER OILS
Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS
Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil
Imperial Turbine Oils
Imperial Eldorado Castor Machine Oil

FOR VARIOUS INDUSTRIAL USES
Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Ink Oils
Imperial Greases.

It is not at all unusual for plant operators to report lubrication savings up to 35 per cent. following standardization on Imperial Lubricants. Economies which are immediately evident reflect our exhaustive study of industrial requirements as well as the scientific methods which govern the manufacture of our complete line of industrial oils and greases. Write our nearest branch for information on any lubrication problem. Your letter will be followed up personally by our expert lubrication engineers.

IMPERIAL OIL LIMITED

KITCHENER AND WATERLOO COLLEGIATE & VOCATIONAL SCHOOL
C. Patrick

S. B. Coon & Sons, *Architects* KITCHENER COLLEGIATE Anglin Norcross, Ltd., *Contractors*

The entire ventilating equipment for the great Kitchener Collegiate above and the Windsor-Walkerville Technical School was supplied by us.

It includes air washers with humidity control, supply and exhaust fans and fans for laboratory and toilet exhaust.

When the finest technical schools in Canada use this equipment to get more and better work out of scholars, there's a lesson for industrial plant executives.

Write to Dept. 101 for Catalogs.

Canadian Blower & Forge Company, Ltd.
Kitchener, Ontario

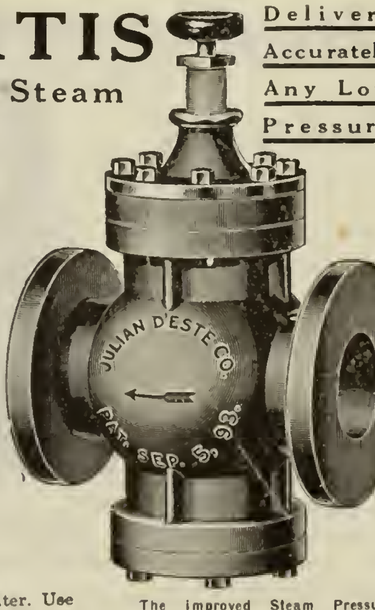
Toronto Montreal Vancouver Calgary St. John Winnipeg

CURTIS
Improved Steam Pressure Regulator

Delivers Accurately Any Low Pressure

A compact, self-contained Regulator suitable for any boiler pressure. It delivers accurately and uniformly any lower pressure from one to within a few pounds of the initial pressure.

It has no levers, weights or projections; no glands or packing; no drip or leak of steam or water. Use it for efficient service on steam-heating apparatus, slashers, jacket kettles, air or water pumps, pulp mills, etc.



The improved Steam Pressure Regulator is a lock valve, very simple and sensitive. Send for descriptive pamphlet.

JULIAN D'ESTE COMPANY

Main Office: 26 Canal St., Boston, 14, Mass.

Free!

—this helpful book

32 pages — 8½ x 11 — will end your furnace troubles — no more poor linings

Jointless Fire Brick Co., P.H. 12-20-23
1142 Clay St., Chicago, Ill.
Send me the free book
Firm ....
Address ....
....
Att'n ....

BOILER EFFICIENCY ALREADY OBTAINED 88%

By Fitting the

HOWDEN-JUNGSTRÖM

PATENT

AIR PREHEATER

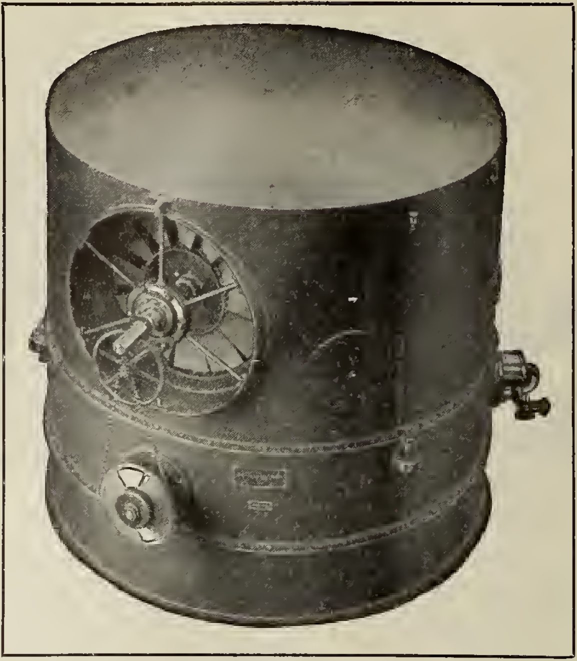
Eliminate Smoke. Reduce Fuel Bills.
Decrease Maintenance. Increase Efficiency.

Our Experience in Fitting Air Heating to some

26,000,000 H.P.

Is at Your Disposal.

Canadian Representative:
Combustion Engineering Corporation, Limited.



External View

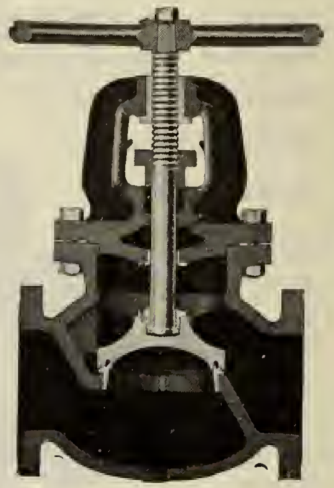
James Howden & Company, Limited

Engineers: GLASGOW Scotland

TORONTO MONTREAL WINNIPEG VANCOUVER

EDWARD *Extra Heavy*
Cast Steel Stop Valves

Designed to offer the least resistance to the flow, with full sized opening through seat, with body, bonnet and gland made of Electric Steel and flanges drilled in accordance with American Extra Heavy Standard of 1914, these EDWARD Stop Valves will give satisfaction under the most severe service.



Superior Valves for Exacting Duty

THE EDWARD PROTECTED SEAT AND DISC

This positive protection of the most vital organ of the valve — the seating surface — is used only in Edward Valves. It prevents cutting from wire drawing, especially under high pressures and temperatures where very small leaks rapidly grow owing to the terrific erosion action.

Send for descriptive catalogue of the Edward line.

The Edward Valve & Manufacturing Co.

General Office & Works : **East Chicago, Ind.**

CANADIAN AGENTS: Lytle Engineering Co., Limited, Montreal; Valve Engineering Company, Toronto.

"BURN ALL."

A Child Can Operate It.

Nonpareil Grates and Sexton's Firebrick Work make an ideal combination—use both. Renewals to all Shaker Grates.

New Year's Resolution!

Resolve, beginning with the New Year, to put "Nonpareil" shaking and dumping grates to the test. It will cost you practically nothing to try them. If they do not save at least 10 per cent. on your coal bills, we will take the grates back if you so wish. Get our guarantee first.

THE W. R. SEXTON BOILER SETTING CO.

Established 1900 - 114 Grenadier Road, Toronto *Phone: Junc. 2765W*

To You

our valued friends in all parts of Canada, we send our most hearty greetings and the sincere wish that the New Year may bring you happiness and prosperity.

May we all put our shoulder to the wheel and make 1924 a better year than the one now drawing to a close.

THE ARTHUR S. LEITCH CO., Limited, Toronto

High Grade Power Plant Equipment

DOMINION BELTING CO. LIMITED

HAMILTON - CANADA

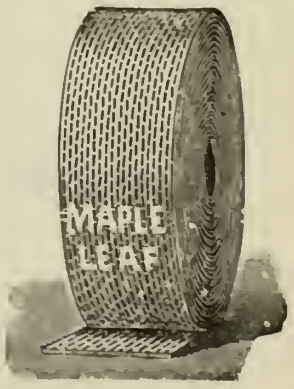
Quebec Branch, 51 Duluth Bldg., Montreal

Sole Manufacturers:

"Maple Leaf" Brand Stitched Cotton

Duck Belting, Belt and Dressing

The demand for our products has steadily increased because the standard of quality has been strictly maintained. We make only one grade, the best that can be produced. Write for prices and further information.



Babcock & Wilcox, Limited, of London, England.
The Goldie & McCulloch Co., Limited of Galt, Ont.

and

The Babcock & Wilcox Company of New York

wish to announce the formation of a new Company
known as

Babcock-Wilcox & Goldie-McCulloch, Limited

for the manufacture of Steam Power Plant Equipment and Accessories,
With Head Office and Works at Galt, Ontario

The Constituent Companies desire to extend to their clients
grateful thanks and appreciation of the confidence
extended to them in the past and express the hope
that the new Company will continue to
deserve and receive it in the future.

* * *

The Goldie & McCulloch Co., Limited

will continue in business as manufacturers of Safes, Vault
Doors, Vault Linings, Safety Deposit Boxes, etc.,
with Head Office and Works at
Galt, Ontario

November, 1923.

POWER HOUSE

ARTHUR MURPHY
Editor

CAMPBELL BRADSHAW, Managing Editor

J. MACTAGGART
News Editor

A Merry Xmas To All

ONE day this week the engineer of one of the Dominion's largest plants sat in his office and talked. All about him were boilers generating steam yet he evidently wasn't thinking of combustion problems or the ever-increasing cost of power when he said:

"It's fun to watch the big eyes of the kiddies when they think about Christmas; to listen to their prattle about Santa; to help them write a letter to the old Saint; to sacrifice a little to make them happy on their biggest day in all the year. Indeed, my wife and I not only plan for our own little ones, but to the extent of our limited means try to make it a Merry Christmas for other youngsters not as fortunate as ours.

"When we see our own boys and girls happy around their tree with the gifts we took so many pains to have just right, we imagine the Christmas spirit covers those other boys and girls too, at the moment, and makes them happy.

"While we think of Christmas as children's day, the children don't get all the joy out of the day. Sometimes the grown-ups, the givers, are even happier in their way. For can anything make one happier than knowing that he has conferred happiness upon others? Can anybody in this world be happier than the father and mother, who, tired after being up all night trimming the tree and arranging the presents, smile over the antics of the youngsters on Christmas morning?"

Yes, this engineer is right when he says Christmas is children's day, but—don't let's forget the old folk who are circling back to the time when Santa Claus seemed so very real — when Christmas morn brought them their heart's desire. The children and the old folk—it's up to the rest of us to make them happy at this time—the one looking forward to life, the other looking backward at life.

Sometimes the world is apt to forget how near to each other the children and the old folk are. Both are so simply satisfied and so easily made happy. Both need love so much and tender care. And while the one openly believes in Santa Claus, the other hugs his memory in secret.

Tuesday is children's day—old children and young children. Let's make it happy for one as the other so that there will be no wistfulness in the eyes of anyone Christmas morn—least of all, in the eyes of the old folk. Their time for giving much is past, but they have come again to that time, when, like the children, there is a wondrous joy in receiving.

* * *

Pulverized Coal

ATTENTION is frequently being drawn these days to the use of pulverized coal for the production of steam and while the system is not being used to any great extent in Canada, rapid strides are being made in the United States in the development of satisfactory methods to utilize it.

The problem has been taken up officially by the United States Bureau of Mines, and a federal bulletin has been issued setting forth the nature and uses of pulverized coal.

This bulletin defines pulverized coal, as coal which is so subdivided as to be capable of being burned in suspension when mixed with air.

Practically all coals from lignite to anthracite and coke-breeze have been pulverized and burned successfully, it is claimed, but anthracite and coke-breeze require more energy to pulverize them than do soft coals.

It is recognized, of course, that the cost of preparing the fuel tends to militate against its wider adoption, but it is possible to offset this by the fact that "slack" can be used at a price much lower than that of good coal.

Probably the two greatest difficulties experienced in the use of pulverized coal are, first the storage of the fuel in its pulverized state, and secondly the keeping of the temperature of the furnace within manageable limits.

Pulverized coal forms a highly explosive mixture with air and being very finely divided is easily disturbed by currents of air. To obviate this difficulty, however, the usual practice is to pulverize the coal as required, the pulverizer being a part of the boiler unit.

In one system, which is being widely adopted, the raw coal is conveyed to the bunkers from which it passes through a waste heat gravity dryer, in which the amount of moisture is greatly reduced before it passes to the mills to be pulverized.

From the pulverizer the fuel is exhausted and delivered through cyclone separators to bunkers arranged immediately above the boilers, the function of the separators being to eliminate as far as possible all air from the fuel.

From these bunkers the fuel is delivered through special burners by means of air under pressure in very much the same way as oil fuel, secondary air to complete the combustion being admitted through the furnace walls at suitable points. To keep the combustion chamber walls as cool as possible, these are made hollow and the secondary air serves the double purpose of cooling the furnace walls and assisting the combustion of the fuel, the air being thus preheated before it actually enters the furnace.

Learn a New Wrinkle

EVERY good thing that is done helps the one who does it, and also helps an untold number of others. Read what James E. Noble says: "My present subscription to Power House does not expire until August, 1924. However, I enclose a money order for $2.00 to extend it to August, 1925. I may say that in my estimation Power House is the best journal published as a helpful medium for the engineer who is striving to reach the position of chief. I am a subscriber to practically all the power plant journals printed in the English tongue, so I know what I am talking about.

"While employed as chief engineer at Rockwood Hospital, a government official asked me what journal I would recommend for the use of their stationary engineers, and I did not hesitate to name Power House.

"I did the same thing when chief engineer at the Eastern Hospital, London. Power House is printed so that the man with a common school education can read, understand, and put into practice for the benefit of himself and his employer, its entire contents."

Pumping Water by Compressed Air in Winnipeg

By S. J. MATHEWSON, Jr.

Low Operating Costs and Flexibility of Unit Big Factors in Making Air—Lift System Popular Since Method Was First Introduced About Ten Years Ago

THERE are many industries in which a constant supply of pure, cold water is an economy, if not an absolute necessity. In the city of Winnipeg, the water in the mains has an average temperature of about 70 degrees Fahr. for several months of the year, and for that reason plants requiring a steady flow of clean, cold water for one purpose or another have had to secure their supply from another source—namely, from artesian wells.

At first, the water from these wells was pumped by means of steam-operated, deep-well plunger pumps; but as both the static head and the pumping head vary considerably in different districts in the city, it was very difficult to determine beforehand the correct size of pump that would be needed.

About ten years ago the first air-lift was introduced, and it at once found favor owing to the low operating costs and the flexibility of the unit. The air-lift pumping plants in Winnipeg to-day range all the way from those operated by small vertical compressors to the installations at the Union Stock Yards, where an Ingersoll-Rand 16 and 10 x 14-inch, Type 10, 2-stage compressor is at work, and the St. Boniface water works where three of these units are installed.

By referring to Figure 1 it will be seen that the essential principle involved is very simple, and knowing the physical principles in action, it will not be difficult to understand why the air-lift pump has sometimes been charged with low efficiency which was really due to improper devices and faulty pipe proportions.

Consider Open Well

Consider an open well, or any body of water deep enough, regardless of its volume, or what may enclose it—a pond, lake or river being as good for our purpose as a well. In this source of supply is suspended, or fixed, a vertical pipe for water and a pipe for air. These pipes should be submerged for a certain depth, proportionate to the lift when the pump is at work.

It is clear that the water, being free to enter the lower end of the pipe, will rise to the same height inside the pipe as it stands outside, and in this connection there will be nothing to cause any movement of the water either upward or downward. If we introduce air under pressure through the air pipe into the base of the water pipe, we will have an air lift pump, and the principle of operation, briefly described, is as follows:

The energy operating the air lift is that energy in a volume of compressed air released in a fluid column in the form of bubbles at, or near the end of the submerged portion of the discharge pipe. And the driving force, causing the pump to operate continuously, is the unbalanced hydrostatic pressure in the discharge pipe resulting from a mixed column of water and bubbles of air of less specific gravity than the outside opposed column of unmodified water.

Power Loss Negligible

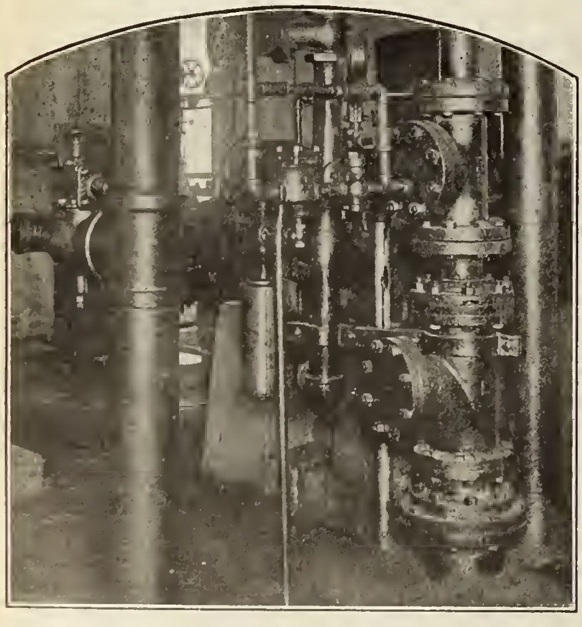
The supply is limited only by the amount available in the subterranean sources. Additional wells may be drilled or the old wells drilled deeper, without the necessity for either deep and expensive pits or concrete linings. The negligible loss in power through air transportation permits the central station to serve wells efficiently even though they are located a mile away from the central station.

Plantations, railway water stations, irrigation projects, large estates and stock farms are using the air lift because of the simplicity of its operation.

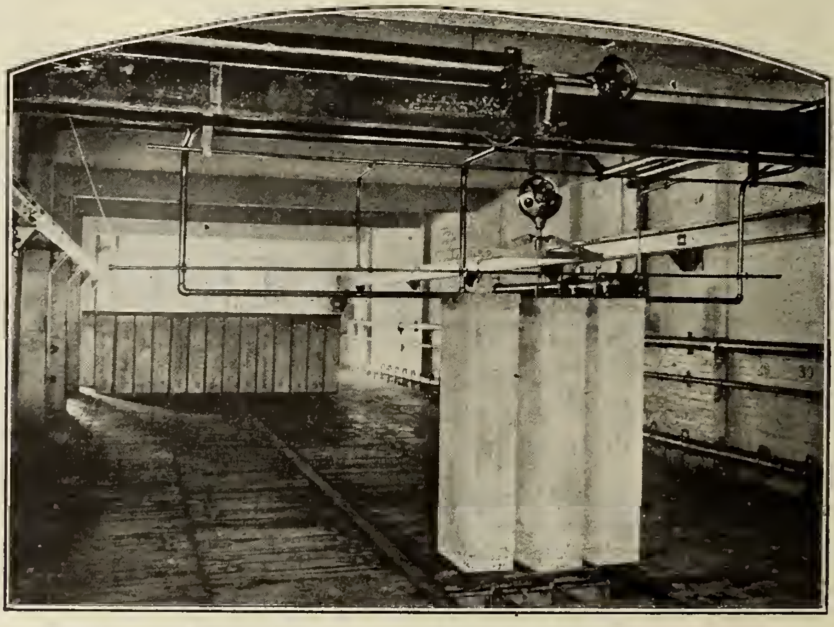
The low maintenance cost and the large capacity of the installations, combined with the flexibility of the entire system, are features which have earned recognition by many industries. Ice and beverage manufacturers, cold storage and packing houses, textile mills, dye works, bleacheries and sewerage installations in increasing numbers are using the air lift for raising water from drilled wells.

For pumping oil wells, dewatering mines and agitating chemicals, the air lift has established its position.

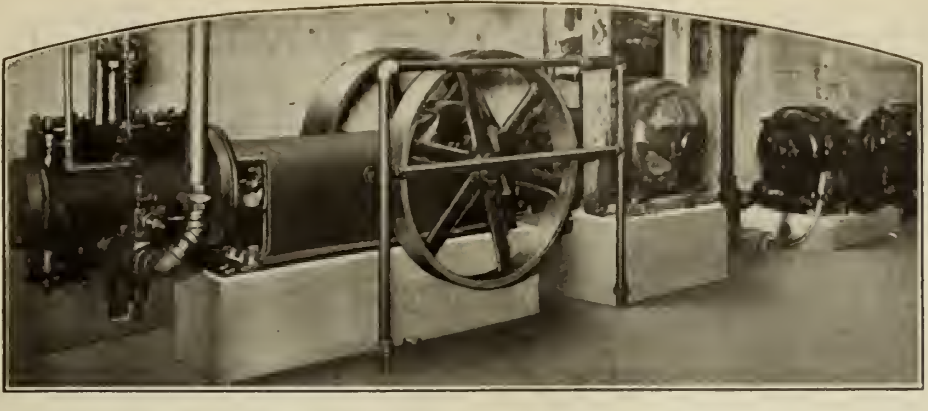
Two of the accompanying illustrations show the very simple arrangement of the



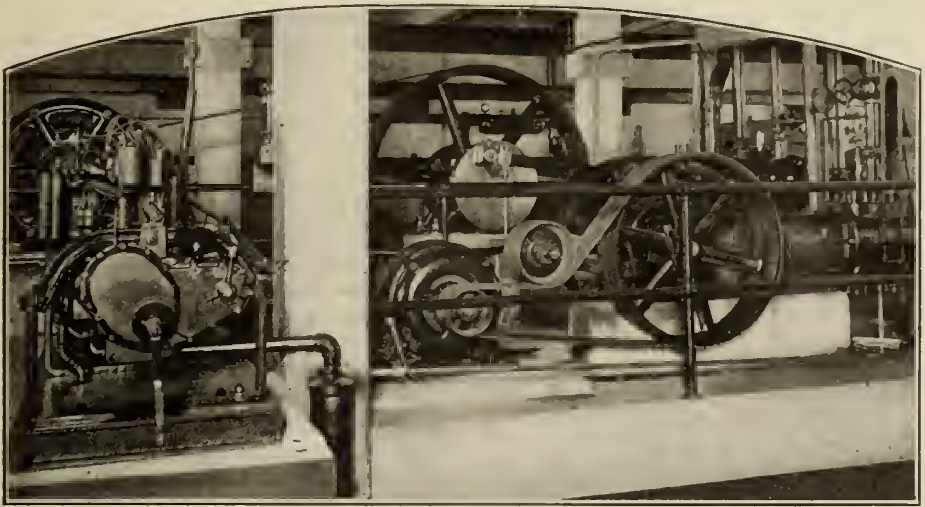
Here are the main features of an air-lift system as installed in the basement of an ice-cream plant.



In addition to using compressed air to operate the hoist in the tank room, the Arctic Ice Company employs this medium to pump water from an Artesian well and to agitate the water in the ice cans.



The 8x8-inch Class ER-1 compressor, with short-belt drive, which furnishes operative air for pumping water at the plant of the Crescent Creamery Company.



In background, compressor which has been giving good service for twenty years in the plant of the Arctic Ice Company, and is still going strong. In foreground, one of the 8x8-inch EL-1 compressors with emergency automobile engine at left.

Well head, with 90-degree headpiece, showing the simplicity of the outdoor features of the air lift at the Crescent Creamery Company's plant.

air-lift system at the Crescent Creamery Company's ice-cream plant at Wininpeg. This plant was using city water, and when it was decided to supply artesian water, the well had to be drilled outside the building.

Well 350 Feet Deep

This well is 10 inches in diameter and 350 feet deep; and the system consists of an Ingersoll-Rand, class VC air-lift pump with a 4½-inch water discharge pipe and a 1½-inch air pipe; of an 8 x 8-inch ER-1 compressor with short belt drive; of an air receiver, and of a Cameron No. 2½ DV pump.

The compressor, the air receiver, and the circulating pump were placed in a convenient corner in the basement of the building, and the air was piped out through a window to the well. The water, in turn, was piped from the well to a large surge-tank in the basement, from where it was distributed throughout the plant by the circulating pump.

It should be obvious that with this system of pumping there is nothing to wear out or to get out of order outside the building, and that it is not necessary to erect a shelter over the well. This is clearly shown in one of the illustrations. The total cost of this pumping plant, including the drilling, the well casing, and the installation of the machinery, was approximately $5,000. Allowing for operating costs, depreciation, interest on the investment, etc., the unit is effecting an annual saving of about $2,500; and, in addition the capacity of the plant has been increased about 15 per cent.

A Simple Adaptation

Another simple adaptation of the air-lift system is that employed by the Arctic Ice Company at their new artificial-ice plant at Winnipeg. Here the well was dug before the buildings were erected. This well is 8 inches in diameter and about 350 feet deep; and the water standpipe is carried straight up about 40 feet to the roof of the structure, where a small tank is placed. The demand for water is so constant that no storage is required, and the tank really serves only to separate the air from the water. The water flows from the tank through the plant by gravity.

This establishment is a striking example of how economy in air consumption can be effected by the application of proper engineering principles. When first put in operation, the ice plant required a compressor with a piston displacement of almost 500 cubic feet. Subsequently, the equipment was carefully gone over, with the result that the changes made brought about a saving of almost 50 per cent. in the consumption of air.

The economies were effected in two ways: first, all the air lines were checked up and, wherever possible, 90-degree elbows were removed, and, where a change of direction was necessary, long sweep bends were substituted for elbows; and, secondly, it was decided that the piping of the air-lift pumping system—that had been installed with a view to taking care of future requirements—

(Turn to page 39)

Selecting the Steam Engine in the Power Plant

*By CHARLES L. HUBBARD

Outstanding Features of the Different Types of Reciprocating Engines Must be Kept in Mind if an Intelligent Choice of the Power Unit is to be Made

WHILE the detailed construction of an engine is beyond the scope of the present article, there are certain parts, such as the valves and governing mechanism, which have an important bearing upon the classification of engines and their selection for different operating conditions.

First, take valves. The different forms of valves most commonly used at the present time are the plain slide valve of both the flat and piston type; the releasing and non-releasing Corliss valve; and the poppet valve used in connection with the "uniflow" engine.

A section through the cylinder and steam chest of a slide-valve engine is shown in Fig. 1. The valve consists of a flat plate with openings corresponding to the port openings to the cylinder.

It is rendered practically frictionless by means of a "pressure plate," shown directly above it, and so arranged as to allow the steam to act on both sides of the valve, thus balancing it and eliminating the excessive pressure and wear which would otherwise take place. The balancing feature is one which should always be looked into when selecting an engine of this type.

Another method of securing the same result is by the use of a slide valve of cylindrical form, which is balanced by equal steam pressures acting upon practically all parts, when in operation. The only exception to this is the varying pressure in the ports, when covered by the valve, a condition which calls for special construction in order to avoid leakage around the end section of the valve.

In order to reduce the effect of inertia, the length of travel is often reduced by making the valve doubleported. With this arrangement the same area of port opening is obtained by one-half the movement, other conditions being equal. In Fig. 2 is shown a piston valve of modern design.

The Corliss Type

The four-valve arrangement, with rotary valves of the Corliss type (see Fig. 3) is generally used when higher steam economy is desired. As the admission and exhaust-valves are operated independently, in most cases this design allows of a better timing of the different events of the stroke, such as admission, cut-off, release, compression, and so on, and makes it possible to secure more work per pound of steam than is possible with a single valve.

Furthermore, the quick action of the valves, especially at the point of cut-off, adds materially to the economy of the engine by preventing wire-drawing and loss of pressure.

Limits Condensation

This type of valve also makes it possible to reduce the clearance spaces, and limits cylinder condensation to some extent, because the live steam and exhaust steam pass through different ports, thus reducing the temperature range of the metal surrounding the supply passage during admission.

When both steam and exhaust valves are operated by means of the same eccentric and wrist-plate, the maximum cut-off obtainable is approximately ⅜ stroke, which limits the overload capacity to about 25 per cent. on a basis of ¼ cut-off for normal load. By using separate eccentrics for steam and exhaust valves overloads of 50 per cent. may be carried.

Corliss valves are operated by two forms of gear, the releasing and non-releasing or positive. In the first case, the steam valves, at the point of cut-off are closed by the suction of dash-pots, while with the positive type they are closed by the direct action of the eccentric, the same as the exhaust valves.

The advantage of the dash-pot is the quicker closing of the valve, but this limits the speed to about 120 r.p.m. For speeds above this, the non-releasing gear is used.

Deciding Normal Load

A steam engine is designed to carry a certain predetermined normal load, which is ordinarily about 70 per cent. of the maximum power which it will develop with the same initial pressure and speed, thus making it possible to carry 50 per cent. overload should occasion require.

The office of the governor is to maintain a practically constant rotative speed through a wide variation of load. In electrical work the variation is the entire range from "no load" to "full load."

While the speed variation should be small in certain kinds of industrial plants, where belt or rope transmission is employed, it is especially important

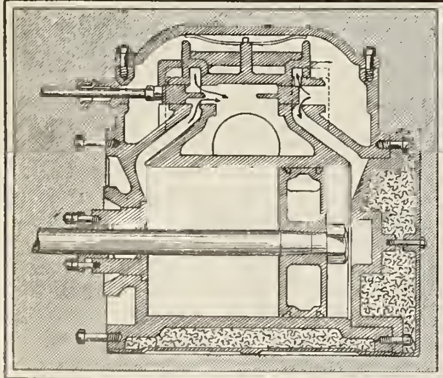


Figure 1: This shows a section through the cylinder and steam chest of a slide-valve engine. Note that the valve is practically frictionless, since steam pressure is allowed to act on both sides.

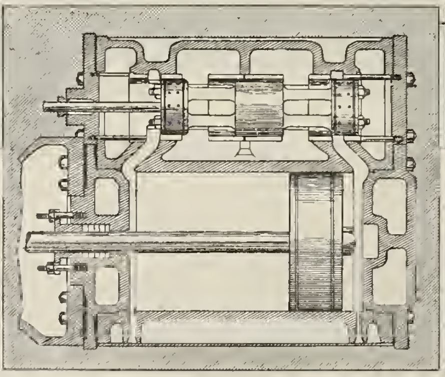


Figure 2: Sometimes small pistons take the place of slide valves as shown in the illustration. By a special design of ports the same size of opening is obtained by one-half the piston travel.

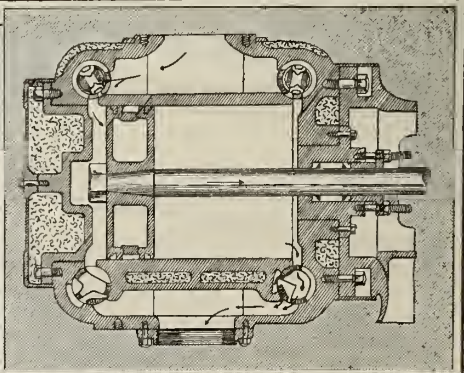


Figure 3: When higher steam economy is desired, the four-valve arrangement with rotary valves is generally used. A somewhat better timing is possible, since exhaust and inlet valves are operated independently.

---

*Consulting Engineer on power house problems. Reprinted in Canada by special permission from Factory, the Magazine of Management.

that it be reduced to a minimum where electricity is generated for power work and lighting. This is because the voltage produced by an electric generator is proportional to its rotative speed, so that a change in speed means a change in voltage, a condition especially undesirable in connection with incandescent lighting.

Governor Little Used

The throttling governor, which operates by lowering the initial pressure of the steam supplied to the engine, is not delicate enough for this class of work and is but little used except on steam-driven air compressors, pumps, fan-engines and turbines.

The cut-off governor, which varies the quantity of steam supplied to the cylinder per stroke, is commonly employed on engines used for the generation of power in industrial plants on account of its sensitiveness and close regulation.

A governor of this type is usually attached to the fly-wheel. The variation in cut-off is accomplished by means of a swinging eccentric, the position of the centre of which, with reference to the centre of the crank-shaft, is regulated by movements of the weight or fly-ball. When the load on the engine becomes less than normal, the speed at once increases, and the increase in centrifugal force acting on the weight overcomes the spring tension, causing the arm to swing outward. This, in turn, throws the eccentric toward the centre of the shaft, thus shortening its throw and causing an earlier cut-off.

Use Shaft Governor

Engines equipped with shaft governors of the general type shown, may be made to regulate within 2 to 4 revolutions per minute between no load and full load. In the case of Corliss engines with releasing valve gear, a fly-ball governor, similar to that used for a throttling engine, is commonly used, although it is made to vary the cut-off. Corliss valves of the positive type make use of the shaft governor.

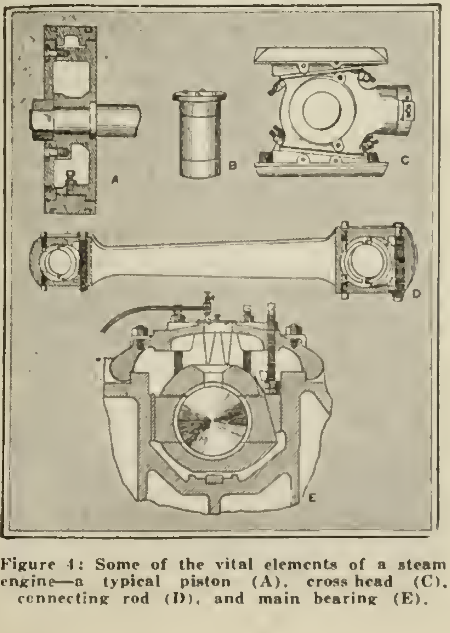


Figure 4: Some of the vital elements of a steam engine—a typical piston (A), cross head (C), connecting rod (D), and main bearing (E).

Without going into details it will be interesting to examine drawings of some of the principle parts of modern engines of the latest design, showing methods employed for adjustment and taking up wear. In Fig. 4 are shown a typical piston, cross head assembly, connecting rod, and main bearing, respectively.

The engines used for the generation of power in shops and factories may be included in six general classes, as follows:

1. High-speed, single-valve, simple engine.
2. High-speed, four-valve, simple engine.
3. Medium-speed, four-valve, simple engine.
4. Low-speed, four-valve, simple engine.
5. Compound engine, and
6. Uniflow engine.

High-speed, single-valve, simple engines are commonly made in sizes up to 100 horse-power or more, and vary in speed from 300 r.p.m. for the smaller sizes, down to 150 r.p.m. for the larger ones. These engines are enclosed, self-oiling and equipped with balanced valve and shaft governor.

Having the fewest parts of any type they require a minimum of attention, and are the least expensive to instal. When floor space is limited or costly, and the exhaust may be utilized for heating and manufacturing a considerable portion of the time, they are suitable for units up to 200 or 250 horse-power, and for larger sizes where practically all of the exhaust can be made use of and where a compact unit is desired.

When more power is required or greater steam economy is necessary, owing to the inability to use all of the exhaust, the four-valve engine should be considered.

Single-valve engines show a fairly constant water-rate from 50 to 125 per cent. of normal load. Below 50 per cent. load the economy falls off rapidly. Steam pressure of 80 to 120 pounds are commonly used, with 3 to 4 expansions under normal working conditions. The water-rate runs from about 28 to 36 pounds per i.h.p. per hour, depending upon the size.

Give Higher Efficiency

The high-speed, four-valve type of engine is equipped with Corliss valves, and non-releasing valve gear, which permits of its being operated at practically the same speed as the single-valve engine. The four valves, however, give a somewhat better steam distribution and higher efficiency, and this type is more often considered for units of 200 horse-power and over where the cost of fuel is high and steam economy of greater importance.

The first cost of an engine of this type is somewhat greater than for the single-valve machine, but considerably less than for the slow-speed Corliss, on account of less weight per horse-power, due to its higher rotative speed.

They are built in sizes up to about 1,000 horse-power, use an initial pressure of 100 to 125 pounds with 3 to 4 expansions, and have a water-rate of 23 to 28 pounds under favorable working conditions.

While the majority of multi-valve engines employ four rotary valves of Corliss type, there are standard makes using both two, and four, slide valves for securing the same results. This type of engine is particularly well adapted for direct connection with electric generators of medium size on account of its high speed, which makes it possible to use a considerably smaller machine for the same electrical output.

Four-Valve Engines

Medium-speed, four-valve engines do not strictly form a class by themselves, but include the smaller sizes of Corliss engines with releasing valve gear, which have a maximum speed up to 120 r.p.m., and the larger sizes of the non-releasing four-valve machines where the maximum speed is around 150 to 175 r.p.m. These employ an initial pressure of 90 to 115 pounds and have a water-rate of 23 to 27 pounds per horse-power, or more, and are especially adapted to industrial plants of fairly large capacity.

A typical engine of this kind is shown which illustrates the massive build of this class of machine.

The classification, "slow-speed, four-valve engines," includes the typical Corliss engine with releasing valve gear, which, until the advent of the perfected steam turbine, represented the highest type of prime mover for large power installations, and for rope driving and belted service in mills and factories is still a favorite type. The speed is limited to 100 to 120 r.p.m., and on account of this low speed, requires a comparatively large floor space and is highest in first cost. The depreciation is less than with the high-speed types, and it will probably maintain its original economy for a longer period than any of the previous machines described.

Needs 80 Pounds Pressure

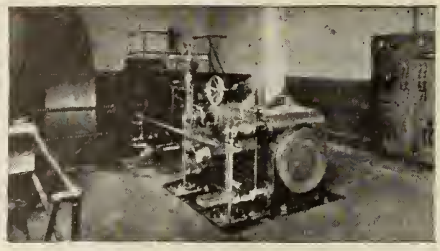
For direct-connected units this engine is not ordinarily chosen for generators of less than 500 to 750 kw., at which point the rotative speed and cost is the same as for the non-releasing four-valve type of engine. This machine is commonly supplied with steam at an initial pressure of 80 to 110 pounds and has a water-rate of 22 to 26 pounds per i.h.p. per hour.

Next come compound engines. The reasons for compounding have been given in a previous article in Power House. All of the different types of simple engines which have been described may be had in compound form, and when used in this way, retain their particular characteristics.

Compound engines are classified as tandem, angle, duplex, and cross-compound, according to their design. The

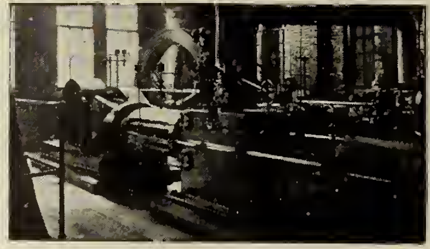
HIGH-SPEED, SINGLE-VALVE SIMPLE ENGINE

Size: Up to 400 h.p.
Speed range: 300 r.p.m. for smaller sizes down to 150 r.p.m. for larger ones.
Water rate: 28 to 36 pounds per i.h.p. per hour. Constant from 50 to 125% of normal load. Below 50% load economy falls off rapidly.
Steam pressure: 80 to 120 pounds with 3 to 4 expansions.
Features: Enclosed; self-oiling; equipped with balanced valve and shaft governor; has fewest parts; requires minimum of attention and is least expensive to instal.



MEDIUM-SPEED FOUR-VALVE SIMPLE ENGINE.

Size: Not strictly a class by itself as regards size for it includes smaller sizes of Corliss engines with releasing valve gear, and larger sizes of non-releasing four-valve machines.
Speed range: 120 to 175 r. p. m.
Water rate: 23 to 27 pounds.
Steam pressure: 90 to 115 pounds.
Features: Adapted to plants of fairly large capacity, have rather massive build.



HIGH SPEED, FOUR-VALVE SIMPLE ENGINE.

Size: 200 to 1,000 h.p.
Speed range: Same as for single-valve engines.
Water rate: 23 to 28 pounds.
Steam pressure: 100 to 125 pounds with 3 to 4 expansions.
Features: Equipped with Corliss valves and non-releasing valve gear: four valves give better steam distribution and higher efficiency; considered where fuel cost is high and steam economy of greater importance; first cost greater than for single-valve machine but less than for slow-speed Corliss.

tandem is the most compact and the cheapest to build, and for these reasons is more widely used than any other. In this case the cylinders are placed end to end, and both pistons attached to the same rod. The remainder of the machine is practically the same as a simple engine.

The angle engine, as the name implies, has the two cylinders placed at right angles; the high-pressure occupies a vertical position and the low-pressure, horizontal. The crank and shaft are common to both cylinders. In the duplex engine one cylinder is placed above the other and both piston rods attached to the same cross-head. A single connecting rod conveys the power to the crank-shaft the same as for a simple engine.

The Cross-Compound

The cross-compound consists of two complete Corliss slow-speed units attached to the same crank-shaft. This type is the most expensive to build and requires the most floor space, but is extensively used in large power installations.

The advantages of the compound engine, as compared with the simple, are a higher ratio of expansion—from 10 to 12 in the non-condensing type; decreased cylinder condensation, due to dividing the temperature range; decreased clearance and leakage losses; equalized crank effort; and increased steam economy, resulting in a saving of 10 to 15 per cent. in the case of non-condensing engines.

Among the disadvantages are increased first cost; greater space requirements; more wear and tear; increased complexity; and greater radiation losses. They are built in all sizes and employ initial pressures of 120 to 160 pounds, depending upon the size and type.

The Uniflow Engine

The latest development in the reciprocating engine for steam, is the uniflow (or unaflow) engine. The economy curve for this type of machine is particularly flat, and for this reason is especially well adapted to the handling of variable loads.

The uniflow principle is employed for the purpose of reducing initial cylinder condensation, which constitutes one of the principal losses in the ordinary form of reciprocating engine. With the uniflow type, steam enters the cylinder at the ends, passing through steam-jacketed heads, and after cut-off and expansion have taken place, is exhausted through ports arranged around the centre of the cylinder which are uncovered by the piston at the end of its stroke.

With the arrangement of cylinder and valves of a condensing engine, the steam flows only in one direction, while in the usual, or counterflow type, it returns on its path at the end of the stroke, and is exhausted at the same end of the cylinder at which it entered.

By this method the cooler expanded steam passes over the cylinder walls and head during 50 to 75 per cent. of the return stroke, thereby cooling them to such an extent that a considerable amount of entering steam at the next stroke is condensed before the point of cut-off is reached.

Multiple Expansion Types

The object of multiple expansion engines, and the use of superheated steam, is to reduce cylinder condensation, but the use of multiple expansion engines complicates the mechanical construction of the engine and increases its cost, while the use of superheated steam results in a certain heat loss and also adds to the cost of installation and operation as well.

The uniflow principle reduces cylinder condensation without superheat, and simplifies the mechanical construction of the engine at the same time. The water-rate varies somewhat with the make and size, but is considerably less than for counterflow engines operating under the same conditions. Published reports of tests run from about 20 to 24 pounds of steam per horse-power per hour for non-condensing engines at full load, down to 13 to 14 for condensing.

From the construction of the uniflow engine it is evident that compression begins as soon as the piston covers the exhaust ports on its return stroke, and therefore continues for about 90 per cent. of its length. With a fairly good vacuum, compression will not rise above initial pressure when running condensing, unless the vacuum for some reason should fail.

Regulating Compression

As fully 90 per cent. of the steam engines in use are operated non-condensing, it is evident that some means must be provided for limiting the compression when starting at, or slightly above, that of the atmosphere. This, in one make of engine, is accomplished by delaying compression through the use of auxiliary exhaust valves placed at that point in the cylinder where it is usual to start compression in a non-condensing, counterflow engine. These valves come into action automatically when the pressure in the exhaust pipe exceeds a predetermined limit.

The condensing engine makes use of a special combination valve which acts as an automatic relief valve when run condensing, and which may also be opened by hand, thus throwing into use additional clearance space when used for non-condensing service.

In some engines the steam is expanded from a small clearance, and by the automatic action of the single sliding valve, is allowed to compress, first into a large chamber, and finally, as the piston nears the end of the stroke, into a small clearance. The steam which has been compressed in the large chamber enters the

LOW SPEED, FOUR VALVE SIMPLE ENGINE.

Size: For direct-connected units this engine not chosen for generators of less than 500 to 750 kw.

Speed range: 100 to 120 r.p.m.

Water rate: 22 to 26 pounds.

Steam pressure: 80 to 110 pounds.

Features: Until advent of steam turbine, represented highest type of prime mover for large power installations. For rope driving and belted service in factories is still a favorite type although highest in first cost.

UNIFLOW ENGINE.

Water rate: 20 to 24 pounds for non-condensing engines at full load down to 13 or 14 pounds for condensing.

Features: Latest development in reciprocating steam engine; well adapted for variable loads; reduced cylinder condensation without superheat; simplified mechanical construction; cost per unit of power is greater than for ordinary single-cylinder, high-speed machine, but less than that of slow-speed multiple expansion engines.

COMPOUND ENGINE

Tandem and angle compound engines: Most compact; cheapest to build; more widely used than others.

Advantages of compound engines: Higher rate of expansion; decreased cylinder condensation; decreased clearance and leakage losses; equalized crank effort; increased steam economy.

Disadvantages of compound engines: Increased first cost; greater space requirements; more wear; increased complexity; greater radiation losses.

cylinder at the opposite end through the automatic action of the valve, and mixing with the expanding steam on the return stroke, expands with it and passes out through the central ports with the exhaust.

The comparative simplicity of a large uniflow engine is shown in the illustration, which also shows the method employed in large units for reducing the friction of the piston. Ordinarily the weight of the piston is supported by the lower half of the cylinder, which is subjected to excessive wear in large machines, and, therefore, makes reboring necessary from time to time, which is an expensive operation.

By extending the piston rod through the rear head, and providing it with a sliding shoe, all pressure is removed from the cylinder walls except that due to the piston packing rings, which is exerted evenly around the entire circumference.

The cost per unit of power for this type of engine is greater than for the ordinary single-cylinder, high-speed machine, but less than that of the slow-speed multiple expansion engines with which it is designed to compete.

The essential features to be considered in the selection of an engine have already been covered, to a considerable extent, in the descriptions given of the different types of machines.

It is evident from what has already been said that there are no hard-and-fast rules to be followed, and that various operating factors must be taken into account as well as first cost and steam economy.

While it is usually assumed that a skilled engineer can be secured for any machine selected, the question of labor actually has a considerable bearing upon the choice of a prime mover. No engine is so good that poor handling, or unfavorable operating conditions, cannot make it an expensive failure. Hence, the availability of an engine room force of sufficient skill should always be taken into account when an engine of complicated construction and high steam economy is under consideration.

The second question to be looked into is somewhat comprehensive, and is usually covered by the term "local conditions." This, in a general way, comprises such considerations as available funds, space for generating machine, cost of fuel of various kinds, quality and quantity of feed water, possible use of exhaust steam, and the value of reliability or cost of shut downs.

All of these points are more or less fixed in any given case, and the task then becomes one of selecting the engine most suitable under the existing conditions, always taking into account plant efficiency rather than engine efficiency alone.

The more important characteristics of the different types of engines have already been given and need not be repeated, except to touch briefly upon the leading features.

Compared with other types of prime movers, the high-speed machines have the advantage of being relatively low priced. Furthermore, the fact that they are comparatively common improves the probability of securing competent attention. The important consideration with this type of engine is the proportion of exhaust steam which can be utilized during each yearly period, under normal conditions.

When all of the exhaust can be employed for useful purposes, the only steam chargeable to power is that which is condensed in the engine cylinder and piping, or leaks past the piston. As this seldom exceeds 25 per cent. of the total amount of steam supplied, it is a comparatively small item and more or less independent of the type of engine. In general, then, where any considerable proportion of the exhaust steam can be utilized, the amount of fuel chargeable to power will be but little less with a high-cost engine than with a high-speed machine of the simplest type.

Each Case Differs

Each case requires individual study in order to determine the comparative costs with engines of the various types.

The items to be considered ordinarily include fixed charges (interest, depreciation, taxes, and insurance; the sum of which is usually assumed as about 15 per cent. of the initial cost), attendance and supplies, fuel and water.

As previously stated, the economy, or fuel per horse-power per hour, may not, under certain conditions, be the determining factor where all things are taken into account, and the plant as a whole—generators, boilers and auxiliaries—must be considered, to make a true comparison.

MERCURY THERMOMETERS

A new method of thermometer tube construction known as the TAG-Hespe Red Reading Column has been developed by the Tagliabue Mfg. Co., Brooklyn. A broad red line shows from the top of the mercury column to the top of the tube. When the mercury rises it covers more of this red line; when the mercury falls a correspondingly greater length of the red line is exposed. The decided contrast between this bright red line and the metallic grey of the mercury brings to the accurate mercury thermometer the easy readability of the red spirit instrument.

TAG-Hespe thermometer glass (tubing) is in every way similar to ordinary lens front thermometer glass except that in TAG-Hespe glass the back of the fine capillary bore (up and down which the mercury travels) is made of bright red glass. This red streak of glass extends all the way from the top of the thermometer down to the bulb.

The red line attracts the eye at first glance and it is easy to follow it down and take the reading at its bottom which is, of course, the top of the mercury column.

What Usually Causes the Scoring of a Journal?

By THOS. H. FENNER

Editor of "Power House" Meets Former Editor of Canada's Power Plant Newspaper at U. C. C. of E. Banquet, as a Result Readers Get This Article on Hot Bearings

IN A RECENT issue of "Power House" the statement was made that a scored crank pin could be cured by lapping it, with a canvas cloth on which emery paste had been laid. It was also stated that if the pin continued to work hot after this treatment white lead would smooth it down.

Regarding the first part of this statement it would be a tedious operation, in the writer's opinion, to attempt to reduce the grooves caused by scoring in this manner, were the pin of any size.

The probability of white lead having any smoothing effect would also be remote.

Scored pins or journals of any kind should be a rarity in modern practice. In the old days, when bearings were made of brass, they were unfortunately only too common, but with the modern white metal bearing surface, a scored journal would be unknown.

What Causes Scoring?

In the first place, let us ask: "What causes scoring of a journal?" It is obvious it is friction from a surface or point that at the moment the scoring occurs, is harder than the surface of the journal.

Taking the old type of brass bearing first, these were often made of very hard material, and this tended to become surface hardened with continued use. As many shafts and crank pins were made of wrought iron, overheating of bearings was frequently followed by fairly deep scoring, both in the journal and the bearing. This was particularly the case where water had been used on them for prolonged periods, as was frequently the case in marine practice.

In this case there is no doubt that a part of the scoring was due to the corrosive action of the salt water used for cooling, in conjunction with the brass iron of the bearing and journal.

We may presume in the case of the brass bearing that overheating caused distortion of the brass, which resulted in a diminished bearing surface. The local heating in the spots that were bearing on the journal under this condition would then be intense, resulting in the breaking of the skin of the journal, from which would occur the grooves.

In the case of bearings with brass or cast steel shells and having babbitt metal bearing surfaces, scoring occurs through a somewhat different process. The cutting of the surfaces in this case is either caused through the babbitt having been allowed to wear down until the chipping strips of the shell have come in contact with the journal, or the babbitt has melted out of the shell, bringing about the same result.

Causes Deep Grooving

In whichever way the scoring is accomplished, the contact of the cast steel shell of a babbitt bearing with the journal results in immediate and usually deep grooving.

For the moment, so much for the causes of scoring. Before going into the question of the proper treatment, let us examine the statement that white lead acts as a smoothing agent.

White lead, as a temporary remedy for overheating, on certain types of bearing, has a wonderful effect. The place where it is most suitable is on a bearing where both rubbing surfaces are cast iron, such as the shoe and slipper of engine guides.

The writer has used it on this type of bearing on many occasions, and always with satisfactory results. It will, however, have no effect on the condition which caused the bearing to heat up in the first place.

To use a medical metaphor, it acts exactly as a salve applied to an external sore. The salve alleviates the external condition, but leaves the internal cause untouched.

The reason white lead has such a good effect on this kind of hot bearing, is because it requires considerable heat to make it flow, and this heat is taken from the bearing which is to be cooled.

It also has certain lubricating properties which water lacks. It does not fly off the face of the guide, but is carried up and down with the shoe, reaching all parts, and it has no tendency to cause sudden contraction and cracking of the cast iron, such as water has.

Lacks Abrasive Qualities

Another point is that it does not spray all its immediate surroundings, including the man who is applying it, as a stream of water directed against a moving object, such as a guide shoe, will do. It has no abrasive qualities, so cannot have any smoothing effect. It is suitable only for guides, because in any enclosed type of bearing, it is impossible to apply it.

Having thus disposed of white lead, let us look into the primary cause of hot bearings.

The first cause may be stated as, bearing set up too tight. The second as, bearing set up too slack, or worn slack. Third, bearing not receiving sufficient lubrication, and fourth, bearings out of line. In the case of the guide, which we have been discussing, there is another cause, which does not apply to the other types of bearings. The first three cases all practically amount to the same thing, and that is insufficient lubrication.

In order to ensure successful working there should be at all times a film of oil between the surfaces of the bearing and the journal surfaces. This is best achieved by forced lubrication, but can be attained with ordinary methods.

In the case of the bearing being too tight, there is no room for this oil film. If the bearing is too slack the oil runs out, or is splashed out at the ends by the continual hammering of the slack parts. If there is not enough oil given to the bearing the oil film disappears, and there is direct rubbing of the surfaces.

All three conditions result in overheating, and the cause in each one is insufficient oil or want of lubrication.

Bearings Out of Line

The fourth case, bearings out of line, is less frequent than the other three. When this condition is present it results in the load, for which the whole bearing surface has been designed, being carried on only a small portion of it. There is also often a side rubbing action on surfaces never meant to be in contact, as for instance, the cheek of the crank web. Where there is a fillet, considerable side friction is often thrown on this fillet. The result of the diminished bearing surface is to throw a greater pressure per square inch on those portions that are bearing than was ever intended, and the result is a hot bearing

Guide shoes and slides may be overheated due to a running condition, which occurs chiefly on compound engines, but may occur in a single cyinder job. It is not an unusual trouble on marine jobs, and in certain types of stationary work. It is due to a very light load, which in the case of compound engines, results in the low pressure cylinder doing no work. The low pressure crank is then carried around by the high pressure, during portions of the stroke, and if there is any slack in the guides, a slapping action is set up between shoes and guides which often results in very rapid heating up.

The same thing may occur in a single engine, where the flywheel is carrying

(Turn to page 40)

Pointers on Proper Commutator Maintenance

With Direct Current Motors 90 Per Cent. of Troubles Due to Neglect—Maintenance Rules Simple but Must be Rigidly Adhered to—Compressed Air Convenient Cleaning Medium

WHEN the word comes to the engineer in charge of a plant that a motor is not acting properly, his thoughts immediately concentrate on one particular part of the machine, namely, the commutator.

A large percentage of motor trouble can be traced directly to that important member. It may properly be termed the business end of the motor, and it is good policy to see that it gets the best of care and attention.

Most text books on electrical machinery give a lengthy list of probable causes of motor troubles. However, the purpose of this article is to give a few hints on the care of commutators from the viewpoint of the man directly charged with the responsibility of continuous operation. All the cases and remedies mentioned herein have been encountered in actual practice, and it is the earnest hope of the writer that some of them may be of benefit to readers of Power House.

Abide By Simple Rules

To ensure that smooth glossy, chocolate color of commutators so much sought by operators, several simple rules must be formulated and strictly adhered to by the engineer. Rule number one is that a regular daily inspection be made of all motors. It is only in this way that one can keep in touch with each motor's peculiarities, and promptly check any irregularity that may arise.

It is necessary to clean motors periodically. Compressed air is best for this purpose. The armature core should be thoroughly cleaned, especially the ventilating air ducts through the core, which are put there for the express purpose of creating a current of air through the core, thereby carrying away much of the heat generated in the armature windings. It is by no means an uncommon occurrence to find these ducts completely clogged with solid matter.

With motors operating in dusty places, particles of dust and the product of manufacture will often collect on the brush holders to a considerable extent. Under such conditions sparking at the brushes is not only dangerous to the motor, but the fire hazard to the building is greatly increased due to the possibility of flying sparks.

Clean Once a Day

Rule two is that all commutators should be wiped clean with a soft cloth each day. This is a very simple operation, but a very important one. Ninety per cent. of motor troubles originate from neglected commutators being allowed to get gummy with oil leakage from the motor bearings. Together with carbon and copper dust the oil will form a gummy smear on the commutator surface, the brushes then become saturated with it, and from that point it is but a short step to costly repairs.

A mixture of carbon and oil is a conductor of electricity, and it will eventually soak into the mica segments, resulting finally in leakage of current from bar to bar. A small arc will be set up between the two bars. This arc may burn itself free, but in the majority of cases it will increase in intensity, resulting in a burn-out between bars. Frequently food armature coils are ruined from the fusing together of two bars.

A clean commutator and brushes, kept dry and free from oil, will very rarely show signs of burning between bars. With this hazard eliminated the operator has taken a great step towards reducing to a minimum costly motor shut-downs and repairs. Therefore, make it a positive rule to keep every commutator on the job perfectly dry and clean.

Sandpaper a Nuisance

Sandpaper has no logical place in the operation of commutators, and the farther away it is kept from the smooth surface of a mass of copper and mica, so much the better for motor harmony. The same may be said of commutator compounds—that black, gummy stuff so often passed on to the man in charge as a cure-all for motor troubles. These compounds are largely a lubricant, and if lubrication is needed use paraffin or a small amount of machine oil, applied with a cloth.

Frequently troubles arise due to other causes. Glowing of the brushes at the surface of the commutator sometimes occurs. This can be due to a number of causes, such as incorrect brush position, brushes not properly spaced, high mica, and brushes covering too many bars. One serious case of glowing was corrected by substituting brushes ⅛ in. narrower than those in use.

Sparking Common

Sparking due to burnt spots on the commutator is a very common occurrence. These spots may be equally spaced, or they may occur at irregular intervals. In either case the cause of this particular trouble is often hard to locate. In one instance it was found to be caused by a loose coil connection to the commutator. The trouble was further aggravated by the fact that this loose connection was what is known as a "flying open."

Violent sparking would occur when the motor was in operation, then suddenly the sparking would cease. This would go on intermittently during the day. The trouble was finally traced to the loose armature lead, which would make and break contact, probably due to variations in the motor speed.

Open Circuit Effects

Effects of a dead open circuit are very apparent. There is a violent, snapping, bluish-green spark at each brush edge as the bar of the open-circuited coil passes beneath each set of brushes. The spark seems to reach out from the brush edge, and attempts to follow around the commutator. The bars to which this coil is connected will be found to be burned and pitted, and the mica segments between eaten out to a considerable depth.

In another case, black spots were found to be caused by one set of brushholders moving out of proper alignment. A strip of heavy paper was drawn about the commutator and the brush positions marked. The paper was than withdrawn and the marks measured. They were found to be unequally divided. The strip was then marked off in four equal divisions and the brushes set to these marks.

An overloaded motor will often produce burnt spots on a commutator. A frequent cause of burning is due to high mica. All or nearly all the bars will be found in this condition, leaving the mica segments protruding slightly above the surface. Continual sparking and heating results, due to poor brush contact. If this condition persists for any length of time, the commutator will become hot enough to melt the solder from the coil connections. A shut-down and a repair is then a certainty.

High Mica

In some cases, high mica is the result of several conditions in no wise chargeable to the operator. One of these is that the mica is of too hard a grade. The copper wears faster than the mica, leaving it protruding above the surface of the copper. Another is that the copper bars are considerably softer than the mica. This condition will produce the same result. Segment copper is usually drop-forged or hard-drawn. With hard-drawn bars the copper and mica will usually wear evenly. It is with cast-copper bars, formerly largely used, that most of the high-mica troubles arise.

Most of the men in charge of electrical equipment will work out their own salvation when troubles arise. Some will be content to turn down the commutator occasionally, and let it go at that. This method will give a smooth-running machine for a short time, but it is costly in labor and greatly shortens the life of the commutator. Some of them will be

(Turn to page 39)

Modern Practice in the Transmission of Power

With Drives From Gas Engines to Dynamos Engineers May Find a Little "Slip" Will Allow the Shock of the Explosion to Pass off Without Light Flickers

MANY engineers calculate the efficiency of a belt drive from the arc of contact on the smaller pulley. This arc of contact can be found by the simple rule of multiplying the difference between the diameters of the pulleys in inches by 4.75, dividing this product by the distance between pulley centres in feet, and then subtracting the quotient obtained from 180°.

It is wise not to have less than 168° of arc of contact, although any small reduction in this arc can be offset by the use of a wider belt.

It is obvious, however, that this cannot be done when the arc is less than a certain figure, as the belt will not wrap round the pulley sufficiently for it to get any grip.

Increase Arc of Contact

The use of tension pulleys on drives with high speed ratios and short shaft centres is sometimes advised. The tension pulley apparatus usually takes the form of a single pulley mounted on an arm which is pressed by a spring or weight so that it presses into the belt and takes up the slack, besides increasing the arc of contact on the smaller pulley.

Compared to the loss of power and continual troubles experienced with a drive with too high a speed ratio or too short centres, this tension pulley apparatus gives better efficiency; but experience has shown that this efficiency is much lower than that of a properly planned drive.

As compared with a free drive, a tension pulley brings from 20 to 30 per cent. more of the belt in contact with the driven pulley, yet this gain is secured at much cost. The pulley itself is a very expensive rig up. It acts like a brake upon the belt, and this is done at the cost of a large amount of horse power. The life of a belt so driven is a very short one compared to what it might be were it working as an open drive. The strain put upon the belt at the short distance between the bottom of the pulley and the point of contact with the driven pulley is enormous.

Oil Causes Trouble

By consigning the tension pulley bag and baggage to the scrap heap and running compound belts instead, there will be a gain of 70 per cent. in power, the drag taken off the engine, and a large saving of coal and lubricating oil secured. Waste oil from the tension gets on to the belt causing stretch and preventing the gripping power of the belt from doing its work.

These disadvantages may be attributed to two causes: (a) Double bending of the belting at points very close to each other; (b) tight belting. By far the majority of the troubles are caused by tight belting, which is a continual source of expense and annoyance. It may waste an enormous amount of power, and the gain of 70 per cent. mentioned above would be chiefly due to dispensing with tight belting.

Whenever a drive slips badly or will not take a heavy enough load, compounding the belts may solve the difficulty.

Run Tandem Belts

By running a second belt on the outside of the existing belt, 50 to 70 per cent. more power may be taken on a drive. The second belt tends to run a little faster than the belt next to the pulley face, owing to the diameter of the pulley being increased by the thickness of the belt underneath. This creeping of the outside belt tends to reduce slip and the effects of centrifugal force.

There are some cases where a little belt slip is useful; for example, with drives from gas engines to dynamos, a little slip allows the shock of the engine explosions to pass off without causing a flicker of the light or an unsteady supply voltage.

It is not wise to bend thick belting round very small pulleys, as some power is then wasted in getting the belts round the pulleys, and the belt is liable to be damaged. When driving on pulleys of 4 inches diameter and under, the belt ought to be barely ⅛ inch thick, on pulleys 4¼ inches to 8 inches diameter, not exceeding 5-32 inch thick, on pulleys 8¼ inches to 12 inches diameter not exceeding 3-16 inch thick, and on pulleys 12¼ inches to 18 inches diameter not more than ¼ inch thick. On pulleys over 18 inches diameter, double leather belting can be used with ease.

If the pulleys of a drive are too small for a very thick belt to be used, and there is not room for a very wide belt, compounding the belt will enable the desired amount of power to be taken. If necessary a third belt can be run on the other two belts, although this will not increase the capacity of the drive proportionately.

A safe working tension for single leather belting is 50 lbs. per inch of width, and for double leather belting 80 lbs. per inch of width.

Increase Belt Speeds

Horse-power being a product of feet per minute and effective pull in lbs., it is easy to increase the load of a drive by increasing the belt speed. This is a very simple solution to many belt transmission troubles, which is often overlooked.

For instance, if a 9-inch pulley is driving on to a 27-inch pulley through a 6-inch single leather belt, and it is desired to increase the load 33 per cent., by substituting 12-inch and 36-inch pulleys the same belting will take the load, and providing the shafting is capable of carrying the increased load, this is all that need be done to the drive.

Centrifugal force necessitates a limit to belt speed, the safe economic limit being 1 mile per minute or a belt speed of 5,280 feet per minute. Compounding the belts will enable higher belt speeds to be used, but it is wise not to exceed this figure, as this speed also coincides with the safe limit of periphery speed for cast-iron pulleys of ordinary construction.

Prevent Slip With Tallow

Some care of the belting is necessary to ensure satisfactory service. Dust should not be allowed to form into cakes on the pulley face or belting, as these prevent pulley and belt getting proper contact, and cause slipping. The life of leather belts can be lengthened by an occasional washing and brushing in warm water, afterwards greasing with melted tallow. Pure beef tallow is a very fine slip preventive and keeps the belts in good order. After this treatment the belts should be carefully and thoroughly dried before being put into use again. The use of resin defeats its own object and makes the leather hard and brittle, besides forming cakes on the pulley face and causing slip.

Chain Positive

The chain drive has come into favor for the transmission of power, owing to its positive drive and high efficiency. Opposition is sometimes given to chain drives because of their positive drive, it being thought safer to have a flexible link in the power chain so that at any undue strain this is the part to give. Belting fulfils this conditions admirably, but there are many cases in which it is very inefficient and the chain drive is the only satisfactory method to employ.

An efficiency of 98 per cent. for ordinary commercial drives, and 99 per cent. for efficient drives is claimed for chain driving. These efficiencies are much higher than that of the average belt drive, and indicate the great possibilities of chain driving.

Hints on the Cleaning and Handling of Motors

By J. J. CURTAIN, General Electric Co.

Proper Lubrication, Inspection and Adjustments Will be Amply Repaid With Dependable Service if the Initial Installation Has Been Properly Made

CANADIAN engineers should be impressed with the fact that a small amount of time given regularly to the cleaning, lubricating, inspection and minor adjustment of electric motors, will be amply repaid with dependable service from the motor and prolonged life of the electrically driven machine, assuming, of course, that the initial installation has been properly made and the motors rightly chosen to fit the service.

Proper motor installation involves some important considerations. The shaft should always be level, and correct alignment and proper distance should be maintained between motor pulley or pinion and the corresponding pulley or gear of the driven machine.

In case of belt drive, an endless belt should be used in preference to a laced belt. Care should be taken that the belt is not so tight as to cause undue wear or heating of the bearings or so loose that slipping will take place.

Allow Gentle Sag

In the location of shafts that are to be connected with each other by belts, care should be taken to allow of a gentle sag of the belt when in motion. It is desirable that the angle of the belt with the floor should not exceed forty-five degrees.

In the event that a number of machines are group driven it is preferable to locate machinery so that belts may run off from the shafting in opposite directions, as this arrangement will relieve the bearings from the extra friction and wear resulting when belts all pull one way.

Those pulling in opposite directions should be placed as near each other as practicable, while those pulling the same direction should be separated. By this procedure much of the friction on the journals may be avoided.

Cleanliness Important

If a dusty, dirty, or damp place is unavoidable, protection in the form of enclosing covers for the standard open motor or enclosure of motor by boxing should be employed. It should be remembered that in proportion as enclosure affects the natural property of an open motor to radiate its heat, provision must be made to balance this changed condition either by reducing the load on the motor or by some special provision whereby cool air may be introduced from an external source.

Enclosure of motors (by boxing particularly) should not be effected without exercise of proper precaution against possible overheating of motor. It is best to consult the motor manufacturer or competent repair man in such cases.

With motors without commutators the necessity of enclosing covers to protect the motor from dust, etc., is not so important, though it is always advisable to make the installation in as clean surroundings as possible. Dust, dirt and moisture can readily be wiped off the motor exterior, while dust may easily be blown from the interior parts with the aid of a small hand bellows or other source of compressed air.

Bearings and Lubrication

It is essential that bearings receive proper lubrication. The usual motor bearings have oil fed to them from reservoirs by rings which are hung on and turn slowly with the shaft, continually bathing the shaft and journal in oil. While the motor is at rest, the reservoirs would be filled (through the oil filler gauges usually provided) with good clean mineral oil till the oil level is just below the top of the oil gauge. As long as this level is maintained no more oil need be added.

Oil should not be poured through the hole at the top of the oil well, as the correct oil level in this manner is apt to be exceeded; furthermore, excess of oil is likely to result in overflow of the oil well into the armature or field coils, eventually weakening their insulation.

An occasional flushing out of the complete bearings and gauge with kerosene or gasolene is recommended, after which a new supply of clean oil should be used. At that time it is good practice to remove the oil well covers and see that the rings turn freely with motor running.

Direct Current Machines

With proper care a new commutator will soon take on a dark brown polish and then the only attention required is an occasional wiping, while running, with a piece of canvas (4 oz. duck). A new or newly turned commutator should be cleaned daily at first, till the brushes reach a good fit; this to prevent roughing, which occurs more readily than after the commutator has become polished. Excessive sparking tends to burn and roughen the commutator.

If sparking continues after the commutator has been cleaned as described above. the surface should be smoothed. either by using a piece of sandstone from which a segmental piece having the same radius as the commutator has been cut, or by pressing a piece of very fine sandpaper (never emery cloth) against the commutator with a block of wood shaped like the sandstone just mentioned.

The sandstone or paper should be moved back and forth parallel to the shaft while the motor is running at full speed. The commutator and brushes should be thoroughly cleaned after this operation.

Brushes and Adjustments

Brushes should be inspected frequently to see that they move freely in the holders and make firm and even contact with the commutator under the proper spring tension. As brushes will wear out in time it is well to keep a spare set on hand. When a new brush is put in, it should be fitted as follows:

A strip of fine sandpaper, a little wider than the brush, should be placed under the new brush after it is in place in the holder. The paper with the rough side against the brush should be drawn in the direction of rotation of the armature with the maximum tension of the spring exerted on the brush. Lift the brush to push the paper in the other direction. Repeat this operation until the brush has been shaped so as to make a firm and even contact with the commutator.

After cleaning away the carbon dust the motor is ready to operate and the commutator surface will soon take on a polish. Care should be exercised to see that the "pigtails" or flexible copper conductors are firmly fastened in place, so that they will carry the current from the brushes to the brush-holder proper. Caution should be observed to leave a light play in the pigtails, since if too tight they might tend to pull the brush out of line and also out of proper contact with the surface of the commutator.

The part of an induction motor that needs the closest inspection is the air gap clearance. This clearance is necessarily small. While the air gap is equal on all sides of the rotor, the magnetic pull will be even, but when, through bearing wear, the rotor drops down the forces become unbalanced and the tendency of the motor to rub against the stator on the wearing side is increased.

The air gap should be regularly tested with a gauge and this test should be verified by a visual inspection when the motor is running.

Electricity in the Power House

By J. A. BURNETT, M.E.I.C., Consulting Engineer, 205 St. James St., Montreal

PRACTICAL EXPERIENCE

ON ONE occasion a trouble man had been sent out to investigate troubles with a direct current motor starting rheostat, and had discovered a large momentary current in starting. In this case a 30 H.P.-110 volt motor drew 400 amperes from the line. This was the result of a weak field due to wrong connections as shown on Fig. 1. The correct method is shown in Fig. 2.

Starting Box Reversed

The writer had occasion to instal an overhead traveling crane with one motor for lift, as well as one for travel and cross travel of car. The lift motor started very badly, and it was found that the starting box (rheostat) was so connected that the high resistance units came last and the low resistance units first, i. e. "backwards." Naturally this was re-connected with excellent "pick-up" for the motor.

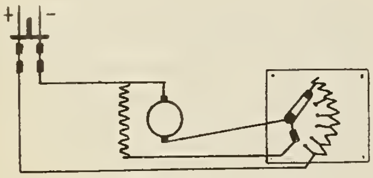


Fig. 1.

Bad Commutation

A large generator would not commutate well on heavy loads. It was found that the machine was guaranteed to over-compound from 550 to 600 volts, at 100 r. p. m., but on account of having to work in with other machines on a large system, it could not be operated above 550 volts as a maximum.

This caused the machine to work low on the saturation curve, and slight sparking at some points with a constantly shifting load. As the engine was relatively large compared with the generator, it was decided to lower the speed to 90 r. p. m. and work the field more nearly as designed. This change made the generator satisfactory to the local company.

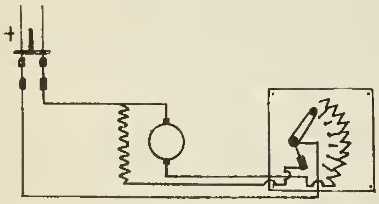


Fig. 2.

A rotating field alternator hummed badly, and investigation showed that the finger plates on the stationary armature were not stiff enough to hold the outer laminations firm between the coil slots. Several efforts were made to stop the trouble by upsetting the iron finger plates, without entirely stopping the trouble. Finally thin strips of mica were driven between the iron laminae, after having been coated with shellac. The method was successful.

Two belted alternators had never been successfully operated in parallel, although driven from the same shaft, and with pulleys of apparently the same diameters. A steel tape was run over each of the driving pulleys, and a difference in circumference of more than an inch, was found, as the driving pulley could not readily be turned, one of the driven pulleys was taken off and turned down to give the desired speed.

A lot of transformers connected in delta and in a system with a large amount of other apparatus, was found to be running too hot. Tests were made of efficiency, iron loss, regulation, cross currents, power factor, etc. Then someone discovered that the oil was low. When the oil was brought up to its proper level, the temperature went down to where it belonged.

A complaint was made that a compound-wound direct-current generator, in service more than a year, did not compound properly, and the switchboard attendant had frequently to adjust the voltage. Investigation showed that the load had been put between the negative and the equalizer, cutting out the series coil. When the matter was explained, the local electrician said he felt like an old man, who, after forty years, discovered that the clock he had wound daily was of the eight day variety.

Westinghouse Company In Japan

Gen. Guy E. Tripp Announces Formation of $7,500,000 Concern to Manufacture Electrical Machinery and Supplies

THE report of an arrangement between Westinghouse and Japanese electrical interests for the formation of a Japanese electrical manufacturing company, is confirmed in a cable this week from Gen. Guy E. Tripp, chairman of the Westinghouse board, and L. A. Osborne, president of the Westinghouse International Company, who are now in the Orient.

Fear Trade Balance

"The new company is known as the Mitsubishi Denki Kabushiki Kaisha, or in English, the Mitsubishi Electric Manufacturing Company," states E. D. Kilburn, general manager of the Westinghouse Electrical International Company.

"As a consequence of this rapid development, electrical apparatus has become one of Japan's largest imports, and since Japan's principal exports, silk, copper and objects of art, cannot be expanded by a corresponding degree, the Japanese began to feel that there was danger of a continuing unfavorable balance of trade. Hence it seemed wise to Japanese interests to begin the manufacture of electrical machinery and supplies in their own country.

"In pursuance of this policy, the important Mitsubishi interests which are engaged in banking, shipbuilding and steel making, approached the Westinghouse Electrical Company with a proposal for a co-operative agreement whereby the Westinghouse Company was to supply technical skill and experience to a Japanese manufacturing company.

"The Mitsubishi Electric Manufacturing Company is the outcome of these negotiations. The Japanese profit by the arrangement because of the employment it will give to Japanese workmen and the improvement in their foreign trade situation, while the Westinghouse Company profits by receiving a continuous revenue for service and royalties in lieu of exports, that it was certain to lose within a comparatively few years.

"The Westinghouse Company has subscribed for a portion of the stock of the Japanese Company.

"A third party to the agreement is Takata and Company, Japanese importers, 30 Church Street, New York. This concern which is the Japanese agent of the Westinghouse Company, will play a large part as distributor for the Mitsubishi Electric Manufacturing Company, and will also continue to import such Westinghouse products, as will be supplied from the American continent."

Practical Ideas From Practical Men

SHAFTING PROBLEMS

THE writer has taken a keen interest in power transmission matters during the past 15 years and has at this time a few remarks to offer which he hopes may be of interest and value.

An excellent way in which to align shafting longitudinally is to simply permit plumb bobs to be suspended around the side of the shaft, as indicated in the sketch. If several such plumb bobs are suspended in line, at least three of them, the engineer can see with his eyes whether or not the shaft is in alignment, and if the plumb bobs are very far apart he can stretch a thread close to the vertical threads leading to the plumb bob and measure the mis-alignment with accuracy.

The plumb bobs suspended in this way are all perfect tangents to the shaft and, knowing the diameter of the shaft, there can be no question as to where the centre of the shaft is all along the line.

On the other hand, in the case of aligning certain apparatus the writer has seen, the accuracy of the apparatus itself may be questionable, whereas with the plain suspended plumb bobs there can be no question at all.

Vertical Alignment

For aligning shafting vertically, the writer does not know of a better method than the use of an ordinary garden hose filled with water, with gauge glasses inserted in the ends, as indicated. No matter how far the ends of the hose are apart, the water will always assume a perfect level and the engineer can be certain whether or not the shafting is absolutely level.

The writer has seen this method used not only for aligning shafting but for laying foundations for machines and buildings and even for laying large floors.

Not long ago, in a prominent American newspaper, the following method was proposed for balancing pulleys. The author said:

"To counteract this extra weight, plant a bit of putty on the inside of the rim opposite the heavy side. By making a few trials with different amounts of putty, at different points on the inside of the rim, the pulley can be brought to a good standing balance. Never try more than one pulley on the shaft at a time. When a balance is temporarily made in this way, remove the putty, weigh it and substitute permanent weight slugs in the form of one or more pieces of strap iron. The weights should be securely bolted in the middle of the inside of the rim, not to one side of the web, because this would impair or destroy the line balance."

This method of balancing is inadvisable, because of the difference in weight of putty and iron per cubic inch.

If putty weighed exactly as much as iron weighs, and if the putty could be molded onto the pulley exactly as stuck in place in the same form and in exactly the same position, without any additional weights due to bolts, nuts, rivets, or anything else, a perfect standing balance could be brought about.

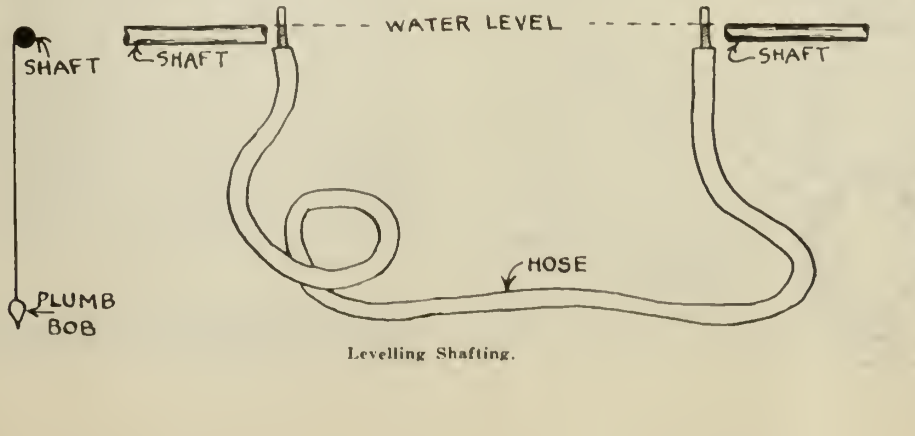
However, it is manifestly impossible to do an accurate job in this way because the iron slugs that will be bolted in place are heavier per cubic inch and consequently the mass is liable to be farther away from the centre of the shaft, and just as soon as the weight is farther away from the centre of the shaft the pulley is bound to be thrown out of balance again.

Also, in order to fasten the weight onto the pulley, bolts, screws, or metallic cement is required, and since all of these things have weight and are heavier than putty, their respective weights must be given consideration.

A better way to balance a pulley, if it can be done at all, is as follows:

"If a pulley is out of balance only slightly, it may be balanced by removing weight from the heavy side instead of adding weight to the light side—usually by boring one or more holes in the rim on the heavy side. Care must be taken, however, that the removal of this weight does not weaken the pulley."

The best way of all is a combination of the two above methods. Use the putty method "approximately" so that the slugs bolted to the pulley will be slightly lighter (not heavier) than the other side of the pulley. Then, to make the pulley balance, drill away a little metal from the opposite or heavier side and by cutting and trying a true balance is quickly attained. In this way the strength of the pulley will not be impaired by excessive cutting, and the desired balance will be found more quickly.



Levelling Shafting.

Another mistake commonly made is to neglect the thickness of the belt when making pulley speed computations. Belt thickness is often an important factor, especially on small pulleys.

Thus, to find the correct speed of a belt in feet per minute, add the thickness of the belt in inches to the diameter of the pulley in inches and divide by twelve. The result is the diameter plus the thickness in feet. Then multiply this by 3.1416 and then by the r.p.m. of the pulley and the result is the speed of the belt in feet per minute, assuming there is no loss due to creep.

In figuring the revolutions that will be made by a driven pulley, this matter of creep and belt thickness must always be remembered.

The correction to be made for creep depends upon the belt. For balata belting, friction surface rubber belting, and stitched and filled canvas belting, the writer usually allows one-half of one per cent., and for solid woven cotton belting, one per cent. For leather belting it is proper to allow one half of one per cent. to three per cent., depending upon the load transmitted. Creep depends entirely upon the elasticity and loading of the belt. Leather is more elastic than substitute belting, consequently a more variable allowance must be made. —W. F. SCHAPHORST.

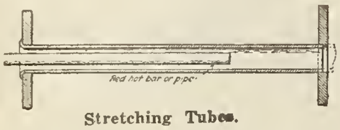
STRETCHING TUBES

Stretching boiler tubes on repair work or new work under construction injures the tubes and may endanger the lives of any persons who may be in the vicinity of the boilers in the event of the tubes rupturing. The stretching of the tubes is performed in the following manner:

A sufficient length is allowed at one end. The tube is then expanded in place, the expander removed and the tube flared and heated. A long pipe or bar is heated in a furnace and then placed into the tube. The tube expands to the point of the least resistance, and when sufficient length is secured, the heated bar is withdrawn from the tube and the opposite end is flared and expanded before the metal has any possible chance of shrinking to its original position.

Naturally, under these conditions, the tube sags and a strain is brought upon the tube close to the head. Moreover, the sagging makes it difficult to clean out the tube properly.

These conditions can be avoided only in the boiler shop by laying out the boiler plate so as to allow sufficient length for a standard size tube. Furthermore, it is important that a strong back be applied to each head and the tube sheet properly leveled before any tubes are expanded. If the tube-sheet flange should be slightly out of proportion, the next longest tube should be cut to suit the required length.



Stretching Tubes.

If a boiler already in service has developed a bulge in the tube sheet or headers and if the standard size tube which the boiler was designed for does not come within the required length, a new tube of extra length should be ordered immediately.

—ONTARIO INSPECTOR.

STEAM RISER SLEEVE

As a rule fire or building regulations require that steam risers be covered with some kind of sleeve where they pass through floors. Engineers are well aware that the proper fitting of such sleeves is often something of a difficulty. When a pipe line runs straight through a ceiling, all is well and good. The sleeve is fitted into place and quickly cut off at the desired length. The top rim will then be cut in a number of places with a pair of snips and the separate segments bent over so as to form a flange on the floor. This holds the sleeve in place, both on the floor above and at the ceiling below.

The difficulty comes when there is one or more T branches or other fittings between the beams. In such cases the sleeve must be cut away so much that it is difficult to make a workmanlike job of it and have it stay securely in place.

The engineer of a large office building in Montreal has noticed this condition and endeavored to solve the problem. By arrangement with a sheet metal worker, he has had special sleeves made for his own purposes.

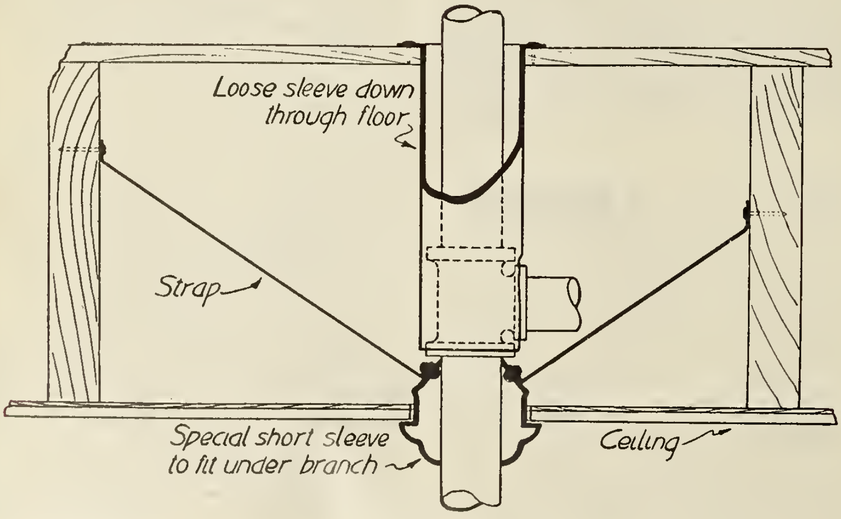
Fig. 1 shows a drawing of the type of sleeve used. The part expected to fit securely on the ceiling below is the one that usually gave trouble. This engineer has arranged for short sleeves, which will fit properly over the pipe line at the ceiling, and be held in place by two or three long straps riveted to the short sleeve at one end and nailed to adjoining beams at the other. This short sleeve has the escutcheon built into it just as the ordinary sleeve has, but it is only about three inches long and tapers immediately at the upper end so as to fit accurately the particular size of pipe. These sleeves are made in the different pipe sizes, just as the other sleeves are.

When this engineer has any repair work to do where there are branches in the risers between the beams, he uses the special sleeve at the ceiling. When the pipe line is in place it is then easy enough to make a sleeve for the upper part out of a plain piece of tin or galvanized iron. The upper part of the sleeve can be cut out, so as to fit around the branch, and the sleeve can be dropped into place easily and quickly and tacked down, if need be. The all-important part of having the ceiling end of the sleeve level in its place and held securely is accomplished only through use of the specially designed arrangement.

OIL PUMP TROUBLE

I was given the job of locating trouble on a duplex oil pump. The pump would lose its suction and race. It had been to a machine shop and overhauled, but still gave trouble. Upon investigation I found that the suction valves were not seating properly.

I used a scraper on the brass disks until they all seated as they should. Upon trying out the pump, the racing had been removed, but the pump would stop occasionally. This was due to its becoming gas bound. There was a 1-32 in. hole in each of the discharge valves originally, but the shop, in overhauling the pump had soldered these up. After these were drilled out, there was no more trouble. —MONTREAL ENGINEER.


Loose sleeve down through floor
Strap
Special short sleeve to fit under branch
Ceiling

Steam Riser Sleeve.

PIPE LINES

UNCOVERED IN ANY OLD SPOT

Under the sod
Lies Fireman Hale;
He winked and drank
Some "ginger ale."

* * *

If a bearing persists in running hot even though the babbitt is apparently in good shape, a small quantity of graphite introduced into the bearing will help. The graphite serves to smooth up any rough or uneven surfaces, so enabling a film of oil to be maintained.

* * *

Says Walter Hudson: "I prefer a sinner who swears once in a while to a saint who makes everybody else swear all the while."

* * *

Filtered cylinder oils separate from exhaust steam more readily than non-filtered oils. If the exhaust steam is to be used in "process" work in an open heater the filtered oil is the more suitable.

* * *

Herb Braund writes to tell us that he has never been "pinched" for going too fast—but he's been slapped.

* * *

Corrosion has been found in turbine installations. It occurs only, however, when the oil piping is steel or iron. Since oil will pick up grit, this in time turns the oil slightly acidulous and attacks the steel piping. Copper lines are always best.

* * *

Breathes there a girl with soul so dead,
Who never to her sheik hath said:
"WHEN DO WE EAT?"

* * *

Some engineers use the litmus paper test to detect presence of fatty acids. This is not always an indication, since the acids that may exist may not be soluble in water, and solubility is necessary to obtain the reaction on the litmus paper. Or the water used in the test may be so alkaline as to neutralize the acid in the solutions. If a small amount of the oil be placed upon a piece of bright brass the acid will etch the brass in about 36 hours.

* * *

We editors may dig and toil
Till our fingertips are sore,
But some poor gink is sure to say,
"I've heard that joke before!"

* * *

In practice a three-phase generator is one that has three armature windings so arranged that when one is generating a maximum voltage the other two will be generating half voltage, and in opposition to the first, or as they are referred to, as being 120 deg. apart.

* * *

The telephone operator was so ignorant—she thought Sherlock Holmes was a row of houses.

Every-day Problems With Answers

Queries are invited on the every-day problems of all industries. Read the questions and answers. If you have had similar problems, or know from experience how the condition can be remedied, do not hesitate to send in your comment or criticism. It will be some satisfaction to you to know that you have helped to solve a problem and a pleasure for us to pass on the data.

HEIGHT OF BRIDGE WALL

What is the proper distance between the bridge wall and the bottom of the shell of a 50 h.p. return tubular boiler? The bridge wall in our plant has been knocked out and in my opinion it is now much too low, the fire catching the shell almost at the back of the boiler.

Coal is burned in the winter months during the day and shavings and cuttings from the saws during the night. In the summer nothing but shavings and cuttings are burned.

The Dutch oven furnace is 12 feet by 4 feet 6 in. Natural draft only is used.

—ARTHUR SHEPLEY, Hamilton.

Ans.:—There is really no "hard and fast" rule as to the distance between the bridge wall and the bottom of the shell, however, there are a few rules which may be of some help to you in checking up the present height of the bridge wall in your plant.

The purpose of the bridge wall is chiefly to prevent the fuel from falling off the back end of the grates. Some claim that the bridge wall holds the heat to the boiler shell. Hot gases rise because they are lighter than cold gases, therefore, the hot gases will tend to stay against the boiler shell.

Some engineers however claim that they have secured better results by "holding" the fire next the shell by having the bridge wall and the combustion chamber built close to the shell.

For a 50 h.p. boiler the most common height of bridge wall is about 15 inches.

The area between the bridge wall and the shell should never be less than one-eighth the area of the grates.

CHARGING BATTERY

Can I keep the battery in my Ford car charged through the winter months by attaching it to a socket in the house? If it is possible to do so, explain the proper method in Power House.—GEO. THOMPSON, North Bay, Ont.

Answer:—If direct current is available it is possible to charge a storage battery by connecting the battery to the supply through a suitable resistance, commonly a bank of lamps. This method however is wasteful, although it involves very little expense.

In North Bay, the supply from the Hydro-Electric is 60 cycle alternating current. Storage batteries can not be charged by alternating current. To change the alternating current to direct current, the following three methods are in common use:—

Rotary converters.—These are confined to large powers as in central station work so need not be considered here.

Motor-generator sets.—In the motor-generator set a generator giving direct current of the proper voltage is connected to a motor which is supplied with the alternating current.

Rectifiers.—There are three common types of rectifiers on the market, the mercury arc, the vibrating armature, and the selective spark-gap.

They are in fairly wide use where only an alternating current supply is available, and where it is desirable to use relatively small quantities as in charging storage batteries.

It is not possible, under your present conditions, to charge a battery in a car by connecting to a socket in the house. If the supply is direct current, a resistance would have to be placed in the circuit; if alternating current only is available, it will have to be changed to direct current of the proper voltage by some one of the methods already mentioned.

METERING FEED WATER

I have placed a counter on a direct steam pump used for boiler feeding in order to register the number of strokes the pump makes in one day. From the calculated capacity of the pump per stroke, how accurately can the boiler evaporation be determined and what errors and corrections are introduced?—A. R. NORRIS.

Answer:—For making an evaporation test with reasonable accuracy, the means employed for determining the amount of feed water supplied to the boiler should be checked by calibration of the measuring apparatus before and after the test and under conditions that are identical with those under which the evaporative trial is conducted.

The objection to employment of a pump as a water meter arises from uncertainty in identification of the actual working conditions and, therefore, uncertainty in application of correct calibrations. The amount of slip from leakage of a pump per unit of time, determined with any usual working speed of pump, may be regarded as constant for all speeds and, in new pumps handling cold water, reasonably free from air, the loss of piston displacement from leakage and other causes of slippage is not usually greater than 3 per cent. at normal speed.

However, a computation of pump delivery, although based on piston displacement, actual number of strokes and calibrations, may be in error more than 10 per cent. on account of the difficulty in making proper allowance for variation in the lengths of the stroke and therefore, the metering of the feed water with a direct steam pump, without means of accounting for the variations in length of stroke as well as the number of strokes, could not be considered other than a rough approximation.

REFRIGERATION TEMPERATURES

We operate two machines, one fifteen-ton and one fifty-ton, and run with about 190 pounds high pressure and twenty-three pounds back pressure. Both machines are double acting. Is it best to run the discharge pipes hot or cold?

If we instal thermometers on both discharge and suction sides, what would you recommend the temperatures to be?

—A READER.

Ans.:—It is conceded that vapors from the refrigerator should come back to the compressor as nearly saturated as possible. Thus, in a refrigerating system where the temperature is below 32 deg., frost may form on pipes that are not insulated. When liquid ammonia, or other liquid refrigerant, is carried back mechanically in the suction vapors to the compressor, the frost forms on the pipe connections in a heavy manner; this is termed "Frosting Back."

It is generally accepted that there should be no liquid carried into the compressor; and the gas should only contain a few degrees of superheat in order to make sure that the liquid refrigerant is not being returned to the compressor.

Under the saturated condition of suction vapors, the largest weight of refrigerant will be handled and the largest amount of refrigeration produced.

Since your compressor is a horizontal double acting machine, general practice would seem to indicate that the machine should be allowed to frost back to the suction manifold. This may be regulated by proper adjustment of the expansion valve.

In some plants where the suction pressure is quite low, it is sometimes advisable to allow a small amount of liquid to be carried into the compressor in order to prevent the temperatures from becoming too high at the end of compression. This is necessary to prevent a cylinder with its stuffing boxes from becoming over-heated.

As a general rule, it is advisable to carry the frost line back to a point near to the compressor and to maintain the suction vapors at only five to ten degrees of heat.

It is advisable to instal thermometers on the suction and discharge connections to the ammonia compressor, in order that the degree of superheat of the ammonia vapor from the refrigerating coils may be controlled accurately.

In the case that the suction pressure is 23 lbs. gauge, the saturated temperature corresponding to this pressure would be 10 deg. F., so that under ordinary considerations the suction gases should have a temperature of fifteen to twenty degrees in order to insure that no liquid is being carried into the compressor. Under such operation, the temperature of the discharge gases would be from 220 to 230 degrees.

The installation of a thermometer on the discharge line is not necessary, since the operation of the machine may be controlled by the thermometer in the suction main. The advantage of having a thermometer on the discharge main lies in the fact that in the event the thermometer in the suction main is broken, the compressor may be operated by means of the thermometer in the discharge main, since by referring to the engine room log it would be possible to determine what the suction temperature should be according to previous conditions.

STEAM VALVE LAP

Why is lap given the steam valves of a single-eccentric Corliss engine?

Answer:—It is desirable to obtain early release of the steam after expansion and early enough closure of the exhaust valves to obtain cushioning of the piston by compression of the exhaust. This requires the eccentric which operates the exhaust valves to be set more than 90 degrees ahead of the crank.

With a single eccentric for operating both steam and exhaust valves, without lap on the steam valves, they would open more than necessary for the proper lead before the crank arrived at dead centre for the beginning of a stroke of the piston. Hence the lap is added to the steam valves to delay their opening until the proper time for admission of steam.

—S. HUGHSON

GRATE SURFACE

A cast iron boiler, used for heating an apartment house, is estimated to be twice as large as necessary. Would it be advantageous to build a bridge wall across the firebox so as to reduce the grate surface to half the present area and cover the rear end of the grate with firebrick to form a combustion chamber?

Answer:—Cast-iron heating boilers generally are provided with grate surfaces of sufficient size to require stoking not oftener than two to four hours, when the boilers are operated at proper capacities. Consequently, boilers of this type usually are designed with a fewer number of square feet of heating surface per square foot of grate than customary for power boilers.

Shortening the grate as proposed would require more frequent firing and the extra attention thus required for operating the boiler should be compensated by somewhat greater economy of fuel, although not from development of the proposed combustion chamber, since the furnace gases would have much lower velocity than in power boilers, where a combustion chamber is beneficial in securing better combustion by obtaining more thorough mixture of the furnace gases while at a high temperature.

—C. A. S. E.

AMMONIA CONDENSERS

I have replaced an atmospheric ammonia condenser by a double type condenser. Can the amount of cooling water be reduced? I understand the amount of heat transferred per square foot is higher in the double pipe.

Answer:—To cut down the condensation surface, the final temperature of the water must be raised or the volume of water increased.

For example, assume that a condenser having 60 lin. ft. of 2-in. pipe per ton of refrigeration requires 2 gal. of water per minute per ton of refrigeration, with a final rise in temperature of 10 deg. F. Suppose, now, that this condenser was replaced with one of the later types having only 30 lin. ft. of 2 in. pipe per ton of refrigeration to do the same work. The same two gallons per minute per ton would be required on the condenser having 30 ft. as on the one having 60 ft. if the final temperature of 10 deg. F. is assumed in each case.

—R. KYLE

STEPPING DOWN

Can a ¼-hp., 110-volt d.c. motor be operated on a 220-volt circuit? Is there any means of stepping down the 220 volts to 110?

Answer:—If the load were constant on the motor, it would be possible to connect a resistance in series with the machine to reduce the voltage at the motor terminals. On a shunt machine it will be necessary to connect a resistance in series with the armature and another in series with the field coils. The resistance in series with the armature will depend upon the load on the motor.

At full load the current will be about 2 amperes, and under this condition the necessary resistance to connect in series with the armature will equal 110 ÷ 2 = 55 ohms. The resistance to be connected in series with the field coils will depend somewhat on the design of the motor, but a 25-watt 110-volt lamp should be sufficient. It should be understood that this arrangement is only a makeshift and, unless the load is constant, the speed will vary inversely as the load. At no load the speed will be practically double that at full load.

If the motor is designed for a slow speed, it may be possible to connect a resistance in series with the field winding only and operate the armature directly on 220 volts and at double the speed for 110 volts.

There is no way of stepping the 220 volts down to 110 except with a motor-generator set, which is impracticable. The cost is so slight that the most satisfactory solution will be to rewind the machine, using wire of one-half the cross-section now used and double the number of turns in the coils.

—BOB RIDDLE

HEATER CONNECTIONS

In a plant, operated condensing, the boiler-feed pumps take their supply from a steel tank which receives the returns from the heating system and drips from traps and also the city water supply controlled by a float valve.

The feed pumps discharge through a closed heater set in the engine exhaust pipe between the low-pressure cylinder and the condenser. From this heater the water is discharged at about 85 deg. F. to another closed heater through which the feed pumps and condenser pumps exhaust and in which the feed water is heated above 200 deg. F.

Would it be advisable to pass the city water through the closed heater on the engine exhaust and then through the float valve in the tank, for pumping direct to the second heater, or would that make the water too hot to be handled by the feed pumps, especially when the engine is operated non-condensing?

Answer:—There should be no difficulty in handling the hot water by the feed pumps, but the proposed change does not seem warranted unless operat-

Can YOU Qualify for that Good Job?

HAVE you got a First-Class Certificate? You cannot get very far, cannot make the most money, until you have passed every examination. To-day it is easy to prepare yourself for any Certificate Examination. T. H. Fenner, former editor of "Power House," will train you by mail in your spare time through Shaw's Course in Stationary Engineering. There's a big demand for qualified men. Decide to-day to get full facts and details.

Write for syllabus to

SHAW SCHOOLS Ltd.
Dept. 101
46 Bloor St. West
TORONTO

ing non-condensing is practised considerably, and with low temperature of feed water discharged from the second heater. By admitting the city water to the heater connected with the engine exhaust, this heater would be of only little more assistance to operation of the condenser in receiving city water before it has become warmed by returns from the traps and the heating system, and the small gain for condensing purposes probably would be offset by losses from radiation and evaporation from the receiving tank.

—A. READER

CRANK END NOISE

When starting up a mill engine in the morning, there is in the crank end a grunting noise that lasts for a few minutes, but by the time the engine is up to speed with a steady load, the noise stops. What is the explanation?

Answer:—The irregular resistance when starting up the engine under the load of shafting and, probably also of laying on of machinery, combined with the turning effort of the engine, give rise to vibrations of the engine shaft that are transmitted to the main bearing and to the other parts of the engine.

When the engine gets up to speed, the vibrations are smoothed out and the noise ceases because irregularities of the load resistance and the varying turning effort of the engine are overcome by inertia of the flywheel of the engine.

—M. D. E. A.

HEAT FROM ENGINE

We would like to know the number of sq. ft. of direct cast iron steam radiation per engine horse power which could be heated with exhaust steam with a maximum of three pounds at the engine. The radiation is to be installed in the same building as the engine. We understand conditions will govern, so we wish only an average estimate of radiation which can be heated. Also kindly advise us if a tubular boiler built for power purposes at 125 lb. working pressure, or more, can be used as economically with the use of a pressure regulating valve as a tubular boiler built for low pressure steam at 15 lb. steam pressure. —W. HOLMES

Answer:—There are so many angles to your question regarding the amount of cast iron radiation that can be supplied per indicated h.p. of engine that I can hardly go into sufficient detail to give you a really satisfactory answer.

Originally the terms "boiler horse power" and "engine horse power" were synonymous; they both meant the same —lifting 33,000 lb. per minute—as determined by Watt. It was estimated that 30 lb. of steam was required to develop a boiler and engine h.p.

Now, as improvements have been made to engines, the pounds of steam required for an engine h.p. have been reduced to 25, 20, 15 and, in some highly perfected engines, to 12. Hence an engine h.p. is quite different from a boiler h.p. If the engine develops a h.p. on 20 lb. of steam, 85 per cent. of its heat value is available for use in the heating apparatus. 85 per cent of 20 is 17, the pounds of steam, or equivalent, available.

The total heat in a pound of steam at from three to five pounds pressure is about 1150 B.t.u. 1150×17=19,550 B.t.u. available per engine h.p. If a sq. ft. of radiation gives off 240 B.t.u. 19,550 ÷ 240 = 81 plus, the sq. ft. served per engine h.p. As a radiator at atmospheric pressure gives off about 200 B.t.u., 19,550 ÷ 200 = practically 100 sq. ft. per h.p. of the engine.

Conditions of installation and method of firing will govern the rate of fuel consumption under the boiler, and we doubt if there is much difference between a high pressure or a low pressure tubular boiler as regards fuel consumption, when the former carries 125 lb. pressure (reduced for use in the heating apparatus) and the latter is operated at 15 lb. pressure. Boilers of the tubular type are considered most economical when used with a high rate of fuel consumption per sq. ft. of grate.

Wins Laurels in Power Field

H. W. Weller Now Vice-President in Charge of Eastern Sales of the Babcock-Wilcox and Goldie-McCulloch Company

H. W. WELLER, vice-president in charge of Eastern sales for the recently consolidated interests of Babcock & Wilcox and Goldie & McCulloch, came to Montreal in May, 1899, to be manager for Canada for Babcock & Wilcox. The fact that, during this period of twenty-four years, the water tube type of boiler has won favor in Canadian power plants is in no small part due to Mr. Weller's ability as an engineer and salesman.

The "Babcock" boiler is installed in power plants from the Atlantic to the Pacific coast. The British Empire Steel Co's. interests in Nova Scotia have 150 boilers, the Canadian Pacific Railway has more than 100 at different points along its lines. The Montreal Tramways have 20 boilers, four of which are 1,000 h.p., and are at present installing two rated at 1,200 h.p. each. In the Toronto district, the boilers sold aggregate upwards of 50,000 h.p. The boilers installed in Canada since Mr. Weller has been representative of the company, exceed half a million h.p., and in many cases these boilers are equipped with superheaters and stokers made by the Babcock and Wilcox company.

Mr. Weller was born in 1858 at London, England. He was educated at Derby, later taking honors at Cambridge in 1872, having specialized in chemistry, machine design and construction. From 1873 to 1889 he was employed for the most part by railway and mining interests in the Midlands. In 1882 he made a trip to the United States on special engineering work for Col. Stuart Wortley and, having observed the greater opportunities on this side of the Atlantic, decided to return to New York.

He was in turn with the Sprague Electric Company, the Edison Electric Company and the General Electric Company as a special engineer and assistant manager of the railway department. From 1895 to 1899 he was the New England manager for the Campbell & Zell Boiler Company, and from 1899 to November of this year in charge of the business of Babcock & Wilcox in Canada.

H. W. WELLER.

Mr. Weller has been an associate member, Institute of Civil Engineers of England, since 1885; he is also a Fellow of the American Institution of Electrical Engineers, a member of the Canadian Mining Institute and past president of the Canadian Association of British Manufacturers.

His clubs are the Constitutional, London; Engineers', Old Colony and Rotary, Montreal. Owing to his part in the early development of the electric railway business he has the honor of being an Edison pioneer.

J. Bartington of the American Locomotive Co. will address the Canadian Railway Club on "Some Recent Developments in Locomotive Construction, Including the Three Cylinder Engine," at the next monthly meeting of the club. The annual dinner will be held Jan. 26.

Elect Canada Council Officers

John Grimshaw Now Worthy Chief of No. 27; Three New Members Initiated

CANADA Council No. 27 Universal Craftsmen Council of Engineers, held a regular meeting Dec. 10, which proved to be one of the best in the annals of the Council, about sixty members being present.

The session was a busy one, starting promptly at 8 p.m. and closing at 11.30 p.m.

The growth of the Council is very gratifying, the following candidates being initiated: Bro. E. Wilkinson, Canadian representative of the Lukenheimer Valve Co., Bro. Beaver, chief engineer of Penmans, Ltd., Paris, Ont., and Bro. A. Fleming, engineer, Imperial Oil Co., making a grand total of one hundred and sixty members.

The nomination and election of officers was an interesting feature of the evening and resulted as follows: Bro. John Grimshaw, worthy chief; Bro. George Jenkins, recording secretary; Bro. H. Parker, financial secretary; Bro. Grand Past Chief H. Terry, treasurer; Bro. W. Bruce, warden; Bro. Alexander Auchterlonie, guard; Bro. George Aldridge, chaplain; Bro. Jas. Miller, trustee.

Regrets were expressed when it was announced that the recording secretary, Bro. Wolfenden, was retiring from office. The efficient manner in which he fulfilled his duties was much appreciated by the council.

An interesting discussion took place relative to the revision of the Boiler Law now before the engineering bodies of Ontario, and Bro. Darbyshire gave an address. Further debate will take place at the January meeting.

Canada Council No. 27 desires to take this opportunity of wishing a merry Christmas and a prosperous New Year to all out of town brothers and readers of Power House.

C. A. S. E. Notes

London No. 30, C.A.S.E., held their regular meeting Dec. 7. The semi-annual report, read by secretary-treasurer J. H. Ward, showed a gradual increase in membership. Mr. Ward is working hard to increase the membership and has many new prospects in sight. A discussion followed the meeting which was beneficial to all present.

T. A. Marsh, A.S.M.E., gave an interesting address under the auspices of Toronto, No 1, C.A.S.E., in the Alhambra Hall, Spadina Ave., Dec. 13, on refractory material ignition arches and their relation to combustion.

Power Notes

The Elliott Co., Pittsburgh, manufacturers of surface and jet condensers, Elliott de-aerators, twin strainers and other steam specialties, have appointed as their Canadian representatives, the Combustion Engineering Corporation, Bank of Hamilton Building, Toronto.

J. P. Porter Co., Hamilton, manufacturers of patent fuel, contemplate the erection of a plant on the C. N. R. property on Burlington St., to cost approximately $100,000. The company proposes to purchase coal screenings, pulverize them and subject them to a process which will extract the ash. The substance is mixed with asphaltic fuel oil and the product formed into a nugget about the size of pea coal. The Canadian company is an off-shoot of the Trent Amalgam Co., of Washington.

The American Steam Pump Co., Battle Creek, Mich., has purchased outright the complete assets of the Advance Pump and Compressor Co., also of Battle Creek. The factories adjoin each other, which feature gives the American Steam Pump Co. an additional unit which it is estimated will increase its production approximately one-third and also give it a larger line of pumps. The Advance plant will be devoted largely to the manufacture of duplex pumps. For the present no changes will be made in the personnel or offices of either organization.

A **150 B. H. P.** Polar Diesel engine has just been installed at the Crown Reserve Mining Company's plant, Larder Lake, Ont. This plant started operations recently.

Two 200 B. H. P. Polar Diesel engines are being installed at the Castle-Trethewey Mines, Gowganda, Ont.

A **75 B. H. P.** Polar Diesel engine is being installed at the New York Porcupine Mines, South Porcupine, Ont.

Representatives of Canada's electrical engineering profession and the hydroelectric industry met at Chateau Laurier, Ottawa, Dec. 7, to discuss Dominion representation at the World Power conference in London next July. A strong committee was appointed to direct the arrangements. It consists of Dr. Charles Camsell, Deputy Minister of Mines; H. G. Acres, Niagara Falls; Arthur Amos, Quebec; John Murphy, Ottawa; Arthur Surveyer, Montreal; J. B. Challies, Ottawa; General Secretary, A. A. Dion, Ottawa; R. J. Durley, Ottawa; J. G. Glassco, Winnipeg; F. R. Glover, Vancouver; A. Monro Grier, K. C., Toronto; B. F. Haanel and O. Higgman, Ottawa; F. S. Keith, O. Lefebvre and Julian Smith, Montreal, and Dean Mitchell, Toronto.

Hon. Charles Stewart, addressing the gathering, stressed the immense power potentialities of Canada, and how scarcity of coal in one province is compensated for by electrical energy in another and vice versa.

An "entertainment" luncheon of the Montreal Electrical Club was held in the Queen's Hotel, Montreal, last week. Every fourth meeting of the club is reserved for entertainment. S. Macnab was chairman, and the meeting was well attended.

Town Council, Bagotville, Que., is in the market for equipment for an electric plant.

Municipality, High River, Alta., contemplate the installation of an additional 75 h.p. unit and equipment for a fuel power plant. S. W. Salt, secretary.

Municipality, Camrose, Alta., contemplate the addition of a 350 h.p. unit and equipment to a power plant. J. D. Saunders, secretary.

In This Issue

Editorial Point of View 19
By Campbell Bradshaw

Pumping Water in Winnipeg 20
By S. J. Mathewson, Jr.

Selecting the Steam Engine 22
By Charles L. Hubbard

Scoring of a Journal 26
By Thomas H. Fenner

Commutator Maintenance Pointers 27
Hints for the Engineer

Modern Power Transmission 28

Motor Cleaning Hints 29
By J. J. Curtain

Electricity in the Power House . . 30
By J. A. Burnett, M.E.I.C.

Westinghouse in Japan 30

Practical Ideas 31
Shafting Problems
Stretching Tubes
Steam Riser Sleeve
Oil Pump Troubles

Pipe Lines 32

Questions and Answers 33
Height of Bridge Wall
Charging Battery
Metering Feed Water
Refrigerating Temperatures
Steam Valve Lap
Grate Surface
Ammonia Condensers
Stepping Down Voltage
Heater Connections
Crank End Noise
Heat From Engine

H. W. Weller Biography 35

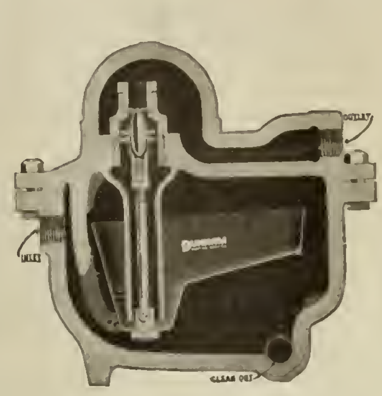
Canada Council Elects Officers . . 36

C. A. S. E. Notes 36
Power Notes

Canada's Fuel Problem 38
Discussion by E.I.C. at St. Catharines.

Dunham High Pressure Bucket Trap—Type No. 80

Quick acting—Powerful—Accessible!



There's nothing "draggy" about the action of this trap. The shape of the Dunham bucket and a short-coupled leverage obtain unusual power and speed. When the bucket is down and the trap is discharging the inclined bottom stands practically in a horizontal position. As the water is forced out through the discharge tube from the bucket, and the bucket begins to rise from the buoyancy of the water surrounding it, all of the water on the bucket "shelf" is suddenly poured over into the water seal. As a result, the movement of the bucket is greatly accelerated in its closing action.

This is a strong, simply constructed trap for removing condensate from fixtures, steam lines, separators, laundry equipment, heaters, vulcanizers, dry kilns and other industrial apparatus where high pressure steam is used. It is the speediest and most powerful trap of its size and type made. This is due mainly to the shape of the Dunham bucket, as described under illustration.

Another big feature is its accessibility. The cap may be removed without disturbing piping connections. This exposes the double-end valve and reversible valve seat which are made of monel metal. These vital working parts may be quickly reversed or replaced. Compare Type 80 with any other trap for operating efficiency and durability.

Write to us to-day for complete information and price list on Dunham Traps and other heating and industrial specialties.

C. A. DUNHAM CO., Ltd., Toronto, Ont.
Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary,
London, Eng.: 18 St. Thomas St., S.E. 1.

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE
(MADE IN CANADA)

Boiler Setting *Service*

THE Gates Engineering Co., Limited, are in a position to contract for and specify on all boiler brick work with the least possible delay. Our Engineering Department is qualified to look after your interests, having made a close study of Combustion Problems.

Our Motto—Service and satisfied clients. The confidence of those who use Gates' Patented Air-Cooled Arch, etc., is unqualified, and is retained, because of the low maintenance cost and the guaranteed results.

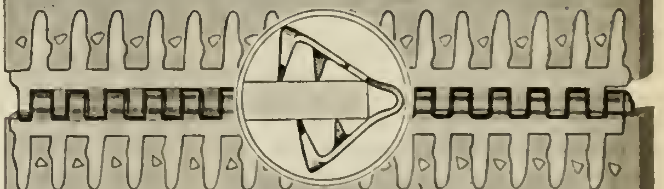
Ask for our Descriptive Catalog.

Gates Engineering Co., Limited
314 Notre Dame Street W., Montreal

ALLIGATOR

TRADE MARK REG. U. S. PAT. OFFICE

STEEL BELT LACING



For Universal Service

In light machine drives, whether slow, medium or high speed, a joint of Alligator Steel Belt Lacing properly applied is safe and long lasting. Recommended also for heavy drives and for use with idlers, on mule and serpentine drives, flat conveyors, or for tape and extra light drives. It combines the essentials demanded of modern belt joint: strength, smoothness, flexibility and simplicity of application.

A universal joint for universal service—gives universal satisfaction.

FLEXIBLE STEEL LACING COMPANY
4669 Lexington St., Chicago, Ill.
In England at 135 Finsbury Pavement, London, E. C. 2

"Every Tooth A Vise"

Just a Hammer to Apply It

For Every Size and Kind of Belt

Analyze Canada's Fuel Problem

Fifty Members of St. Catharines Branch E. I. C. Study Perplexing Aspects of Present Coal Supply

ABOUT fifty members of the St. Catharines branch of the Engineering Institute of Canada inspected the big power house at Queenston on Dec. 8.

In the evening at the Lafayette Hotel a brief business meeting preceded the main item on the program, namely, "A Symposium on Fuel." The subject was divided into seven sections prepared by members who had made a study of particular aspects of the fuel situation as follows: Pennsylvania Anthracite, by F. S. Lazier, Welland Ship Canal; U. S. Bituminous Coal, by L. B. McDonald, Canada Cement Co.; Canadian Coals, by T. F. Scott, city engineer, Niagara Falls, Ont.; Welsh Coals, by E. P. Johnston, Welland Ship Canal; Coke, by S. R. Frost, American Cynamid Co.; Oil, by J. R. Bond, Niagara Falls, Ont.; Secondary Fuels, by Walter Jackson, H. E. P. O.

Mr. Lazier said that Canada contained 18 per cent. of the coal resources of the world, but it was so placed with respect to Ontario, that the province had to be dependent on Pennsylvania for its fuel.

Mr. McDonald confined his remarks to bituminous slack coal. This fuel was, he said, a by-product of "mine run," of which there was a large surplus on hand until the strike of 1920 made it valuable. Among coals used at the Canada Cement plant, in Port Colborne, in the past few years, was a shipment from Nova Scotia, which Mr. McDonald claimed, was superior to U.S. bituminous.

A description of the lignite found in the Northwest was given by Mr. Scott. While this coal was very cheap, selling at the mines for $1.75 per ton, yet due to its high moisture content, it was not suitable for shipping. The contained moisture dried out in the air in a few hours, leaving a slack which could not be burned in the ordinary furnace. Attempts have been made to briquette it, but without much success as yet, Mr. Scott declared.

Mr. Johnston spoke highly of Welsh coal, anthracite and semi-anthracite, in comparison with other fuels. His figures indicated that Welsh anthracite, costing $19.40 per ton, was about 20 per cent. cheaper than U. S. anthracite at $18.

After a detailed description of the methods used in preparing coke, Mr. Frost claimed coke is as clean a fuel as anthracite and will burn in the same furnace.

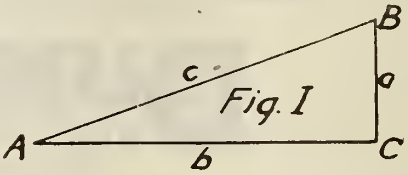
Mr. Bond foresaw the day when oil would find wide use as a heating fuel, claiming the supply is sufficient for hundreds of years.

Mr. Jackson spoke of the relative merits of wood, peat, gas, or electricity, for heating purposes. He did not hold out any hope of relief from any of these materials in the easing of the fuel situation of the province.

SLIDE RULE ACCURACY

In preparing this article the writer has reference to the 20 in. polyphase rule, although the principle is applicable alike to any length rule whether polyphase or not. While the 10 in. rule is commonly used, more so than the 20 in., the former is practically limited to checking, whereas the 20 in. rule can be depended upon almost entirely for accurate figures, if we take advantage of a few "tricks of the trade."

A decided advantage of the polyphase rule is, that with but a very few exceptions, three numbers can be multiplied with but one setting of the slide.



In performing this operation if we have three numbers as, 165 x 917 x 253, it makes no difference which one is taken first, as, if the operation can be performed with one combination, it can be performed with all and the converse is also true.

Still another advantage of the polyphase is, that two numbers may be multiplied and the result divided by a third, with only one movement of the slide. (This also with a few exceptions.) The operations must be performed in the order named, else two movements of the slide will be required.

For Triangulation

The slide rule is used extensively for figuring triangulation and it is with this in mind that the writer offers the following "kinks."

In the triangle A, B, C, Figure 1, let A = 20° and b = 2.6587. Now to find c we have b x secant 20°, which is 2,6587 x 1.0642, and equals as found by long hand, 2.82939. To perform this operation on the rule with the numbers as they stand, we read 2.829, but this is not close enough as many engineers will work to four decimals, except if they are dealing with long distances. Let us think of 1.0642 as 1 + .0642 and express the problem in this form: (2.6587 x 1) + (2.6587 x .0642).

The result of the first quantity is very evident, and multiplying on the rule the figures in the second parenthesis, we obtain .1707. Then 2.6587 + .1707 = 2,8294.

For the accuracy of the result we compare with the long hand figures and note that the error is only .00001.

Referring again to the triangle and supposing we wish to find B having given A = 20° and c = 2.8294. Then b = c x cosine 20°, = 2.8294 x .93969. Now the cosine equals 1 minus versine, therefore if we multiply by the versine instead of the cosine, and subtract the result from the first number, the same final result is obtained.

The problem is then 2.8294 — (2.8294 x .06031). Here again advantage is taken of the decimal point and zero, instead of using such a formidable number as .93969. Multiplying the two numbers in the parenthesis, we read .1707 and subtracting, the result 2.6587 is obtained, the correctness of which is easily seen.

The assistance for accuracy we are able to give ourselves in division, is, for example:

$$\text{Secant A} = \frac{2.8294}{2.6587} = 1.0642$$

2.6587) 2.8294 (1
2.6587
———
1707

The first figure of the quotient, 1, is obtained by actually dividing on paper, and then .1707 divided by 2.6587, on the slide rule, gives the remaining four places, .0642.

The reader having followed thus far will note that by using the slide rule for actually doing most of the figuring, "brain fag" is eliminated to a large degree, and real time saved as well.—CLIFFORD CORNWALL, Toronto.

Obituary

J. Robert Prior, stationary engineer, died at his home, 150 Moy Ave., Windsor, Dec. 5, in his 49th year.

The voltage of a direct-current machine having the same winding as the single-phase alternating-current machine will generate a constant voltage equal to the maximum electromotive force of the alternating-current machine. The effective voltage generated by the alternating-current machine would be only 0.707 times that of the direct-current voltage.

In replacing cylinder head gaskets or valve cages the surfaces should be thoroughly cleansed. Small carbon particles or grit often cause the gaskets to leak.

In a lead storage battery the positive plates are made of lead oxide and the negative plates of sponge lead. The electrolyte is a solution of sulphuric acid and water having a specific gravity of between 1.210 and 1.220 for stationary work and about 1.270 to 1.300 for vehicle and starting and lighting batteries when the battery is fully charged.

PUMPING WATER BY COMPRESSED AIR

(Continued from page 21)

was too large. As it was, a 5-inch water standpipe and a 1½-inch air pipe were in use. A 4-inch water standpipe with special thin pipe couplings was then lowered inside the 5-inch pipe, and the 1½-inch air pipe was discarded in favor of a ¾-inch air pipe.

Demand Continuous

As the demand for water is so continuous and as air at different pressures is needed for various purposes around the plant, a pressure regulating valve was placed in the air line, and this reduced the pressure from 90 pounds to an operating pressure of 45 pounds.

The original installation consisted of a belt-driven air compressor having a piston displacement of 280 cubic feet. This machine has been in operation for twenty years, and is still giving excellent service. In addition, there were two Type EL-1, 8 x 8-inch compressors with short belt drive. One of these machines was removed when the alterations were made and the second one was left for standby purposes only. The present installation is shown in an accompanying picture, and attention is drawn to the automobile engine at the left. This engine was added to the equipment as a precautionary measure in order to guard against a failure of the air supply, inasmuch as a 10-minute interruption would mean the loss of all the ice in process of manufacture. The motor is fitted with a pulley and a long belt, and can be connected to the standby compressor in a very few minutes by simply removing the short belt from the electric motor and substituting the long belt from the gasoline engine.

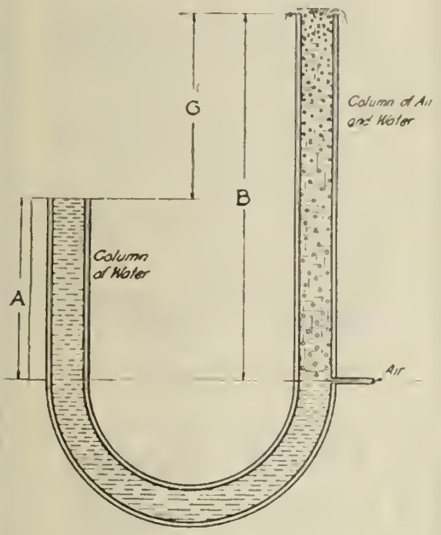


Fig. 1.
The injection of air, at the point indicated, produces a column of mixed air and water "B" which has slightly less weight than the solid column of water "A." Thus the weight of the column "A" causes the water to rise the distance "C" and overflow.

Operates Hoist

Besides using compressed air for pumping water from the well and for agitating the water in the ice cans, it is also utilized to operate a hoist to lift the ice dumped from the cans and to carry it to the daily storage rooms; to convey the ice to the permanent storage rooms; and to operate a direct-lift hoist for harvesting the ice, as shown in one of our illustrations.

In this picture can be seen the air manifold, running along the wall, from which the air is taken for agitating the water while it is undergoing freezing. The pressure reducer is also shown on the wall directly behind the three ice cans. This establishment is interesting not only because compressed air has been put to service wherever possible to operate mechanical labor-saving devices but because it is the first all-Canadian ice-making plant built in Canada.

The saving effected by the air-lift system in this case can be readily appreciated when the added advantages of pure, cold water in an industry of this kind are taken into consideration. In other words, economies are effected through the use of cold water for condensing purposes; through the lower initial temperature and the purity of the water put in the cans for the manufacture of ice; and, lastly, through the pumping of the water itself, which costs less than two cents per 1,000 gallons, as compared with the city water rate of nineteen cents per 1,000 gallons.

POINTERS ON PROPER COMMUTATOR MAINTENANCE

(Continued from page 27)

guided by the opinion of a brush salesman. This gentleman will usually advise their "special abrasive brush made expressly for such conditions." He goes on to state that the abrasive qualities of the brush will grind down the high mica, and your troubles will end as if by magic. He fails to state, however, that the brush will also grind down the copper and very decidedly shorten the life of the commutator.

Locate the Trouble

A man that is really on to his job will seek until he has located the cause of the trouble. Once the cause is found and remedied, sparking will cease permanently.

If it is certain that high mica results from the natural condition of the copper or mica, then undercutting is about the only permanent relief. To do a good job of undercutting requires some knowledge of operating conditions, and quite a bit of patience.

Many different tools and methods have been devised to do the work. The average plant would not be justified in purchasing one of the elaborate electrically driven saw outfits made for this purpose. Occasionally the work can be done in a milling machine. All things considered, the hand method, while taking longer to accomplish the same result, nevertheless often produces a more satisfactory job. A 6-in. slim taper file is the only tool necessary. Break off about ½-in. of the file tip and grind square.

M. BARRY WATSON
B.A. Sc., C.E., M.E.
Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.
Consulting Engineer
Power Plants
Heating—Ventilation—Lighting
192 Arlington Avenue, Toronto
Hillcrest 6976W

J. A. BURNETT,
M.E.I.C., P.E.Q.
CONSULTING
AND APPRAISAL
ENGINEER
Room 301—205 St. James St.
Telephone Main 6737. Montreal.

Every Engineer, Mechanic and Electrical Worker will welcome this new master set. It will answer your problems.

It will help you with yoor daily work.—A sure source of advancement and higher pay. Complete up-to-date information that is thoroughly and easily explained on every branch of modern engineering and electrical practice.

AUDEL'S ENGINEERS & MECHANICS GUIDES
4750 PAGES $1 A MONTH
8754 ILLUSTRATIONS $12 COMPLETE

These Guides tell you all about—

Theory, Practice and Operation of ALL Steam Engines: UNIFLOW and POPPET VALVE ENGINES, and LOCOMOBILES. Locomotive-Marine Engines; Turbines; Rotary Engines the Indicator -- Lubrication -- PRACTICAL MANAGEMENT. GAS, GAS ENGINES--*Aeroplanes* and *Aviation*--HOW TO SELECT AN ENGINE, STEAM ENGINE rules and formulae. Steam Boilers; Heat-Combustion; Fuel and Flue Gas Analysis-CO2 Recorders-Construction of all types of Boilers.--Mechanical Stockers--Oil Burners--Setting--Chimneys--Mechanical Draught HOW TO SELECT A BOILER--BOILER DESIGN based on A.S.M.E. BOILER CODE--OPERATION FIRING. Pipes, Fittings--Heating and Ventilation--Refrigeration--Cooling Towers--Condensers--Distilling Apparatus--Elevators--Cranes--Ropes and Cables--Splicing--*Practical Electrical Engineering* as an aid for engineers and electricians in obtaining a license--ready reference index, covering entire field of Modern Electricity.

SHIPPED TO YOU FREE

Not a cent to pay until you see the books. No obligation to pay unless you are satisfied. Send coupon now--today and get this new master set for engineers. Pay only $1 a month.

SEND NO MONEY

THEO. AUDEL & CO.,
72 Fifth Ave., N.Y.

Please submit me for approval, AUDEL'S $10,000 MASTER SET FOR ENGINEERS & MECHANICS. Ship at once prepaid, the 8 numbers. If satisfactory, I agree to send you $1 within 7 days and to mail you $1 monthly until $12 is paid.

Signature ____________________
Occupation ____________________
Employed by ____________________
Residence ____________________
Reference ____________________

CLASSIFIED ADVERTISEMENTS

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

BUSINESS CHANCES

SMALL BOILER REPAIR BUSINESS FOR SALE—with house property adjoining. No opposition. Located in a large manufacturing city. Reason for selling, owner in ill-health. Apply Box 110, Power House.

POWER PLANT FOR VILLAGE OF TIGNISH About 18 kil. hour capacity 110 to 220 volting alternating current. Apply to John A. Hackett, Box 67, Tignish, P. E. I.

EQUIPMENT FOR SALE

TAYLOR SAFE FOR SALE—INSIDE DIMENsions 15" deep, 2 ft. 6" wide, 3 ft. 11½" high. We will accept $225.00 for this safe—a bargain for someone. Apply Box 110, Power House

For Quick Sale

Self-oiling high speed engine, single cylinder 17 in. bore x 16 in. stroke. Engine develops 200 H.P. when running at 235 R.P.M. with 100 lbs. steam pressure. There are two heavy leather belts 18 in. wide. The engine has two fly-wheels, each 78 in. diameter x 18 in. face. Apply Box 112, Power House.

PISTON RINGS

EVER-TYTE and ZELCO Piston Rings with Patented Zelco Process Save Gasoline, Oil, Increase Capacity, Prevent Cylinder from Wearing Out of Round, Lessen Carbon; after using, make arrangement with us to sell them; made up to 80-inch; used in Locomotives, Boats, Engines, Compressors, Ice Machines, Autos, Trucks, Tractors, etc.; are looking for distributors with mechanical knowledge; all or part time; real opportunity. Ever-Tyte, St. Louis, Mo.

When answering advertisements, please mention POWER HOUSE

Hold the file at a slight angle to the commutator surface.

Keep Slots Shallow

Start the file at the end of the mica segment and work back towards the armature core, keeping in the centre of the mica. The square end of the file will act as a sort of plough. Remove the mica to a depth of about 1-32 in. The shallower the slots, the easier to keep clean and free from accumulations of carbon dust and grit. Be sure that the entire width of the mica is removed. A thin sliver left flush with the surface of the copper will often defeat the purpose of undercutting. All sharp edges should be removed from the copper bars.

One precaution to be taken with undercut commutators is that oil should not be permitted to work on to the commutator. Oil and carbon dust will clog the slots and cause endless trouble.

A hard, non-abrasive carbon brush will give good results when undercutting is resorted to. Brush tension can also be reduced considerably. Usually 1½ lb. per sq. in. of cross-section is sufficient.

WHAT USUALLY CAUSES THE SCORING OF A JOURNAL

(Continued from Page 26)

the engine round certain portions of the stroke, under a very early cut off. The only remedy for this is close attention.

If in spite of the vigilance of the engineer, or because of lack of it, scoring of a journal does actually occur, the writer would suggest the following remedies. First, do not waste time and avoirdupois trying to get the score out with a piece of canvas. If the scoring warrants it, and it is possible, send the job to a shop, and have the journal turned up, or have the grooves filled by electric welding, and the journal smoothed up in the lathe.

If this cannot be done, get a good second cut file and a pair of calipers. File carefully with a half round motion, going round the journal evenly, and trying with the calipers frequently to see that the journal isn't being made oval. When the surface is reasonably good, finish up with a smooth file, and emery paper. If a really good job is desired use last of all an oil stone.

Then set up the bearing in the proper way, and look after it in future.

A FLOATING DRIVE

We had to get a boring fixture at work in a hurry and there wasn't a floating joint to be had in the place. So the foreman told us to wrap a layer of heavy wrapping paper around the taper shank of the tool, put it in the socket and drill through for a drive pin.

Then we took off the paper, put the next sized larger drill through the holes we'd drilled in the socket, used a pin that was a light drive fit in the shank, and we had a drive with just a little "float," which was what we wanted. And we made it in a hurry, too.—A. SMYTH.

Stationary Engineer's Certificates

Personal tuition in preparation for the above by a practical Engineer holding First-Class Ontario and B. O. T. Certificates.

Be Prepared.

For Particulars Apply

T. S. JONES
18 North Apartments.
755 Yonge Street at Bloor.

Extraordinary BARGAINS

Steam Engines

1 Goldie & McCulloch heavy duty, cross compound, latest type Corliss condensing engine with rope drive, line shaft pulley and idlers complete, equipped with Dean condenser. Cylinders are 20"x40"x42" stroke. Water heater included.

1 Robb-Armstrong 11"x14" high speed automatic engine, direct connected to a Westinghouse 70 k.w., 3 phase, 60 cycle, 220 volt generator, complete with exciter and marble control panel.

Also several smaller automatic engines and some air hoists from 4" to 10½".

Chain Blocks

2 15-ton Herbert Morris chain blocks with trolleys.

1 10-ton Herbert Morris chain block with trolley.

Water Tube Boilers

2 250 h.p., 175 lbs. working pressure, government certificate. Everything complete and in first-class condition.

SPECIAL

One Jenny Electric Co. push button control complete, in first-class condition, capacity up to a double width sextuple press. This is a rare bargain. For quick sale.

Get full particulars and remarkably low prices from

Wm. Coates
Mail Building
Toronto, Ont.

HINTS TO BUYERS

The Simplest and best cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For Sale by Leading Canadian Jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street. St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

Read "Power House"

for

Articles of Merit on Refrigeration, Equipment and Management

McDaniel Improved
STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded by sudden flushes of water.

May we send one on trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Head Ejectors and Steam Separators.

Send for Catalogue

THE GARTH COMPANY
Craig Street, MONTREAL, CAN.
WATSON & McDANIEL CO.,
No. 146 N. 7th St., Philadelphia, Pa.

Westco Pumps

Specially adapted for:

Water Supply Systems,
Fire Protection,
Oil Burner Installations,
Boiler Feed, Transfer and Booster Service.

A Marvel of Simplicity.

WESTCO MFG. CO.
LIMITED
220 King St., W.
Toronto

AMERICAN STEAM ASH CONVEYORS

75% of all steam jet ash conveyors in Canada are American. Satisfactory and economical performance guaranteed. Ask for booklet.

Canadian Representatives:
CLEATON CO., (Canada) Ltd., Montreal
GORMANS, LTD., Edmonton, Calgary.
WM. A GOOLD, Winnipeg.
T. M. GRINDLEY Co., Vancouver.

CONVEYORS CORPORATION OF AMERICA
326 WEST MADISON STREET CHICAGO

Power House Buyers' Directory

This department is maintained for the benefit and convenience of our readers. It contains the name of practically every manufacturer of appliances needed in the power plant, but readers are requested to advise the publishers regarding any equipment they are buying that is not listed. See last page for alphabetical index of advertisers.

AIR COCKS
H. Mueller Mfg. Co., Ltd., Sarnia, Ont.

AIR COMPRESSORS
Laurier & Lamb Co., Montreal.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Teronto.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Michigan.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Toronto.

AIR FILTERS
Midwest Canada, Ltd., Montreal.

ALARMS (LOW WATER)
Bristol Co., Waterbury, Conn.
James Morrison Brass Mfg. Co., Ltd., Toronto.

AMMETERS
Bristol Co., Waterbury, Conn.

AMMONIA COMPRESSORS
The Vitter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

ASH CONVEYORS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal, Que.
Heat Automatic Damper Control.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Magnolia Metal Co., Montreal.

BEARINGS
Can. Fairbanks-Morse Co., Ltd., Montreal
Beveridge Supply Co., Montreal, Que.

BELT LACING
Bristol Co., Waterbury, Conn.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BELTING, LEATHER
Can. Fairbanks-Morse Co., Ltd., Montreal.
D. K. McLaren Ltd., Montreal.
Dominion Belting Co., Hamilton.
L. F. Smidth & Co., New York.

BELTING LINK
Can. Fairbanks-Morse Co., Ltd., Montreal.
Link-Belt Ltd., Toronto, Ont.

BELTING, ROLLER
Hans Renold of Canada, Ltd., Montreal and Toronto.

BELTING, RUBBER
Can. Fairbanks-Morse Co., Ltd., Montreal.
Dunlop Tire & Rubber Co., Ltd., Toronto.
Gutta Percha & Rubber Co., Ltd., Toronto.

BLOWERS, TURBINE
Arthur S. Leitch Co., Toronto.
Coppua Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BLOWERS, FAN
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
De Laval Steam Turbine Co., Trenton, New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

BLOWERS, FORCED DRAFT
Canadian Blower & Forge Co., Kitchener, Ont.
De Laval Steam Turbine Co., Trenton New Jersey.
Can. Fairbanks-Morse Co., Ltd., Montreal.

BOILER TUBE CLEANERS
Pilley Packing & Flue Brush Co., St. Louis, Mo.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd. Toronto.

BOILER COMPOUNDS
G. F. Sterne & Sons, Ltd., Brantford.
H. P. Stephens, Toronto.
Shell Bar Boico Co., Toronto.
Refinite Co. of Can., Ltd., Toronto.
Kirby & Co., Toronto.

BOILER TUBES
Babcock & Wilcox, Ltd., Montreal.

BOILER SETTINGS
A. E. Itule Co., Toronto.
Beveridge Supply Co., Montreal, Que.
Gates Engineering Co., Ltd., Montreal.
Celite Prodcuts, Ltd., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto, Ont.
Shell Bar Boico Co., Ltd., Toronto.
Sterne & Sons, G. F., Brantford, Ont.
W. R. Sexton Boiler Setting Co., Toronto.

BOILERS, HEATING
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Waterous Engine Works, Brantford.

BOILERS, RETURN TUBULAR
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOILERS, VERTICAL WATER TUBE
Geo. T. Ladd Co., Pittsburgh, Pa.

BOILERS, WATER TUBE
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

BOXES, STEEL, FOR ELECTRIC SERVICE
Canadian Drill & Electric Box Co., Ltd., Toronto.

BREECHINGS
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Engineering & Machine Works of Canada, St. Catharines, Ont.

BRICK, FIRE
Goldie & McCulloch Co., Ltd., Galt, Ont.
Elk Firebrick Co., Ltd., Hamilton, Ont.
Sexton Boiler Setting Co., W. R., Toronto, Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

BRICK, INSULATING
Celite Products, Ltd., Chicago, Ill.

CABINETS, LIGHTING
Canadian Drill & Electric Box Co., Ltd., Toronto.

CALORIMETERS
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

CASTINGS, BRASS & IRON
Canadian Steam Boiler & Equipment Co., Ltd., Toronto.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Kerr Engine Co., Ltd., Walkerville, Ont.
Gollie & McCulloch Co., Ltd., Galt, Ont.

CASTINGS, GREY IRON
Velter Mfg. Co., Milwaukee, Wis.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CEMENT, ASBESTOS
Sterne & Sons, G. F., Brantford, Ont.

CEMENT, IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

CEMENT, FIRE BRICK
Sterne & Sons, G. F., Brantford, Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.

CHAINS (Sse sprockets and chains)
Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, DRIVING
Hans Renold of Canada, Ltd., Montreal and Toronto.

CHAINS, ROLLER
Hans Renold of Canada, Ltd., Montreal and Toronto.

CIRCUIT BREAKERS
Dominion Engineering Agency, Ltd., Toronto.

COAL AND ASH HANDLING MACHINERY
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COAL CRUSHERS
Babcock & Wilcox, Ltd., Montreal.
Canada Stoker Company, Ltd., Toronto and Galt.
The Canadian-Fairbanks Morse Co., Ltd., Montreal.

COAL PULVERIZING EQUIPMENT
Combustion Engineering Corp., Ltd., Toronto.

COCKS, BRASS & IRON
Homestead Valve Mfg. Co., Homestead, Pa.
James Morrison Brass Mfg. Co., Ltd., Toronto.

COCKS, GAGE
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COCKS, STEAM
James Morrison Brass Mfg. Co., Ltd., Toronto.

CO2 RECORDERS AND FLUE GAS ANALYSIS INSTRUMENTS
Sarco Co., Inc., N. Y.
Foxboro Co., Inc., Foxboro, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal.

CONDENSERS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine, Toronto.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

CONDENSERS (JET)
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Galt, Ont.

CONDENSERS (SURFACE)
Turbine Equipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

CONVEYORS (SEE COAL AND ASH HANDLING MACHINERY)
Babcock & Wilcox, Ltd., Montreal.

COUPLINGS, FLEXIBLE SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

COUPLINGS, SHAFT
De Laval Steam Turbine Co., Trenton, New Jersey.

CRANES
Babcock & Wilcox, Ltd., Montreal.
John T. Hepburn, Ltd., Toronto.

DEALERS (MACHINERY)
Can. Fairbanks-Morse Co., Ltd., Montreal.

DISTILLING APPARATUS
Laurie & Lamb Co., Montreal.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.

DISTRIBUTING BOARDS
Can. Drill and Electric Box Co., Ldt., Toronto.

DRILLS
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

EJECTORS
Laurie & Lamb Co., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ELECTRIC GENERATING SETS (STEAM ENGINE)
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton, Ont.
Laurie & Lamb Co., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC GEN. SETS—(Steam Turbine)
Can. General Elec. Co., Ltd., Toronto.
Can. Westinghouse Co., Ltd., Hamilton.
Laurie & Lamb Co., Montreal.
E. Laurie & Co., Montreal.
De Laval Steam Turbine Co., Trenton.
Turbine Evipment Co., Ltd., Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont.

ELECTRIC MOTORS
Can. General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

ENGINES, DIESEL
Laurie & Lamb Co., Montreal.

ENGINES, CORLISS
Laurie & Lamb Co., Montreal.
Frick Co., Wanesboro, Pa.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, GAS & OIL
Laurie & Lamb Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal.

ENGINES, PUMPING
Laurie & Lamb Co., Montreal.

ENGINES, STEAM
Can. Sirocco Co., Ltd., Windsor, Ont.
Laurie & Lamb Co., Montreal.
John T. Hepburn, Ltd., **Toronto.**
Goldie & McCulloch Co., Ltd., Galt, Ont.

ENGINES, UNA-FLOW
Vilter Mfg. Co., Milwaukee, Wis.
Frick Co., Wanesboro, Pa.

ENGINE REPAIRS
Goldie & McCulloch Co., Ltd., Galt, Ont.

EXPANSION JOINTS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FANS (SEE BLOWERS, FAN)
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

FEED WATER HEATERS
Arthur S. Leitch, Toronto.
Goldie & McCulloch Co., Ltd., Galt, Ont
Sims Company, Erie, Pa.

FEED WATER PURIFIERS
Sterne & Sons, G. F., Brantford, Ont.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

FILTERS, FEED WATER
Babcock & Wilcox, Ltd., Montreal.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

FILTERS, OIL
Babcock & Wilcox, Ltd., Montreal.
Turbine Equipment Co., Ltd., Toronto.

FILTERS, WATER
Laurie & Lamb Co., Montreal.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

FIRE BRICK ARCHES
Combustion Engineering Corp., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.

FITTINGS, AMMONIA
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto.
Frick Co., Waynesboro, Pa.

FITTINGS, PIPE
International Malleable Co., Guelph, Ont.

FITTINGS, STEEL
Reading Steel Casting Co., Bridgeport, Conn

FITTINGS, CAST IRON
Can. Fairbanks-Morse Co., Ltd., Montreal.

FLOATS
James Morrison Brass Mfg. Co., Ltd., Toronto.

FUEL OIL SYSTEMS
Combustion Engineering Corp., Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
T. J. Cunerty Co., Toronto.

FURNACES
Can. Sirocco Co., Ltd., Windsor, Ont.

FURNACE ARCHES, FLAT SUSPENDED
Canada Stoker Co., Ltd., Toronto and Galt.
Bell Fire Brick Co., Toronto.
Shell Bar Boico Co., Ltd., Toronto.
Gates Engineering Co., Ltd., Montreal.

FURNACE LININGS
Shell Bar Boico Supply Ltd., Toronto, Ont.
G. F. Sterne & Sons, Ltd., Brantford, Ont.
Jointless Fire Brick Co., Chicago, Ill.

GAGE COCKS (SEE COCKS GAGE)
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASS GUARDS
Babcock & Wilcox, Ltd., Montreal.

GAGE GLASSES
Durabla Mfg. Co., New York City.
Babcock & Wilcox, Ltd., Montreal.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, DIFFERENTIAL
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.

GAGES, DRAFT
Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd. Toronto.

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES,

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

MADE IN CANADA

THE SUPERHEATER CO., LIMITED,
Transportation Bldg., Montreal

WORKS AT SHERBROOKE, QUE.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is **economical.** British Made.

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: **W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA**

BOILER SETTINGS

SPECIALISTS IN

FIRE BRICK AND ARCHWORK

FOR EVERY TYPE OF STEAM BOILER

A. E. RULE COY.

122 Garden Ave. TORONTO Lakeside 1274

I HAVE been treating FEEDWATER for steam boilers for 24 years and am in a position to investigate your feedwater problems.

I WILL give you a formula for your special plant and thus save you 10% to 20% of your fuel.

Send in Your S.O.S. to:—

H. P. STEPHENS
Feedwater Specialist.
Junc. 5642 2004 Dundas St. W. Toronto

YORK Ice Making & Refrigerating MACHINERY

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO., LIMITED

Villiers and Munition Sts., Toronto.
324 Craig St. West, Montreal.
1415 Whyte Ave., Winnipeg.
1158 Homer St., Vancouver.

WATER TUBE TILES

Special Firebrick Shapes, Slabs, Furnace Arch Brick, Stoker Bricks, Etc.

Made to withstand Highest Temperatures

BELL FIREBRICK CO.
1347-51 DUFFERIN ST.
KENWOOD 4335 TORONTO

THE BROWN INSTRUMENT CO.
The Largest Pyrometer Manufacturors in the World
PHILADELPHIA - - PA.

Agents: LaChapelle Eng. Co., 414 St James St., Montreal, P. Q.
Brown Instrument Co., 1421 Ford Bldg., Detroit, Mich.

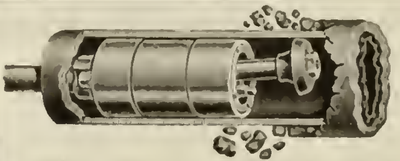
Brown Pressure Gauge

WHEN YOU REQUIRE

Industrial Electric Control Apparatus
Consult "Sundh"

Dominion Engineering Agency Limited

TORONTO:- D. M. Fraser, 24 Adelaide East
MONTREAL:- E. W. Playford, 358 Beaver Hall Square



Removing Scale from Return Tubular Boilers.

Phone Adel. 1135.
Day and Night Service.

Write or Phone for full particulars.

SIX REASONS WHY

You should give the Dean Boiler Tube Cleaner a Trial in your own Boiler and see what it will save YOU.

1. We will give you a demonstration FREE showing you the conditions of any Boiler.
2. We guarantee to save you from 20% to 50% of your fuel.
3. Is recommended by both Boiler Makers and Inspectors.
4. 90% cheaper to clean old ones than to retube with new.
. A clean Boiler is 50% safer, more efficient and economical, than one covered with Scale, if only 1-16 thick.
6. We will send you a Dean on Trial in one Boiler FREE

OR CLEAN YOUR BOILERS OF SCALE BY CONTRACT.

Geo. Farrow & Son, 17-19 Victoria Blvd., Mount Dennis, Toronto

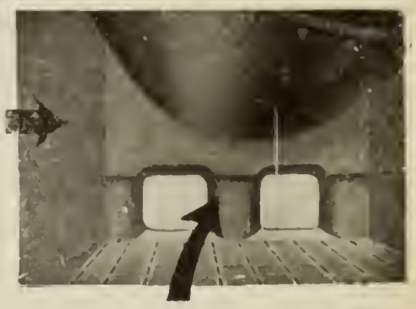
---

REDUCE UPKEEP COSTS

Use Betson Plastic Fire Brick For

Arches and Furnace Linings in one piece. No brick, no joints. Any handy man installs it without special forms or tools.

Betson Plastic Fire Brick kept on hand for emergency repairs and for use in building sloping baffles, always proves profitable.



Write for instructive Booklet.

Betson Plastic Fire Brick Co., Inc. P. O. Box 386-6 ROME, N.Y.

CANADIAN DISTRIBUTORS: International Chemical Co., 26-8 Adelaide St. E., Toronto, Ontario, Canada

---

Morehead Back to Boiler SYSTEM

Stops Waste of Condensation

Saves Fuel--Raises Efficiency In the Plant

Write us for information

J. E. FARRELL
Director of Sales
304 Manning Chambers, Toronto, Ont.

GAGES, PRESSURE

Bristol Co., Waterbury, Conn.
Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
James Morrison Brass Mfg. Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

GAGES, RECORDING

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

GAGES, STEAM

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
Babcock & Wilcox, Limited, Montreal, Que.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, VACUUM

The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

GAGES, WATER

The Bristol Co., Waterbury, Conn.
The James Morrisson Brass Mfg. Co., Limited, Toronto, Ont.

GAS EXHAUSTERS

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

GASKETS

Jenkins Bros., Limited, Montreal, Que.
Shell Bar Boico Supply Ltd., Toronto, Ont.

GEARS

E. Laurie & Co., Montreal, Que.
Turbine Equipment Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Limited, Montreal, Que.

GEARS, CUT

Hans Renold, of Canada, Ltd., Montreal and Toronto.

GEARS, ROLLER CHAIN

Hans Renold of Canada, Ltd., Montreal and Toronto.

GEARS, SILENT CHAIN

Hans Renold of Canada, Ltd., Montreal and Toronto.

GENERATORS, ELECTRIC

Laurie & Lamb Co., Montreal, Que.

GENERATORS, HOT WATER

The Sims Co., Erie, Pa.
Arthur S. Leitch Co., Toronto.

GOVERNORS, PUMP

Canada Stoker Co., Ltd., Toronto and Galt.
Northern Equipment Co., Erie, Pa.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Under-Feed Stoker Co., Ltd., Toronto.

GRATES

Beveridge Supply Co., Montreal, Que.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Can. Steam Boiler Equipment Co., Ltd., Toronto, Ont.

GRATE BARS

Canadian Steam Boiler Equipment Co., Toronto, Ont.
Engineering & Machine Works of Canada, Limited, St. Catharine, Ont.
Babcock & Wilcox, Limited, Montreal, Que.
John T. Hepburn Ltd., Toronto, Ont.
Goldie McCulloch Co., Ltd., Galt, Ont.
Shell Bar Boico Supply Ltd., Toronto, Ont.

GREASE EXTRACTORS

Babcock & Wilcox, Limited, Montreal, Que.

HEATERS, FEED WATER

Goldie & McCulloch Co., Ltd., Galt, Ont.

HEATING SYSTEMS

Can. Sirocco Co., Ltd., Windsor, Ont.

HOISTS, ELECTRIC

Canadian Ingersoll Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

HOPPERS, COAL & ASH

Combustion Engineering Corp., Ltd., Toronto, Ont.

HOSE, AIR

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

HOSE, RUBBER

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Babcock & Wilcox, Limited, Montreal, Que.

HOSE, STEAM

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

HOSE, WATER

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Limited, Toronto, Ont.

ICE AND REFRIGERATING MACHINERY (SEE REFRIGERATING MACHINERY)

Jamieson Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
Can. Ice Machine Co., Toronto, Ont.
York Mfg. Co., York, Pa.
Frick Co., Waynesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.

INDICATORS, SPEED

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.

INDICATORS, STEAM ENGINE

American Schaeffer -& Budenburg Corp., Brooklyn, N. Y.

INJECTORS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

LUBRICATORS, CYLINDER

The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, FORCE FEED

The James Morrison Brass Mfg. Co., Toronto, Ont.

LUBRICATORS, SIGHT FLOW

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

MACHINE WORK, SPECIAL

Engineering & Machine Works of Canada, Limited, St. Catharines, Ont.
John T. Hepburn, Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

METERS, BOILER

Laurie & Lamb Co., Montreal, Que.

METERS, FLOW

Canada Stoker Co., Ltd., Galt and Toronto.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

OILING DEVICES

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PACKING, ASBESTOS

Durabla Mfg. Co., New York City.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC

Laurie & Lamb Co., Montreal, Que.

PACKING, SHEET

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Durabla Mfg. Co., New York City.
The James Morrison Brass Mfg. Co., Ltd., Toronto Ont.

PACKING, VALVE STEM PIPE

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

PIPE, BRASS & COPPER

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE BENDING

Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PIPE COILS

Can. Ice Machine Co., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Crane Ltd., Montreal.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
York Mfg. Co., York, Pa.

PIPE CUTTERS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

PUMPS, BOILER FEED

Albany Pump Co., Toronto.
American Steam Pump Co., Battle Creek, Mich.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CENTRIFUGAL

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
E. Laurie & Co., Montreal, Que.
DeLaval Steam Turbine Co., Trenton, New Jersey.
Young Pump Company of Canada, Hamilton, Ont.
John T. Hepburn Co., Toronto, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Westco Mfg. Co., Toronto.

PUMPS, CONDENSER

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.

PUMPS, FORCE FEED

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb, Montreal, Que.

PUMPS, OIL

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Westco Mfg. Co., Toronto.

PUMPS, POWER

American Steam Pump Co., Battle Creek, Mich.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont.
Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

PUMPS, ROTARY

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Turbine Equipment Co., Ltd., Toronto, Ont. Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Westco Mfg. Co., Toronto.

PUMPS, STEAM

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb Co., Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
John T. Hepburn, Ltd., Toronto, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
F. L. Smidth & Co., New York.
Turbine Equipment Co., Ltd., Toronto, Ont.

"PUMPS-SUMP"

Albany Pump Co., Toronto.
Canadian Blower & Forge Co., Limited, Kitchener, Ont.

PUMPS, TURBINE

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Arthur S. Leitch Co., Toronto.
Coppus Engineering Corp., Worcester, Mass
De Laval Steam Turbine Co., Trenton, New Jersey.
Turbine Equipment Co., Ltd., Toronto, Ont.

PUMPS, VACUUM

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Laurie & Lamb, Montreal, Que.
American Steam Pump Co., Battle Creek, Mich.
Young Pump Company, of Canada, Hamilton, Ont.
John T. Hepburn Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt, Ont.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Arthur S. Leitch Co., Toronto.
Nash Engineering Co., (Hytor) South Norwalk, Conn.

PYROMETERS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

REFRACTORY MATERIAL

G. F. Sterne & Sons, Ltd., Brantford.
Jointless Fire Brick Co., Chicago, Ill.

REFRIGERATING MACHINERY

Jamison Cold Storage Door Co., Hagerstown, Md.
The Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.
Frick Co., Wanesboro, Pa.
The Linde Can. Refrigeration Co., Montreal, Que.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.

REGULATORS, DAMPER, DRAFT & FAN

Laurie & Lamb, Montreal, Que.
Julian D'Este Company, Boston, Mass.
Under-Feed Stoker Co., Ltd., Toronto.

REGULATORS, FEED WATER

Canada Stoker Co., Ltd., Galt and Toronto.
Northern Equipment Co., Erie, Pa.

REGULATORS, TEMPERATURE

Sarco Co., Inc., New York.
The Bristol Co., Waterbury, Conn.
Julian D'Este Company, Boston, Mass.
The Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

REGULATORS, PRESSURE

The Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, AIR

Can. Sirocco Co., Ltd., Windsor, Ont.

SEPARATORS, AMMONIA

York Mfg. Co., York, Pa.
Can. Ice Machine Co., Toronto, Ont.

SEPARATORS, OIL

Anderson Co., V. D., Cleveland, Ohio.
Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que.
The James Morrison Brass Mfg. Co., Toronto, Ont.

SEPARATORS, STEAM

Anderson Co., V. D., Cleveland, Ohio.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SMELTING LININGS

G. F. Sterne & Sons, Ltd., Brantford.

SODA ASH

G. F. Sterne & Sons, Ltd., Brantford, Ont.

SODA SILICATE

Diamond Specialty Mfg. Co., Windsor.

SOOT BLOWERS

Diamond Specialty Mfg. Co., Windsor.
Pilley Packing & Flue Brush Co., St. Louis, Mo.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

SPRAY NOZZLES

Can. Sirocco Co., Ltd., Windsor, Ont.

SPROCKETS AND CHAINS

Hans Renold of Canada, Ltd., Montreal and Toronto.

STACKS, METAL

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STACKS, RADIAL BRICK

Combustion Engineering Corp., Ltd., Toronto, Ont.

STEEL PLATE WORK

Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt, Ont.

STOKERS, CHAIN & TRAVELING GRATE

Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que. Que.

STOKERS, OVERFEED

Canada Stoker Co., Ltd., Galt and Toronto.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.
Detroit Stoker Co., Detroit, Michigan.
Under-Feed Stoker Co., Ltd., Toronto.

STOKERS, UNDERFEED

Detroit Stoker Co., Detroit, Mich.
Combustion Engineering Corp. Co., Ltd., Toronto, Ont.
Under-Feed Stoker Co., Ltd., Toronto.

STOKERS, HAND OPERATED

Combustion Engineering Corp., Toronto, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

STRAINERS, WATER

Sarco Co., Inc., New York.

SUPERHEATERS

Babcock & Wilcox Ltd., Montreal, Que.
Goldie & McCulloch Co., Ltd., Galt, Ont.

SWITCHES, ELECTRIC

Canadian Drill & Electric Box Co., Ltd., Toronto.
Canadian General Electric Co., Ltd., Toronto.

TACHOMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Laurie & Lamb, Montreal, Que.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

TANKS

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Engineering & Machine Works of Canada, Ltd., St. Catharines, Ont.

THERMOMETERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

THERMOMETERS, FLUE GAS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

THERMOMETERS, RECORDING

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The Bristol Co., Waterbury, Conn.
The Foxboro Co., Inc., Foxboro, Mass.

TRANSFORMERS

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Canadian General Electric Co., Ltd., Toronto.
Canadian Westinghouse Co., Ltd., Hamilton.

TRAPS, NON-RETURN

Anderson Co., Inc., V. D., Cleveland, Ohio.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Sarco Co., Inc., New York.

TRAPS, RADIATOR

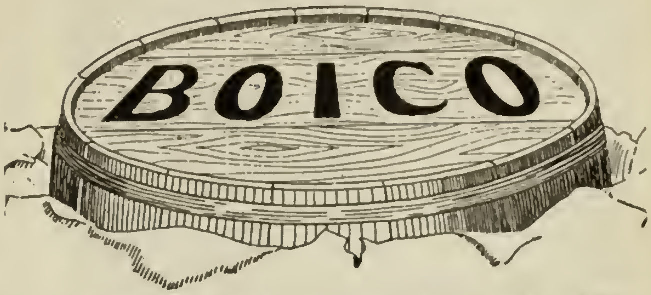
Sarco Co., Inc., New York.

Makes Short Work of Boiler Scale

In hundreds of plants BOICO has been adopted as the one sure clean-boiler insurance. The speed with which it removes the most stubborn scale formations is surprising. Hurts nothing but boiler scale. It's economical, too.

TRY IT FREE—let us send you a sample to convince you. Write us to-day—you've nothing to lose.

SHELL-BAR BOICO SUPPLY LTD.
1-15 SAUNDERS AVE. - TORONTO



SALES AGENTS: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ontario.

Why Individual Boiler Feed Water Treatment

Because the Condition of Each Individual Boiler Differs

We have demonstrated it to be the most successful method of freeing boilers of scale and stopping the further formation of scale-forming deposits or incrustations. Corrosion or pitting stopped at once by our scientific process which accomplishes the results desired.

"CLEAN ALL"

Indicates in a few words what the process does.

The Allen Feed Water Purifier Co., Limited (Sole Makers)
Distributors: William C. Wilson & Co., 21 Camden Street, Toronto
Phone Adel. 1054 or write for full particulars.

Power House

is a dominating factor in maintaining power plant efficiency in equipment and service

⁂

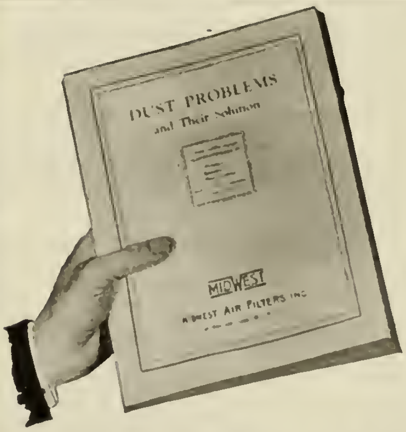
Every issue teems with advertising and editorial matter of a character that will keep YOU right up to the minute in power plant knowledge. Every issue is full of real worth while ideas.

Two Issues per Month

24 Issues (one year) $2.00

Special Offer

48 Issues (two years) $3.00


DUST PROBLEMS and Their Solution
MIDWEST
MIDWEST AIR FILTERS INC

Get
Your
Copy
of this
New
Handbook

YOU NEED CLEAN AIR

Not only for air compressor and internal combustion engine, but on the cooling-air system for turbo generators, transformers, etc.

MIDWEST AIR FILTERS

are the only reliable means of a steady supply of *clean* dust- and dirt-free air. Do you want to know how reasonable *insurance* against dust-made shut downs and power losses can be? Then

Ask Dept. F. 15 to Send You a Copy of this New Catalog

MIDWEST CANADA LIMITED
83 CRAIG ST., WEST MONTREAL, QUE.

"99 44/100 % Pure"

After testing out ordinary boiler feed water regulators in direct comparison with COPES, Procter & Gamble Company have placed another repeat order for 18 more Copes.

N. K. Fairbanks & Co., Colgate & Co., and the Larkin Co., Inc., also use COPES.

The highest standards of power plant efficiency are maintained at these great plants. So they use the boiler feed control that is

99 4/5% Accurate

24-hour tests which have been made, in actual service, show that the COPES gives smooth feeding that is accurate to 1/5 of one per cent.

The savings in fuel and labor, directly due to the accurate and reliable feeding of the COPES, pays back the cost of installation over and over again. Write for Catalog D, giving the facts.

Northern Equipment Co., 112 West 11th St., Erie, Pa.

BRANCH PLANTS:- Hamilton, Ontario, Canada; London, England; Paris, France; Merseburg, Germany; Vienna, Austria; Milan, Italy.

COPES

SYSTEM OF BOILER FEED CONTROL

TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and draft in last pass.

It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

Write for Bulletin CF-131.

THE FOXBORO CO., INC., Foxboro, Mass., U. S. A.

FOXBORO

REG. U.S. PAT. OFF.

THE COMPASS OF INDUSTRY

5323

GARLOCK

Main Canadian Offices and Factory
Hamilton - - Ontario

Montreal, Que. St. John, N.B.
Calgary, Alta. Winnipeg, Man.
Toronto, Ont. Vancouver, B.C.

PACKINGS

THE GARLOCK PACKING COMPANY

TRAPS, STEAM

Can. Sirocco Co., Ltd., Windsor, Ont.
Farrfhern Steam Services, Ltd., Toronto.
Laurie & Lamb, Montreal, Que.
Sarco Co., Inc., New York.
Fisher Governor Co., Inc., Marshalltown, Iowa.
Julian D'Este Company, Boston, Mass.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que

TRAPS, VACUUM

Anderson Co., Inc., V. D., Cleveland, Ohio.

TUBE CLEANERS, BOILER

Pilley Packing & Flue Brush Co., St. Louis, Mo.
Combustion Engineering Corp., Ltd., Toronto, Ont.
Babcock & Wilcox, Ltd., Montreal, Que.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal, Que.

TURBINE BLADING

De Laval Steam Turbine Co., Trenton, New Jersey.

TURBINES, STEAM

Coppus Engineering Corp., Worcester, Mass.
Laurie & Lamb Co., Montreal, Que.
E. Laurie & Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Arthur S. Leitch Co., Toronto.
Turbine Equipment Co., Ltd., Toronto, Ont.
Goldie & McCulloch Co., Ltd., Galt. Ont.

TURBINES, WATER

De Laval Steam Turhine Co., Trenton, New Jersey.

UNIONS & UNION FITTINGS

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVE OISK

Kerr Engine Co., Ltd., Walkerville, Ont.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, AIR

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, BACK PRESSURE

The Fisher Governor Co., Inc., Marshalltown, Iowa.
Underfeed Stoker Co., Ltd., Toronto.
Jenkins Bros. Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BALANCED

Julian D'Este Co., Boston, Mass.
The James Morrison Brass Mfg. Co., Toronto.

VALVES, BLOW-OFF

Arthur S. Leitch Co., Toronto.
Babcock & Wilcox, Ltd., Montreal, Que.
Homestead Valve Co., Homestead, Pa.
Jenkins Bros., Ltd., Montreal, Que.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, BRASS & IRON BODY

Reading Steel Casting Co., Bridgeport, Conn.
Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairhanks-Morse Co., Ltd., Montreal, Que.

VALVES, BYPASS

Kerr Engine Co., Ltl., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, CHECK

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, EXHAUST RELIEF

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Under-Feed Stoker Co., Ltd., Toronto.

VALVES FLOAT

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, GATE

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que

VALVES, GLOBE

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, HYORAULIC

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, NON-RETURN STOP

Babcock & Wilcox, Ltd., Montreal, Que.

VALVES, SAFETY POP

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, PUMP

Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, RADIATOR

Kerr Engine Co., Ltd., Walkerville, Ont.
Jenkins Bros., Ltd., Montreal, Que.

VALVES, REDUCING

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The Jas. Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, REGRINOING

Jenkins Bros., Ltd., Montreal, Que.

VALVES, REGULATING

Northern Equipment Co., Erie, Pa.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
The Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Underfeed Stoker Co., Ltd., Toronto.

VALVES, RELIEF

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.
Under-Feed Stoker Co., Ltd., Toronto.

VALVES, SAFETY

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
The James Morrison Brass Mfg Co., Toronto, Ont.
The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.

VALVES, STOP

Babcock & Wilcox, Limited, Montreal, Que.
Jenkins Bros., Ltd., Montreal, Que.
The James Morrison Brass Mfg Co., Ltd., Toronto, Ont.

VALVES, SUPER-HEATED STEAM

American Schaeffer & Budenburg Corp., Brooklyn, N. Y.
Reading Steel Casting Co., Bridgeport, Conn.
Jenkins Bros., Limited, Montreal, Que.
The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, THROTTLE

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VALVES, VACUUM

The James Morrison Brass Mfg. Co., Ltd., Toronto, Ont.

VENTILATION

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor. Ont.

WASHERS, AIR

Canadian Blower & Forge Co., Limited, Kitchener, Ont.
Can. Sirocco Co., Ltd., Windsor, Ont.

WATER COLUMNS

The James Morrison Brass Mfg. Co., Toronto, Ont.

WATER SOFTENING APPARATUS

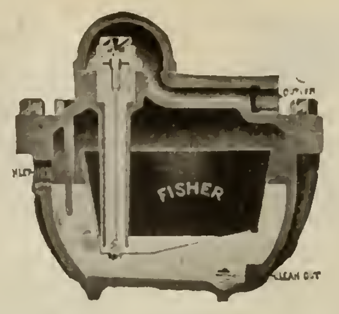
Laurie & Lamb Co., Montreal, Que.
De Laval Steam Turbine Co., Trenton, New Jersey.
Babcock & Wilcox, Ltd., Montreal, Que.
W. J. Westaway Co., Ltd., Hamilton, Ont

WHISTLES

The James Morrison Brass Mfg Co., Ltd., Toronto, Ont.

WRENOHES

The Canadian Fairbanks-Morse Co., Ltd., Montreal, Que.



Removes Every Drop of Water

LOSSES amounting to thousands of dollars each year, as well as many serious accidents, are caused where condensation is not properly drained from coils, pipe lines, separators or other apparatus.

Steam traps of many designs are used to remove the condensation. To be efficient they must remove all the water and discharge it as fast as it condenses. They too must avoid any discharge of steam pressure. This is exactly what the Fisher Steam Trap is designed to accomplish—and what it is accomplishing in the many plants where it is installed.

If your present trap is not in every detail satisfactory, you will make no mistake in installing a Fisher Trap.

Fisher Features

The Fisher Trap has many superior features. Valve seats can be changed instantly without disturbing pipe connections. Has intermittent discharge, eliminating wire drawing of valve seat. All parts extra heavy. Float made of cast iron, open bucket type, which is trouble proof. Lifts condensation two feet to each one pound pressure on the trap. It has many other features, too, in which you will be interested. Write for complete description.

The Fisher Governor Co.

951 Fisher Avenue - Marshalltown, Iowa

Agencies in all principal cities.

FISHER
TRADE MARK
REGISTERED

In the engine room of Dowswell, Lees & Co., Ltd., largest manufacturers of washing machines and wringers in the Dominion.

Still Going Strong

This pump was put in here fifteen years ago, and with no more than ordinary attention is still good for years to come.

There are many pumps made by Smart-Turner Machine Company that are older than this. Have you one?

The first pumps made by Smart-Turner Machine Company were built nearly a quarter of a century ago, and the records of the earliest manufacture have been destroyed.

If you have a Smart-Turner pump older than the one above, please write us, giving date of installation.

The Smart-Turner Machine Co.

LIMITED
HAMILTON - CANADA

Established 1907

POWER HOUSE

Member A.B.C.

B. G. NEWTON, Manager

CANADA—Toronto (head office): 153 University Ave., Tel. Ad. 5740
Montreal: L. C. Hazelton, 128 Bleury St., Tel. Plateau 946. Winnipeg:
810 Confederation Life Bldg., Tel. Main 3449.

S. S. MOORE, Advertising Manager

UNITED STATES—New York: J. J. Gillen, 1133 Broadway, Tel. Watkins 5869. Chicago: A. H. Byrne, 104 Federal Life Bldg., Tel. Dearborn 8694. Boston: C. L. Morton, Room 734 Old South Bldg., Tel. Main 1024.

GREAT BRITAIN—London: The MacLean Company of Great Britain Limited, 88 Fleet Street, E.C., E. J. Dodd, Director. Tel. Central 11960. Cable, Atabek, London, England.

Subscription Rate:—Canada and United States, $2.00; Great Britain and Countries in Postal Union, 14s. Australia and all other countries, 19s.

THE MACLEAN PUBLISHING COMPANY, LIMITED, 153 University Avenue, Toronto, Canada.
JOHN BAYNE MACLEAN, President. H. T. HUNTER, Vice-President. H. V. TYRRELL, General Manager.

INDEX TO ADVERTISERS

A
Audel, Theo. 39
Allen Feed Water Purifier Co... 45

B
Babcock-Wilcox & Goldie-McCulloch Co., Ltd.......... 18
Betson Plastic Fire Brick Co., Inc. 43
Brown Instrument Co. 43
Bristol Co. 10
Buyers' Directory 42, 44, 46
Bird Archer Co. 2
Burnett, J. A. 39
Bell Fire Brick Co. 43

C
Canadian Fairbanks-Morse Co., Ltd. 5
Conveyors Corp. of America.... 41
Combustion Engineering Co..... 13
Can. Allis Chalmers Co.....Inside Back Cover
Celite Products 9
Canadian Blower & Forge Co... 15
Coates, Wm. 40

D
Dart Union Co. 6
D'Este Co., Julian 15
De Laval Steam Turbine Co.... 8
Detroit Stoker Co.............. 7
Dominion Belting Co. 17
Dominion Engineering Agency.. 49
Dunham Co., C. A............ 37
Durabla Mfg. Co. 5

E
Engineering and Mach. Works of Canada 2
Edward Valve & Mfg. Co....... 16
Ever-Tyte Co. 40

F
Fisher Governor Co. 47
Foxboro Co., Inc. 46
Flexible Steel Lacing Co........ 37
Flexible Metallic Packing Co... 8
Farrfhern Steam Service....... 43
Farrow & Son, Geo............ 43

G
Garlock Packing Co. 46
Garth Co., The 41
Gutta Percha & Rubber Co..... 4
Gates Engineering Co. 37

H
Hays Corp., Jos. W............ 48
Homestead Valve Mfg. Co....... 12
Howden & Co., Limited, James 16

I
Irving Iron Works............. 12
Imperial Oil Co. 14

J
Jeffrey Mfg. Co. 3
Jamieson Cold Storage Door Co., Inside Front Cover
Jenkins Bros. ....Front Cover
Jointless Fire Brick Co. 15
Jones, T. S. 40

L
Leitch, Arthur S. 17

M
Morrison Brass Mfg. Co., Jas. Outside Back Cover
Midwest Canada, Ltd. 45
Moncrieff, Ltd. 43

N
Northern Equipment Co......... 46

P
Pilley Packing & Flue Brush Mfg. Co. 41

R
Rule, A. E. 43

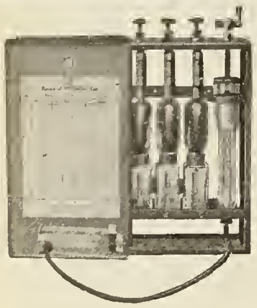
S
Superheater Co., Ltd........... 43
Sterne & Sons, G. F. 12
Sarco Co., Inc. 8
Sanford Riley Stoker Co....... 11
Shell Bar Boico Supply Co...... 45
Sterling Engine Co. 10
Stephens Chemical & Mfg. Co. Limited 48
Stephens, H. P. 43
Smart-Turner Machine Co., Ltd. 47
Sexton Boiler Setting Co., W. R. 17

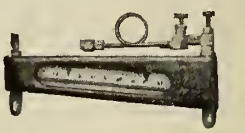
T
Thomson-Gordon, Ltd. 41

U
Underfeed Stoker Co. of Canada 11

W
Wall, W. J. 43
Waterous Engine Works Co..... 1
Watson & McDaniel Co. 41
Watson, M. Barry, M. E........ 39
Westco Mfg. Co. 41

Y
York Mfg. Co. 43
Young Pump Co. of Canada.... 6





Are You Wasting Fuel?

Numerous Canadian power plant men correctly answer that question by using the HAYS IMPROVED GAS ANALYZER. Rugged, portable, fast, accurate and INEXPENSIVE, it is the acknowledged leader of Flue Gas Analysis Instruments. Made in two styles. 3-chamber Analyzer for CO_2, O_2 and CO; 1-chamber Analyzer for CO_2 only. Stocked by Canadian Agents listed below.

Hays Improved Gas Analyzer.

HAYS DRAFT GAGES, "the fireman's compass," tell him how to regulate his damper, the condition of fires, baffles and settings. Write for your FREE copy of Jos. W. Hays' Treatise on "Drafts and Draft Regulation."

The Jos. W. Hays Corporation
Combustion Efficiency Appliances
Michigan City, Indiana

P. A. Goepel, Vancouver, B.C.
Wm. A. Goold, Winnipeg, Man.
The Arthur S. Leitch Co., Ltd., Toronto, Ont.

General Engineering Company, Regd., Montreal, Quebec.
H. N. Brown, New Glasgow, Nova Scotia.

Stephen's Boiler Feedwater Treatment

Don't endanger your boilers with old-fashioned, expensive methods which are often ineffective. You'll find that the Stephen's Feedwater Treatment is not only more economical but ensures the removal of old scale and prevents the formation of new scale in absolute safety.

Consult our engineers. They are always happy to discuss your feedwater problems in a practical way without obligation to you.

Stephen's Chemical Mfg. Co., Ltd., 2 Johnston St., Toronto, Canada

26

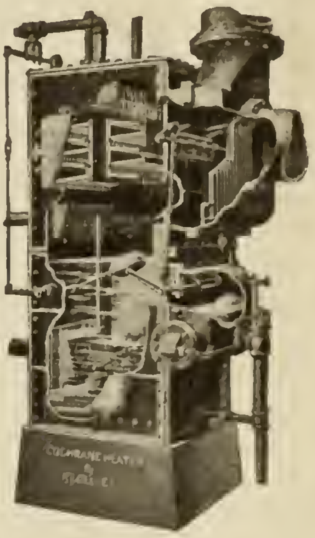
Increase Your Business By Reducing Production Costs

Locate, and thru the COCHRANE METHOD Stem the Tide of Waste in your Steam Power Plant

HEATING boiler feed water by means of exhaust steam effects a very considerable saving in fuel. The heat imparted to the water in the feed-water heater takes the place of an equivalent amount of heat from fuel on grates. If the water is heated from 60° to 210° F., the fuel saving amounts to approximately 14%, or 1% of fuel is saved for each 11° F. rise in the temperature of the water.

The importance of having the right kind of feed-water heater is shown by the fact that a difference of 1, 2, or 3% of the yearly fuel bill will, in most cases, cover the entire cost of a heater of any type.

The use of exhaust steam for heating the boiler feed water adds to the boiler steaming capacity; since, as part of the heat is supplied to the water in the heater, the boiler is able to make more steam with a given amount of heat supplied by the fuel. Roughly, six boilers and a Cochrane Heater will make as much steam with less fuel and labor, as seven boilers without a heater.



Cochrane Steam Stack and Cutout Valve Heater

Let Us Show You—Write for Bulletin 710

CANADIAN ALLIS-CHALMERS PRODUCTS
Hydraulic Turbines
Centrifugal and Steam Pumps
Steam Power Plant Equipment
Mining Machinery
Crushing and Cement Machinery
Flour and Saw Mill Machinery

CANADIAN ALLIS-CHALMERS LIMITED

Head Office—KING AND SIMCOE STREETS, TORONTO

BRANCH OFFICES: HALIFAX, SYDNEY, ST. JOHN, MONTREAL, QUEBEC, OTTAWA, HAMILTON, LONDON, WINDSOR, COBALT, SOUTH PORCUPINE, WINNIPEG, CALGARY, EDMONTON, VANCOUVER, NELSON AND VICTORIA

The James Morrison
Brass Manufacturing
Company cordially
extends to you

Best Wishes

for a

Merry Christmas

and

**Prosperous New
Year**

The James Morrison Brass Mfg. Co., Limited
93-97 ADELAIDE STREET W., TORONTO